STATE OF CONNECTICUT

NINETEENTH ANNUAL REPORT

OF

The Connecticut Agricultural Experiment Station

For 1895

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
THE TUTTLE, MOREHOUSE & TAYLOR PRESS
1896

CORRECTIONS.

Page 5. Among firms who have paid analysis fees to May 1, 1896 insert,

Danbury Fertilizer Co., Danbury, Conn.	Bone Meal. Nameless Fertilizer. Potato Manure.

Page 16. Fourth line from top, insert organic, before the word nitrogen and in the same line, for 18½, read 16½.

Page 41. The valuation of Sanderson's Old Reliable Phosphate, analysis No. 4800, should be $23.28 instead of $26.79, and the percentage difference, 28.8 instead of 11.9.

Page 102. Thirteenth line from top, for 11.4 read 13.4.

Page 105, pot No. 117. For weight of water-free Maize crop, read 141.58 instead of 145.58.

Page 146, in the table of Composition of Fertilizers, the per cent. of potash in cotton hull ashes should read 24.11 instead of 2.41.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1895.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXCELLENCY O. VINCENT COFFIN, *President.*

Appointed by Connecticut State Agricultural Society: — Term expires,

HON. E. H. HYDE, Stafford, *Vice-President.* — July 1, 1897

Appointed by Board of Trustees of Wesleyan University:

PROF. W. O. ATWATER, Middletown. — 1897

Appointed by Governor and Senate:

EDWIN HOYT, New Canaan. — 1898

JAMES H. WEBB, Hamden. — 1896

Executive Committee:

Appointed by Board of Agriculture:

T. S. GOLD, West Cornwall. — 1898

Appointed by Governing Board of Sheffield Scientific School:

W. H. BREWER, New Haven, *Secretary and Treasurer.* — 1896

Ex-officio.

S. W. JOHNSON, New Haven, *Director.*

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director.* — T. B. OSBORNE, PH.D.
E. H. JENKINS, PH.D., *Vice-Dir.* — A. W. OGDEN, PH.B.
A. L. WINTON, PH.B. — G. F. CAMPBELL, PH.B.

Mycologist.

WILLIAM C. STURGIS, PH.D.

Horticulturist.

W. E. BRITTON, B.S.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

MISS C. S. GREEN.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. — JULIUS KORN.

Sampling Agents.

C. L. BACKUS, Andover. — M. H. PARKER, So. Coventry.

Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Station Staff.

All Bulletins earlier than No. 71 and Nos. 83, 93, 101, 102 and 118 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887, 1891 and 1893.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the Annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

☞ By a recent Act of Legislature it is made the business of this Station to examine articles of food and drink on sale in Connecticut, with reference to their adulterations.

Here it may be stated that, *until further notice*, the Station will examine only such samples of food and drink as are collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in this State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*.

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications on Station business that requires immediate attention, therefore, should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.,

and all remittances should be made payable to the undersigned.

☞ Station Grounds, Laboratories and Office are on Suburban st., five minutes walk west from Whitney avenue and 1⅝ miles north of City Hall.

☞ Suburban st. may be reached by Whitney ave. Electric Cars, which leave the corner of Chapel and Church sts., five times hourly, viz: on the striking of the clock and at intervals of twelve minutes thereafter.

☞ The Station may also be reached by taking Winchester ave. Electric Cars, going north, which pass the Union R. R. Depot, and also start from corner Chapel and Church sts., at intervals of sixteen minutes. Get off at Harriet st., whence five minutes walk eastward, crossing Prospect st., and entering Suburban st. brings to the Station.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot, New Haven.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, two minutes walk from the line of the Manchester Electric Cars, leaving City Hall square, State st., Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. JOHNSON, *Director.*

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REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1895.

RECEIPTS.

	Oct. 1894 to June 1895.	July to Sept. 1895.	Total.
State Appropriation	$6,000.00	$2,500.00	$8,500.00
United States Appropriation	5,625.00	1,875.00	7,500.00
Analysis Fees due last fiscal year	617.96		617.96
Analysis Fees due this fiscal year	4,507.07	1,504.93	6,012.00
Miscellaneous Receipts	113.11		113.11
Balance from last account	18.13		18.13
Total Receipts	$16,881.27	$5,879.93	$22,761.20

EXPENDITURES.

	State Acc't.	U. S. Acc't.	Total.
Salaries*	$5,563.00	$5,600.00	$11,163.00
" †	1,897.50	1,875.00	3,772.50
Labor*	549.80		549.80
" †	28.05		28.05
Publications*	210.56		210.56
" †	106.93		106.93
Postage*	94.22		94.22
" †	45.10		45.10
Stationery*	68.83		68.83
" †	42.90		42.90
Freight and Express*	63.44		63.44
" " †	15.82		15.82
Coal*	554.05		554.05
Gas*	239.29		239.29
" †	46.75		46.75
Water*	147.00		147.00
Chemicals*	156.58		156.58
" †	295.93		295.93
Laboratory Supplies*	58.63		58.63
" " †	41.28		41.28
Agricultural Supplies*	51.90		51.90
" " †	12.00		12.00
Horticultural Supplies*	4.50		4.50
" " †	21.65		21.65
Botanical Supplies*	5.64		5.64
" " †	14.28		14.28

* For the 9 months, October 1st, 1894, to June 30th, 1895.
† For the 3 months, July 1st to September 30th, 1895.

	State Acc't.	U. S. Acc't.	Total.
Miscellaneous Supplies*	$58.87		$58.87
" " †	8.07		8.07
Fertilizers*	128.50		128.50
Feeding Stuffs*	80.90		80.90
" " †	24.79		24.79
Library*	378.52	$10.00	388.52
" †	115.83		115.83
Tools and Machinery*	18.35		18.35
" " †	24.70		24.70
Furniture and Fixtures*	24.71		24.71
" " †	46.30		46.30
Scientific Apparatus*	318.89	15.00	333.89
" " †	138.23		138.23
Live Stock*	140.00		140.00
Traveling Expenses of the Board*	5.65		5.65
" " " " †	38.77		38.77
" " " Staff, dairy Exp.*	28.80		28.80
" " " Tobacco Exp.*	63.75		63.75
" " " " †	24.54		24.54
" " " Field Exp.*	26.55		26.55
" " " " †	25.40		25.40
" " " Miscel. Work*	183.06		183.06
" " " " †	12.35		12.35
" " " Sampling Fer.*	234.99		234.99
" " " " †	3.45		3.45
Telephone*	147.42		147.42
" †	11.60		11.60
Tobacco Investigation*	140.43		140.43
" " †	286.72		286.72
Grass Investigation*	50.00		50.00
Field Experiments†	38.50		38.50
Miscellaneous Sundries*	50.67		50.67
" " †	52.20		52.20
Food Sampling†	11.74		11.74
New Buildings*	1,013.80		1,013.80
" " †	403.66		403.66
Betterments*	135.65		135.65
Repairs*	220.82		220.82
" †	208.39		208.39
	$15,261.20	$7,500.00	$22,761.20

The accounts of the treasurer were duly audited by the State Auditors of Public Accounts, on September 13th, for the first nine months, and for the remaining three months on December 3d, and after rendering the report for the United States fiscal year, the books of the treasurer were examined by an agent of the Secretary of Agriculture.

By Act of Congress, the Experiment Stations receiving appropriations from the United States are required to make treasurer's reports annually to the Secretary of Agriculture as to how the money received from that source has been expended, which reports are to be in accordance with a schedule prepared by the said Secretary and for the fiscal year of the United States. The Secretary of Agriculture makes the reasonable request that all the Stations having other sources of income, keep their books in accordance with the before mentioned schedule and furnish him with a full treasurer's report of the Station's total receipts and expenses.

* For the 9 months, October 1st, 1894, to June 30th, 1895.

† For the 3 months, July 1st to September 30th, 1895.

In complying with above requirement and request, it is necessary that the treasurer of this Station make two different annual reports, one to the United States Secretary of Agriculture and covering the United States fiscal year ending June 30th, and the other for the State fiscal year ending September 30th.

If the two reports of receipts and expenditures give the amounts for the respective years only as a whole, it is obvious that the figures in these reports will differ both in their totals and in their details, and consequently that their comparison and agreement could only be made by a study of the original books. The treasurer has therefore given in each report the figures for the nine months and the three months respectively, in order that their correlation and comparison may be easily made.

WM. H. BREWER, *Treasurer.*

Dec. 13th, 1895.

Report of the Board of Control.

To His Excellency, O. Vincent Coffin, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its report for the year ending October 31st, 1895.

Legislation affecting the Station.

The General Assembly at the January session, 1895, passed an Act making an appropriation to the Connecticut Agricultural Experiment Station, which added $2,000 to the annual appropriation made by the State, and provided besides the sum of $2,500 for better equipping and making additions to the laboratories, and for other specified objects.

The General Assembly also passed an Act regulating the manufacture and sale of food products which appropriated $2,500 annually to this Station, to execute the provisions of the law.

Copies of these acts will be printed with the Report of the Station staff, which is now in preparation.

Examination of Food Products.

Although the appropriation made in the Pure Food Bill does not become available until the first of November, 1895, the work of preparing for the execution of the law and of collecting and examining samples of food was early begun.

Nineteen samples of molasses, sixteen of sugar, twenty-one of maple syrup, eighteen of strained honey, forty-one of lard and forty of spices have been collected and examined or are in process of examination. The results of this work will be discussed in the Report on Foods, which will form part of the 20th annual Report of this Station for the year 1896.

The Fertilizer Control.

During the months of April, May and June, Messrs. C. L. Backus, of Andover, and M. H. Parker, of Coventry, agents of this Station, visited one hundred and six towns and villages, to inspect commercial fertilizers, and drew five hundred and fifty-five samples, representing one hundred and ninety-nine brands of commercial fertilizers.

Analyses of all these brands have been made in duplicate in the chemical laboratory by Messrs. Winton and Ogden, with the assistance of Mr. Lange, and manuscript copies of each analysis have been sent to the manufacturer and to the dealers.

No fraudulent fertilizers have been found in the State this year. A small number, of very inferior value, are annually offered, but usually disappear from the market after their analyses have been published.

The Work of the Chemical Laboratory.

Besides the work of analyzing food and of the fertilizer control just mentioned, Messrs. Winton and Ogden, with Mr. Lange's help, have analyzed two hundred and eight commercial fertilizers and manurial waste products, making the whole number of fertilizer analyses four hundred and seven.

To supplement horticultural work done by Mr. Britton, they have analyzed eight samples of lettuce, five of tomato vines, eight of tomato fruit, one of soil, one of chemicals, and one hundred and thirty-seven of crops grown in vegetation pots.

In connection with Station field experiments they have analyzed six samples of cow-pea plants, eighteen of potatoes, eight of corn and corn stover, and one hundred and sixteen of leaf tobacco.

Thirteen samples of feeds, one of vinegar, five of poultry feeds and fourteen of milk, have been analyzed in response to requests from citizens of the State. No record has been kept of the considerable number of determinations of fat in cream and milk, made for creameries, milk dealers and consumers. Fifteen determinations of nitric acid in soil decoctions were also executed.

Forty-eight samples of butter and molasses have been examined for the State Dairy Commissioner.

In connection with the tobacco experiment at Poquonock, daily determinations of moisture were made in the soil of the tobacco field, during the tobacco-growing season. The total number of determinations amounted to one hundred and forty-seven.

Two hundred and eighteen samples of seeds have been tested with regard to vitality by the laboratory staff.

A very considerable number of determinations have also been made in testing methods, on samples submitted by the Association of Official Agricultural Chemists, and in the preparation of a paper by Mr. Winton, on "Some Conditions Affecting the Accuracy of the Determination of Potash," published in the American Chemical Journal, Vol. XVII, No. 6.

Exclusive of these last mentioned, the total number of analyses made in the chemical laboratory during the year is eleven hundred and seventy-one.

Studies on the Vegetable Proteids.

The work done by Dr. Osborne, with the assistance of Mr. Campbell, may be summarized as follows:

The investigation of diastase, the sugar-forming ferment of sprouting seeds, has been continued and the results obtained are ready for the printer.

A study of the proteids of the potato has been completed.

The proteids of malt have been investigated and the changes of the proteids occurring during germination shown by a comparison with those of ungerminated barley investigated last year.

The proteid substances, described under the name conglutin, the chief nitrogenous constituents of a large number of cattle foods, have been investigated and the conflicting statements of earlier investigators have been cleared up. In this work the seeds of the peach, almond, walnut and hazel nut, have also been studied. These seeds, together with those already examined in this laboratory, have afforded a complete review of the subject of conglutin.

A similar study of the proteid at present known as legumin has been commenced and is well under way, several of the leguminous seeds having been already studied.

The Work of the Mycologist.

Dr. Sturgis, with the aid of Mr. W. H. Olcott at South Manchester, has carried out a field experiment to study the efficacy of the corrosive sublimate treatment of potato seed, where the land which is planted to potatoes is already fully infested with the potato-scab fungus.

In the same experiment the effect on the prevalence of this disease, of application of lime and of stable manure both fresh and composted, has been noted. This work is supplementary to that done last year on the same subject.

A field experiment on the land of Mr. Buckingham, of Southport, and a much smaller one on the Station grounds, have been made to determine how far transplanting onions (on smutty land) is practicable as a means of preventing smut, increasing the yield and hastening maturity.

An experiment on spraying apple trees has been made at Shaker Station.

Much time has also been spent in studies on a blight of melons which has been very destructive in some parts of the State, on a leaf-curl of plums, not hitherto described, on the powdery mildew of grapes, and the shot-hole fungus of plums.

Attention has also been necessarily directed to certain dangerous insect pests.

Specimens of wood sent by an orchardist living near New London from trees which were dying or dead, proved to be affected with the dreaded San José scale. Dr. Sturgis and Mr. Britton immediately visited the orchards, directed the course of treatment to keep the disease in check, till a winter treatment could be used to eradicate it, and a Bulletin was at once issued to call the attention of fruit growers to the subject.

Certain other insect injuries to fruit and ornamental trees have also been studied.

Horticultural Work.

Mr. Britton, with the coöperation of Dr. Jenkins, has made a study of the relative availability of different forms of organic nitrogen by vegetation experiments with corn and oats. In addition to the artificial soil used in 1894, two other soils have been used for this work; one a soil on which corn has been raised for five years in succession without fertilizers, the other from a pasture which has been uncultivated for at least thirteen years and has had no fertilizer for the last six years. These vegetation experiments, 137 in number, have been made in galvanized pots and were carried out during the summer season in a house built specially for such purposes.

During the winter a study was begun, in the forcing house, of the fertilizer requirements of the tomato and lettuce crops, and of the growth of these crops with fertilizer chemicals in artificial soils.

Field Experiments.

Under the supervision of Dr. Jenkins, two field experiments have been made to study the effect on the quality, as well as the quantity, of the potato crop, of applications of various potash salts, both with and without lime.

An experiment on bringing worn-out sandy land into arable condition, by the use of chemical fertilizers and leguminous crops, has been begun.

The extensive experiment on the effect of fertilizers on the quality and quantity of the tobacco crop, and the experiment on the growth of maize continuously on the same land, previously noticed in our reports, have been continued this year.

The Grass Garden.

Mr. J. B. Olcott has continued the study of native and foreign turf-making grasses in the Grass Garden at South Manchester. The garden has been considerably enlarged during the year by collections made in England, France, Denmark and Austria by Mr. Olcott.

Station Publications.

The eighteenth report of this Station, for the year 1894, a volume of 296 pages, has been issued in an edition of 12,000 copies, and the 7,000 copies at the disposal of this Station have been distributed, after satisfying our exchanges, among the farmers of Connecticut. Less than 25 copies remain in our hands.

A spraying calendar for the use of Connecticut farmers was issued during March in an edition of 1,800 copies.

Bulletin No. 120, on Analyses of Fertilizers, Trade Values of Fertilizer Ingredients for 1895, and Poultry Foods, containing sixteen pages, was issued in April in an edition of 4,000 copies.

Bulletin 121, on The Elm Leaf Beetle; and the San José Scale; containing sixteen pages, was issued in July, in two editions of 7,000 copies.

These Bulletins are republished in the Annual Report of Station Work for the year.

Attendance at Farm Institutes and other Farmers' Meetings.

In response to request, members of the Station staff have attended a considerable number of meetings of farmers during the year and read papers or made addresses. The time devoted to this work has been equivalent to twenty-four days' time of one man.

Correspondence.

During the year 1728 letters have been written by the Station staff and 885 manuscript reports of fertilizer and seed tests have been made.

New Buildings.

A forcing house, fifty feet long by twenty feet wide, with a potting room twenty-five feet by ten is now being built and will be used during the coming winter for further experiments on the fertilizer requirements of forcing-house crops.

Meetings of the Board.

During the year ending October 31, the Board of Control has held three meetings.

All of which is respectfully submitted.

WM. H. BREWER, *Secretary*.

Nov. 1st, 1895.

REPORT OF STATION WORK.

A general statement regarding the work done by the Station Staff is to be found on previous pages in the Report of the Board of Control to the Governor.

The following papers present a full and detailed account of the operations of the Station within the twelve-month ending October 31, 1895.

It has been found necessary to repeat annually certain statements regarding the fertilizer law and the explanations regarding the analysis and valuation of fertilizers.

FERTILIZERS.

More than 22,500 tons of Commercial Fertilizers are annually brought into Connecticut. This does not include the large quantities of cotton seed meal and cotton hull ashes used in the tobacco-growing sections, nor the unleached Canada ashes used generally throughout the State.

More than $700,000 are annually paid by Connecticut farmers for fertilizers.

In 1883, the year following the passage of the fertilizer law, 38 manufacturers entered 90 brands of fertilizers for sale in the State. The number of brands has increased steadily year by year, while the number of firms doing the fertilizer business has remained about the same.

During the season of 1895 the forty-seven manufacturing firms doing business in the State have entered two hundred and nine brands for sale. These include:

Special manures made for particular crops,	75 brands.
Other nitrogenous superphosphates,	89 "
Bone manures and bone and potash,	28 "
Chemicals, including tankage and castor pomace,	17 "
Total,	209

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, at its session in 1882, passed an Act concerning Commercial Fertilizers which, as amended by an act passed at the session in 1893, is still in force. Copies of those sections of the General Statutes of Connecticut which relate to commercial fertilizers may be had on application to the Station.

Attention is specially called to the following requirements:

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufactures of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid and Potash. The analysis-fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen and Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May, 1895.

Firm.	*Brand of Fertilizer.*
Alderman, G. B., Suffield, Conn.	Special Potato Fertilizer.
Armour Packing Co., Kansas City, Mo.	Fruit, Vegetable and Tobacco Special.
Baker, H. J. & Bro., 93 William St., New York City.	Special Corn Manure. Special Tobacco Manure. Castor Pomace. A. A. Ammoniated Superphosphate. Complete Onion Manure. Complete Potato Manure. Harvest Home Phosphate.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure. " " Grain Manure. " " Grass Top-Dressing and Forage Crop Manure. Stockbridge Special Potato and Vegetable Manure. Bowker's Hill and Drill Phosphate. " Farm and Garden Phosphate or Ammoniated Bone Fertilizer. " Potato Manure. " Tobacco Grower. " Sure Crop Bone Phosphate. " Market Garden Manure. " Bone and Potash, Square Brand.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top-Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Ground Bone and Potash, Circle Brand. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. " B. D. Sea Fowl Guano. " Original Coe's Superphosphate. " Farmer's New Method Fertilizer. " High Grade Tobacco Manure.

Firm.	*Brand of Fertilizer.*
Buckingham, C., Southport, Conn.	A No. 1 Fertilizer.
Chicopee Guano Co., 140 Maiden Lane, New York City.	A 1 Vegetable and Potato Manure. Farmer's Reliable.
Church, Daniel T., Tiverton, R. I.	Fish and Potash.
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Bay State Fertilizer. Bay State Fertilizer G. G. Potato Manure. Great Planet. Potato and Tobacco Fertilizer. King Philip Guano. Fine Ground Bone.
Cleveland Dryer Co., 92 State St., Boston, Mass.	Cleveland Superphosphate. " Potato Phosphate.
Coe Co., The E. Frank, 133-137 Front St., New York City.	E. Frank Coe's High Grade Potato Fertilizer. E. Frank Coe's High Grade Phosphate. " " Alkaline Bone. " " Ground Bone and Potash.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's Special Potato Manure. " Practical Ammoniated Superphosphate. " Ammoniated Wheat and Corn Superphosphate. " Vegetable Bone Superphosphate. " New Rival Ammoniated Superphosphate. " Pure Ground Bone. " Special Conn. Tobacco Manure. " Potato, Hop and Tobacco Phosphate. " Ammoniated Bone Superphosphate.
Cumberland Bone Phosphate Co., State St. and Merchants Row, Boston, Mass.	Cumberland Superphosphate. " Potato Fertilizer. " Fertilizer. " Concentrated Phosphate. " Ground Bone.
Darling Fertilizer Co., The L. B., Pawtucket, R. I.	Potato and Root Crop Manure. Animal Fertilizer. Garden and Lawn. Tobacco Grower. Fine Bone. Animal "G."
Downes & Griffin, Birmingham, Conn.	Ground Bone.

Firm.	Brand of Fertilizer.
Eastern Farm Supply Association, Montclair, N. J.	Carteret Long Island Special. " Market Garden Manure. " Potato Manure.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Bone Meal. " " " Superphosphate. Collier Castor Pomace.
Great Eastern Fertilizer Co., Rutland, Vermont.	Great Eastern General for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco. Great Eastern General. Soluble Bone and Potash.
Hartford Fertilizer Co., Hartford, Conn.	Bone Meal.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Success Fertilizer. Potato Manure. Special Potato Fertilizer. Special Tobacco Manure. Animal Bone and Potash. Ammoniated Dissolved Bone Phosphate. Standard Pure Bone Superphosphate. Crescent Bone Dust.
Ludlam, Frederick, 108 Water St., New York City.	Cereal. Cecrops or Dragon's Tooth.
Lyman, Chas. E., Middlefield, Conn.	Corn Manure. Potato Manure.
Mapes' Formula and Peruvian Guano Co., 143 Liberty St., New York City.	Potato Manure. Complete Manure for General Use. Fruit and Vine Manure. Corn Manure. Fine Bone Dissolved. Complete Manure for Light Soils or Vegetable Manure. Tobacco Starter. Grass and Grain Spring Top-Dressing. Complete Manure "A" Brand. Tobacco Manure. Wrapper Brand. Seeding Down Manure.
Mason, Chapin & Co., Providence, R. I.	Odorless Chemical Compound. Odorless Chemical Compound for Tobacco. Odorless Chemical Compound for Lawn and Grass. Homestead Chemical Compound. Homestead Chemical Compound for Tobacco. Homestead Chemical Compound for Lawn and Grass.

Firm.	Brand of Fertilizer.
Miles, G. W., Milford, Conn.	Ground Fish. IXL Ammoniated Bone Superphosphate.
Miller, Geo. W., Middlefield, Conn.	Unexcelled Phosphate. Ground Bone.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Wheat and Corn Producer. " Triumph. " Grass and Grain Grower. " Potato, Tobacco and Hop Fertilizer.
Nuhn, Frederick, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate. Red Seal Castor Pomace.
Pacific Guano Co., Boston, Mass.	Soluble Pacific Guano. Special Potato Manure. Special for Potatoes and Tobacco. Nobsque Guano. Fine Ground Bone. High Grade General Fertilizer. Pacific Fish and Potash.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, R. I.	Potato Fertilizer. Ammoniated Bone Superphosphate.
Quinnipiac Co., 92 State St., Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Market Garden Manure. " Grass Fertilizer. " Corn Manure. " Onion Manure. " Havana Tobacco Fertilizer. " Pure Bone Meal. " Dry Ground Fish. " Pine Island Phosphate. " Fish and Potash, Crossed Fishes Brand. Nitrate of Soda. Muriate of Potash. Double Manure Salts. Sulphate of Potash.
Read Fertilizer Co., Box 3121, New York City.	Read's Standard. High Grade Farmer's Friend. Fish and Potash. Vegetable and Vine.

Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., Middletown, Conn.	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Flour.
	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Meal.
	The Rogers & Hubbard Co's Strictly Pure Fine Bone.
	The Rogers & Hubbard Co's Oats and Top-Dressing Fertilizer.
	The Rogers & Hubbard Co's Soluble Potato Manure.
	The Rogers & Hubbard Co's Soluble Tobacco Manure.
	The Rogers & Hubbard Co's Grass and Grain Fertilizer.
	Fairchild's Corn Formula and General Crops.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone.
	Grass and Grain Fertilizer.
	Soluble Potato and General Crops.
	High Grade Fertilizer for Oats and Top-Dressing.
	Complete Fertilizer.
	High Grade Corn Fertilizer.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate.
	Formula A (Complete).
	Pulverized Bone and Meat.
	Blood, Bone and Meat.
	Fine Ground Bone.
	Muriate of Potash.
	High Grade Sulphate of Potash.
	Regular Sulphate of Potash.
	Nitrate of Soda.
	Sulphate of Ammonia.
	Dissolved Bone Black.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Superphosphate.
	" Fertilizer.
	" Potato and Tobacco Fertilizer.
	" Complete Manure.
	" Guano.
	" Ground Bone.
Walker, Stratman & Co., Pittsburgh, Pa.	Potato Special.
	Smoky City.
	Big Bonanza.
	Four Fold.
Wheeler, M. E. & Co., Rutland, Vermont.	High Grade Potato Manure.
	Electrical Dissolved Bone.
	Grass and Oats Fertilizer.
Wilcox, Leander, Mystic, Conn.	Potato, Onion and Tobacco Manure.
	Ammoniated Bone Phosphate.
	Complete Bone Superphosphate.
	High Grade Fish and Potash.

Firm.	*Brand of Fertilizer.*
Wilkinson & Co., 54 William St., New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., New York City.	Americus High Grade Special.
	" Ammoniated Bone Superphosphate.
	" Potato Phosphate.
	" Fine Wrapper Tobacco.
	" Corn Phosphate.
	" Potato and Tobacco Fertilizer.
	Dry Ground Fish Guano.
	Royal Bone Phosphate.
	Fish and Potash.
	Grass Manure.
	Pure Bone Meal.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Messrs. C. L. Backus of Andover and M. H. Parker of South Coventry, agents of this Station, visited one hundred and six towns and villages of Connecticut to draw samples of Commercial Fertilizers for analysis. These places were distributed as follows:

Litchfield County,	5
Hartford "	27
Tolland "	8
Windham "	11
New London "	9
Middlesex "	14
New Haven "	16
Fairfield "	16
	106

In these places the agents drew 555 samples, representing 199 brands of fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must be drawn in strict accordance with the Station's Instructions for Sampling, and must also be properly certified*, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

ANALYSIS OF FERTILIZERS.

During the year, 416 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 18.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers are Nitrogen, Phosphorus and Potassium. The other elements found in fertilizers, viz: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root-nodules, viz: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podacarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may readily take the form of ammonia, it has been termed *potential ammonia.*

Ammonia (NH_3) *and Nitric Acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen; 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, in which it exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-Soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced by acting on "insoluble" (or

* Prepared and revised by the Director.

"citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is therefore used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted, reduced* and *precipitated*, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops, in others the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate" and of similar dense mineral phosphates, as well as that of "bone-ash" and "bone-black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $50 per ton has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect on the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones which envelops it;

but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached wood-ashes it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend for their trade-value exclusively on the substances *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1895.*

The average Trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1894, were as follows :

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1895.

	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood and in mixed fertilizers	16½
in cotton seed meal	12
in fine bone and tankage	16
in fine-medium bone and tankage	14
in medium bone and tankage	11
in coarser bone and tankage	5
Phosphoric acid, water-soluble	6
citrate-soluble*	5½
of dry ground fine fish, bone and tankage	5½
of fine-medium bone and tankage	4½
of medium bone and tankage	3
of coarse bone and tankage	2
of fine ground fish, cotton seed meal, castor pomace and wood ashes	5
of mixed fertilizers insoluble in ammonium citrate	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as :

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,
Ground South Carolina Rock.	

* Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c.c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality, 18½ cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5¼ cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1895 the average selling price of Ammoniated Superphosphate and Guanos was $32.32 per ton, the average valuation was $23.37 and the difference $8.95, an advance of 38.2 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $37.33, the average valuation $27.94 and the difference $9.39 or 33.6 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

Uses and Limitations of Fertilizer Valuation.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

Agricultural Value of Fertilizers.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	9
Dried Blood	1
Horn and Hoof	1
Leather	5
Cotton Seed Meal	30
Castor Pomace	7

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Rock Phosphate	2
Odorless Mineral Guano	1
Dissolved Bone Black	4
Dissolved Rock Phosphate	11

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	2
Double Sulphate of Potash and Magnesia	3
Muriate of Potash	7
Saltpeter Waste	2

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	34
Tankage	11
Fish	8

MIXED FERTILIZERS.

Bone and Potash	8
Nitrogenous Superphosphates and Guanos	106
Special Manures	101

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	23
Wood Ashes	17
Home Mixtures	15
Muck	4
Marine Mud	2
Beef Scraps	1
Anthracite Ashes	1
Total	416

DESCRIPTION AND ANALYSES OF FERTILIZERS.*

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

4511. Sold by National Fertilizer Co., of Bridgeport, to S. E. Curtis, Stratford, and sampled by him.

4489. Sold by National Fertilizer Co., to T. J. Stroud, Shaker Station, and sampled by him.

4777. Sold for Quinnipiac Co. Boston. Stock of Olds & Whipple, Hartford.

4926. Stock of Olds & Whipple, Hartford. Sampled and sent by P. P. Hickey, Burnside.

4762. Sold by Read Co., of New York, to A. Wetmore, Litchfield, and sampled by Milo D. Beach, Litchfield.

4778. Sold by L. Sanderson, New Haven.

4629. Bought of New York broker by J. Norris Barnes, Yalesville, and sampled by him.

ANALYSES.

	4511	4489	4777	4926	4762	4778	4629
Moisture	.21	.94	2.10	4.25	1.26	1.77	2.05
Insoluble in water	.17	.20	.30	2.37	.21	.40	.00
Common Salt	.13	.20	.98	.79	.45	.99	.86
Sodium Sulphate	.27	.23	.37	2.12	.12	.27	.33
Sodium Nitrate	99.22	98.43	96.25	90.47	97.96	96.57	96.76
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Equivalent Nitrogen	16.37	16.24	15.88	14.92	16.15	15.93	15.95
Cost per ton	$50.00§	50.00	50.00	55.00	48.20†	50.00	39.60‡
Nitrogen costs cents per pound	15.2	15.4	15.7	18.4	14.9	15.7	12.5

* This chapter, pages 19 to 74, has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have been made by Messrs. Winton and Ogden with the constant assistance of Mr. Lange.

† Wholesale, at Litchfield. ‡ In car lot at Yalesville.

§ The prices given are regular retail rates unless otherwise stated.

Sample **4926** is of inferior quality. It contains several per cent. more of moisture, sand and other impurities than the other samples, and correspondingly less nitrogen.

The samples **4511** and **4489** were drier than the average, and in consequence the per cent. of nitrogen was higher. The others are of average quality, and the average retail price for the season has been about 15½ cents per pound of nitrogen.

Dried Blood.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or dark red in color, and rich in nitrogen that is quickly available to vegetation.

4544. Purchased of L. Sanderson, New Haven, for vegetation experiments. The material contained 13.40 per cent. of nitrogen and 1.54 of phosphoric acid and cost $40.00 per ton, making the cost of nitrogen 14.4 cents per pound.

Preparations of Leather.

As has been proved abundantly by experiment, leather, whether in its untreated state or steamed or roasted, and pulverized, has no value as a fertilizer. The State fertilizer law wisely forbids its use in any form as an ingredient of commercial fertilizers without explicit printed certificate of the fact, "such certificate to be conspicuously affixed to every package," etc.

The materials on which the following analyses were made were used in vegetation experiments to be described on following pages.

4565. Ground leather, imported from England, for use as a cheap "ammoniate" in mixed fertilizers. The method of manufacture is unknown. It is a brownish black powder, in appearance resembling dried blood. When pulverized it emits an odor of benzine.

4581. Hemlock-tanned sole leather.

4622. Steamed leather prepared from **4581** by heating over water in the autoclave for 1¾ hours at a pressure of 58 pounds to the square inch, and drying the gummy product in the water-bath.

4623. Roasted leather prepared from **4581** by heating the powdered leather at 240° C. for four hours.

4625. Dissolved leather. 148 grams of samples **4581** and 100 grams of oil of vitriol, sp. gr. 1.84, were heated gradually, with

constant stirring, till fumes of sulphurous acid appeared. Water was added and the mass digested, evaporated to dryness, and heated till sulphurous acid was evolved. Water was again added, the acid was nearly neutralized with carbonate of lime, and the whole dried on the water-bath.

Analyses.

	From England.	Sole Leather.	Steamed Leather.	Roasted Leather.	Dissolved Leather.
	4565	**4581**	**4622**	**4623**	**4625**
Nitrogen	7.39	6.76	6.21	8.54	2.81

Cotton Seed Meal.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal the hulls and the ground press-cake are mixed together.

Nitrogen alone has been determined in most of the samples whose analyses follow. In those cases the per cents. of phosphoric acid and potash given in the table are the averages derived from all the analyses of decorticated meal made in the last two years at this Station. The per cent. amounts of phosphoric acid and potash in clear cotton seed meal do not vary so much in different samples as to make their determination necessary in order to determine the general quality of the sample.

Two of the samples, **4604** and **4466**, consist of undecorticated meal, containing only about four per cent. of nitrogen. The purchase of this low grade meal, at present prices, is not economical.

The average cost of nitrogen per pound in the twenty-five samples was 11.2 cents; the lowest price paid was 8.6 cents, the highest 13.5.

Cotton seed meal has been by far the cheapest source of available nitrogen, during the past season. Experiments indicate that it is as rapidly and fully available as the best forms of animal matter. It has been extensively used this year in home-mixed fertilizers and has given perfect satisfaction.

ANALYSES OF COTTON SEED MEAL.

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
4508	Not stated	Station agent, from stock of S. D. Woodruff & Sons, Orange.	8.32	2.42	1.69	$18.50	**8.6**
4767	Noble Bennett, New Milford	Noble Bennett, New Milford	6.81	2.81	1.85	18.00	**9.7**
4665	Abner Hendee, New Haven	Station agent, stock of J. H. Webb, Hamden	7.16	2.81	1.85	18.75	**9.8**
4810	Olds & Whipple, Hartford	C. J. Dewey, stock of Wilbur Hills, Buckland	6.97	2.81	1.85	18.50	**9.8**
4708	James Perkins, Suffield	F. B. Hathaway, Suffield	6.98	2.81	1.85	18.50	**9.8**
4550	C. M. Cox & Co., Boston, Mass.	C. J. Dewey, Buckland	7.20	2.81	1.85	19.00	**9.9**
4765	B. C. Patterson, Torrington	Milo D. Beach, Litchfield	8.08	2.81	1.85	21.00	**10.0**
4811	August Pouleur, Windsor	L. L. Bedortha, Windsor	6.93	2.81	1.85	19.00	**10.2**
4498	Abner Hendee, New Haven	Station agent, stock J. H. Webb, Hamden	7.76	2.81	1.85	21.00	**10.4**
4707	W. S. Pinney, Suffield	S. Seymour, Windsor Locks	6.80	2.81	1.85	19.00	**10.5**
4569	F. L. Worthy & Co., Mittineague, Mass	David L. Brockett, Suffield	7.70	2.81	1.85	21.25	**10.7**
4503	H. K. Brainard, Thompsonville	E. N. Barnes, Thompsonville	7.08	2.81	1.85	20.50	**11.1**
4735	Abner Hendee, New Haven	H. C. C. Miles, Milford	7.00	2.81	1.85	21.00	**11.6**
4509	Not stated	S. E. Curtis, Stratford	6.96	2.81	1.85	21.00	**11.7**
4589	Olds & Whipple, Hartford	T. W. Lester, Windsor Locks	7.12	2.81	1.85	21.50	**11.7**
4583	Olds & Whipple, Hartford	Wm. S. Pinney, Suffield	6.38	2.81	1.85	19.00	**12.0**
4709	Olds & Whipple, Hartford	P. P. Hickey, Burnside	6.96	2.81	1.85	21.50	**12.0**
4570	F. L. Worthy & Co. Mittineague, Mass.	David L. Brockett, Suffield	6.55	2.81	1.85	20.00	**12.0**
4481	A. E. Arnold	Wm. W. Thompson, Warehouse Point	7.90	2.06	1.73	23.00	**12.1**
4495	R. A. Parker, Warehouse Point	Wm. W. Thompson, Warehouse Point	7.28	2.81	1.85	22.50	**12.2**
4522	Olds & Whipple, Hartford	H. V. Griffin, East Granby	6.96	2.81	1.85	22.00	**12.4**
4497	Not stated	S. E. Curtis, Stratford	6.56	2.81	1.85	21.00	**12.4**
4480	J. M. Williams, Manchester	W. H. Olcott, So. Manchester	6.87	3.15	2.01	23.00	**12.9**
4502	Olds & Whipple, Hartford	G. S. Phelps, Warehouse Point	6.79	2.81	1.85	23.00	**13.4**
4675	For Tobacco Experiment	Station agent	6.65	2.35	1.73	22.00	**13.5**
4604	N. C. Hall & Co., New Haven	James H. Webb, Hamden	4.0			15.00	
4560	F. A. Betts, New Haven		8.40	----	----	----	----
4466	Not stated	F. Ellsworth, Hartford	4.10	----	----	----	----
4494	Not stated	S. O. Griswold, Windsor	7.21	----	----	----	----
4591	Not stated	Miss M. A. Neale, Southington	8.59	----	----	----	----

CASTOR POMACE.

This is the ground residue of castor beans from which castor oil has been extracted. It is an excellent fertilizer, but extremely poisonous to animals, which often eat it greedily when the opportunity offers.

4893. Made by H. J. Baker & Bro., N. Y. From stock of Edmund Halliday, Suffield.

4738. Made by H. J. Baker & Bro. Sampled and sent by Francis Granger, East Granby.

4895. Made by Collier Co., St. Louis, Mo. Stock of F. Ellsworth, Hartford.

4545. Made by Collier Co. Stock of F. Ellsworth. Stock of 1894.

4894. Made by Red Seal Castor Oil Co., St. Louis, Mo. From stock of Olds & Whipple, Hartford.

4546. Made by Red Seal Castor Oil Co. From stock of Olds & Whipple. Stock of 1894.

4676. Bought of Bowker Fertilizer Co., Boston, for the Tobacco Experiment Co.

ANALYSES.

	4893	4738	4895	4545	4894	4546	4676
Nitrogen	4.56	4.42	5.50	4.78	4.78	4.98	5.04
Phosphoric Acid	1.71	----	1.69	----	1.87	----	4.18
Potash	1.16	----	.93	----	.93	----	1.81
Cost per Ton	$18.50		19.00		20.00		15.00
Nitrogen costs cents per pound	17		14.7		17.9		8.8

The per cents. of phosphoric acid and potash in sample 4676 are abnormally large for this material.

Castor Pomace is an expensive form of organic nitrogen at present prices and is used chiefly by certain tobacco growers who still prefer it to cotton seed meal. The Poquonock experiments indicate that cotton seed meal in equivalent quantity yields tobacco of the same quality in all respects as castor pomace, and at a much lower cost for fertilizers.

II. Raw Materials of High Grade Containing Phosphoric Acid as the Chief Valuable Ingredient.

Odorless Mineral Guano.

4499. This material, sold by the Forest City Ash Co., Boston, Mass., sampled and sent by T. J. Stroud, Shaker Station, is stated by the agents to be a Florida Soft Phosphate.

It contained 20.52 per cent. of phosphoric acid, of which 18.73 per cent. was insoluble in water and ammonium citrate.

Dissolved Bone Black and Dissolved Rock Phosphate.

Dissolved Bone Black.

Bone Black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black dried, and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

4780. Stock of L. Sanderson, New Haven.

4638. Stock of Leander Wilcox, sampled and sent by Lawrence Daily, East Windsor Hill.

4661. Sold by Mapes' F. & P. G. Co. in 1894.

4662. Sold by L. Sanderson in 1893. The two last were sent by Prof. C. J. Phelps, of the Storrs Agricultural College.

See table of analyses, page 26.

Dissolved Rock Phosphate or Acid Rock.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

The per cent. of phosphoric acid in a fertilizer multiplied by 2.18 gives the amount of tricalcium phosphate or so-called "bone phosphate," which figures in commercial transactions but does not signify that the phosphate is derived from bone.

4507. Made by Liebig Manufacturing Co., Cartaret, N. J. From stock bought by S. D. Woodruff & Sons, Orange.

4493. Made by Liebig M'f'g Co. Sample sent by manufacturer.

4513. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

4490. Sold by National Fertilizer Co. Sampled and sent by T. J. Stroud, Shaker Station.

4764. Read's Dissolved Bone. Made by Read Fertilizer Co., N. Y. Stock of A. Wetmore, Litchfield. Sampled and sent by Milo D. Beach, Litchfield.

4664. Sold by L. Sanderson, New Haven, from stock bought by J. H. Webb, Hamden.

4736. Sold by G. F. Taylor and Brush, New York City. Sampled and sent by H. C. C. Miles, Milford.

4628. Bought from New York broker. Sampled and sent by J. Norris Barnes, Yalesville.

4875. Electrical Dissolved Bone. Made by M. E. Wheeler & Co., Rutland, Vt. Sampled from stock of P. B. Moffit, Pomfret, and Wm. M. Owen, North Haven.

See table of analyses, page 26.

In acid rock phosphate available phosphoric acid has cost on the average very considerably less than in dissolved bone black. Those who have tried the acid phosphate in home-mixed fertilizers report very favorably, finding little or no trouble from caking or "setting" after mixing. There is no reason in the claim that the "available" phosphoric acid of the dissolved rock phosphates is any less valuable agriculturally than that of dissolved bone black. See further remarks on this subject, on pages 64 and 65.

III. Raw Materials of High Grade containing Potash.

High Grade Sulphate of Potash.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

4728. Sold by the Quinnipiac Co. Sampled from stock of Olds & Whipple, Hartford.

4670. Sold by L. Sanderson, New Haven. Sampled from stock bought by Conn. Tobacco Experiment Co.

(For analyses see table on page 28.)

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of potassium oxide. Besides

ANALYSES.

	4780	4638	4661	4662	4507	4493	4513	4490	4764	4664	4736	4628	4875
Soluble phosphoric acid	16.29	16.67	16.11	16.46	8.58	13.00	8.35	12.83	5.74	11.31	12.34	9.86	7.65
Reverted phosphoric acid	.32	none.	.37	1.08	6.34	2.92	6.85	2.93	7.02	2.78	2.67	5.92	6.35
Insoluble phosphoric acid	.06	none.	.06	.18	1.47	.15	2.01	1.15	1.43	.40	1.11	.60	.53
Cost per ton	$26.00	26.00	----	----	11.50*	----	15.00	18.00	16.20‡	----	13.00	10.20†	24.00
"Available" phosphoric acid costs per pound	7.8	7.8	----	----	3.9	----	4.9	5.7	6.1	----	4.1	3.3	8.6

* Car lot in Orange. † Car lot in Yalesville. ‡ Wholesale in Litchfield.

some 46–50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

4727. Sold by Quinnipiac Co., Boston. Sampled from stock of Olds & Whipple, Hartford.

4779. Sold by L. Sanderson, New Haven. Sampled from stock of Clifton Peck, Lebanon.

4672. Sold by L. Sanderson. Sampled from stock bought by the Conn. Tobacco Experiment Co.

(For analyses see table on next page.)

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

4701. Sold by Cumberland Bone Phosphate Co., Boston. Sampled and sent by D. C. Spencer, Saybrook.

4512. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

4892. Sold by Quinnipiac Co., Boston. Sampled from stock of O. S. Olmstead, Melrose.

4763. Sold by Read Fertilizer Co., N. Y. Sampled and sent by Milo D. Beach, Litchfield.

4666. Sold by L. Sanderson, New Haven. Sampled from stock bought by J. H. Webb, Hamden.

4506. Sampled from stock bought of a N. Y. broker by S. D. Woodruff & Sons, Orange.

4630. Sampled from stock bought of a N. Y. broker by J. Norris Barnes, Yalesville.

The analyses show the usual variations in composition. The Quinnipiac Co. has protested that analysis No. **4892** does not fairly represent the quality of the muriate sold by them, which contains a larger per cent. of potash than is shown by that analysis. The Station was unable to find other samples in market on which to make further analyses.

Potash in the sulphates, both high and low grade, has cost about one cent more per pound than in the muriates.

Analyses of Potash Salts.

	High grade Sulphates.		Double Sulphates.			Muriates.						
	4728	**4670**	**4727**	**4779**	**4672**	**4701**	**4512**	**4892**	**4763**	**4666**	**4506**	**4630**
Actual Potash	47.36	50.39	26.95	28.12	28.39	49.78	50.73	50.07	50.60	50.30	49.77	51.03
Equivalent Sulphate	87.6	93.2	49.9	52.0	52.5	....	....	....	....	....	....	....
Equivalent Muriate	....	....	....	....	....	78.6	80.1	79.0	79.9	79.5	78.6	80.6
Cost per ton	$55.00	50.00	32.00	30.00	30.00	45.00	41.00	45.00	46.20	42.50	41.60†	40.60*
Actual potash costs cents per pound	5.8	4.9	5.9	5.3	5.3	4.5	4.0	4.4	4.5	4.2	4.2	3.8

* Car lot in Yalesville. † Car lot.

Saltpeter Waste.

Two samples of this material, **4542** light-colored, and **4543** dark colored, both from stock of Taylor & Brush, New York City, were sent for analysis by A. E. Plant, Branford.

Analyses.

	4542.	**4543.**
Nitrogen as nitrate	Trace.	.16
Potash	3.80	3.52

The material is for the most part salt. The amount of potash in a ton of it can be bought in form of muriate for about $3.00.

IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is fully explained on page 16.

1. *Sampled by Station Agents.*

On pages 31 and 32 are tabulated twenty-five analyses of this class of bone manures.

In case a brand has sold at two or more different prices, the manufacturer's price, when known, has been used in calculating percentage difference.

Otherwise an average, or nearly average price forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The Hartford Fertilizer Co. protested that analysis No. **4890** did not fairly represent their goods and was made on goods manufactured in the previous season. Another sample of the same brand, No. **4924,** was accordingly drawn and analyzed. It proved to be quite similar to the other in chemical composition, but was mechanically much finer.

The Rogers & Hubbard Co. protested that analysis No. **4773** of their Strictly Pure Fine Bone did not fairly represent its mechanical condition, and that the same brand for the last six years had shown a much finer state of pulverization. Accordingly another sample of the same brand, No. **4923,** was drawn and analyzed. It proved to be considerably finer than the sample previously examined and agreed with the average of the analyses of the last six years.

Sample **4882** was sent as Nuhn's Self-Recommending Fertilizer. This brand, however, is understood to contain potash.

Cost and Valuation.

The average cost per ton of the twenty-four brands of bone manures analyzed has been $32.09, and the average valuation $31.03 per ton.

2. *Sampled by manufacturers ; and* 3. *Sampled by consumers.*

Sample **4889,** deposited at the Station by the manufacturer in compliance with the law, was analyzed to meet the requirement of the law which calls for an annual analysis of each brand. The sampling agents of the Station did not succeed in finding this brand on sale in the State.

The other samples described below were sent in by private parties and this Station is not responsible for the accuracy of the sampling. The Station holds, however, in each case a written certificate that the sample was drawn in accordance with its printed instructions.

2. *Sampled by Manufacturers.*

4889. Crescent Bone Dust. Made by Lister's Agricultural Chemical Works, Newark, N. J.

Bone Manures Sampled by Station Agent.

Station No.	Name or Brand.	Manufacturer.	Dealer	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Chemical Analysis.		Mechanical Analysis.			
									Finer than			
						Valuation exceeds cost.	Nitrogen.	Phos. Acid.	1/50 inch.	1/25 inch.	1/12 inch.	Coarser than 1/12 inch.
4899	Bone Meal.	Danbury Fertilizer Co., Danbury.	E. Baker, Green's Farms.	**$27.00**	$36.72	26.4	3.96	24.14	70	24	6	--
			Manufacturer.	30.00	----	----	----	----	--	--	--	--
4924	Bone Meal.	Hartford Fertilizer Co., Hartford.	Manufacturer.	**25.00**	32.56†	23.2	2.45	25.73	71	15	7	7
4898	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	H. M. Ives, West Cheshire.	**30.00**	36.38	17.5	3.08	26.55	70	20	10	--
4711	Peter Cooper's Bone.	Peter Cooper's Glue Factory, New York City.	George Beaumont, Wallingford.	**28.00**	29.93	6.4	2.22	27.68	52	15	16	17
4669	Peter Cooper's Bone.	Peter Cooper's Glue Factory, New York City.	George Beaumont, Wallingford.*	**28.00**	----	----	2.24	26.65	--	--	--	--
4613	Bone Meal.	Quinnipiac Co., Boston, Mass.	F. M. Raymond, Westport.	**30.00**	31.70	5.4	3.38	22.94	55	26	19	--
4775	Fine Ground Bone.	L. Sanderson, New Haven.	Clifton Peck, Lebanon.	**33.00**	34.48	4.2	4.16	24.64	44	33	23	--
4890	Bone Meal.	Hartford Fertilizer Co., Hartford.	Manufacturer.	**25.00**	26.06†	4.0	2.37	28.31	45	15	12	8
4712	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Treat & Clark, Orange.	**33.00**	34.30	3.7	2.06	27.99	70	18	12	--
4923	The Rogers & Hubbard Co.'s Strictly Pure Fine Bone.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	**30.00**	30.65†	2.1	3.98	22.67	45	23	24	8
4612	Fine Ground Bone.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	32.00	30.06	.2	3.77	19.24	59	29	12	--
			A. M. Clark, Scotland.	**30.00**	----	----	----	----	--	--	--	--
						Valuation equals cost.						
4902	The Rogers & Hubbard Co.'s Raw Knuckle Bone Meal.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	**37.00**	36.99	----	3.75	26.35	60	27	13	--

* From stock bought by the Tobacco Experiment Co.

† See note on page 30.

Bone Manures Sampled by Station Agent.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation. Cost exceeds Valuation.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phos. Acid.	Mechanical Analysis. Finer than $\frac{1}{50}$ inch.	Finer than $\frac{1}{25}$ inch.	Finer than $\frac{1}{12}$ inch.	Coarser than $\frac{1}{12}$ inch.
4774	The Rogers & Hubbard Co.'s Raw Knuckle Bone Flour.	The Rogers & Hubbard Co., Middletown.	S. E. Frisbie, Milford.	**$40.00**	$38.99	2.5	4.04	25.46	71	29	..	..
4535	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	J. P. Barstow & Co., Norwich.	39.00	----	----	----	----	..	..	..	..
			F. Ellsworth, Hartford.	**40.00**	38.47	4.0	5.60	23.19	53	30	17	..
4773	The Rogers & Hubbard Co.'s Strictly Pure Fine Bone.	The Rogers & Hubbard Co., Middletown.	Strong & Tanner, Winsted.	32.00	28.52†	5.1	4.18	21.21	28	34	32	6
			J. P. Barstow & Co., Norwich.	33.00	----	----	----	----	..	..	..	..
				30.00								
4897	Pure Ground Bone.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	W. W. Sheldon, So. Woodstock.	**36.00**	34.14	5.4	4.09	24.29	45	33	22	..
4614	Pure Ground Bone.	Rogers Mfg. Co., Rockfall.	Manufacturer.	**30.00**	28.29	6.0	4.34	20.39	25	36	36	3
4781	White Oak Pure Ground Bone.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck.	**31.00**	29.09	6.6	2.60	22.86	56	24	17	3
4882	Self-Recommending Fertilizer.	Frederick Nuhn, Waterbury.	Apothecaries Hall Co., Waterbury.	**32.00**	29.03†	10.2	3.66	24.18	47	15	12	26
4769	Bone Meal.	Williams & Clark Fertilizer Co., New York City.	D. B. Wilson, Waterbury.	**34.00**	30.68	10.8	3.18	23.14	49	29	22	..
4771	Pure Ground Bone.	Downs & Griffin, Birmingham.	F. L. Hallock & Co., Birmingham.	**35.00**	30.32	15.4	4.02	22.99	38	27	27	8
4903	Fine Ground Bone.	Standard Fertilizer Co., Boston, Mass.	J. W. Howe & Son, South Glastonbury.	**35.00**	29.56	18.4	3.90	19.87	49	27	24	..
4710	Pure Ground Bone.	Peck Bros., Northfield.	D. B. Wilson, Waterbury.	30.00	22.69	23.4	4.28	21.07	8	23	41	28
			Strong & Tanner, Winsted.	30.00	----	----	----	----	..	..	..	..
				28.00								
4891	Fine Ground Bone.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	**35.00**	24.28	44.1	2.28	18.17	59	24	17	..
4896	Extra Fine Ground Bone.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	**36.00**	20.91	72.1	2.16	15.67	55	21	24	..

† See note on page 30.

3. *Sampled by Consumers.*

4647. Bone Meal. Made by the Danbury Fertilizer Co., Danbury. Sampled and sent by S. D. Woodruff & Sons, Orange. The manufacturer protested that this sample was from old stock which had been in Messrs. Woodruff & Sons' possession since the previous year and did not therefore represent their output of 1895.

4537. Bone Meal. Made by L. F. Frisbee & Co., Hartford. Sampled and sent by S. M. Wells, Wethersfield.

4532. Pure Ground Bone, made by the Rogers Manufacturing Co., Rockfall. Sampled and sent by S. A. Smith, Clintonville.

4737. Finely Ground Steamed Bone, sold by Geo. F. Taylor & Brush, New York City. Sampled and sent by H. C. C. Miles, Milford.

4541. Ground Bone, sold by G. F. Taylor & Brush. Sampled and sent by A. E. Plant, Branford.

4627. Fine Bone, bought of a New York broker by J. Norris Barnes, Yalesville.

Mechanical Analyses.

	4889	4647	4537	4532	4737	4541	4627
Fine, smaller than $\frac{1}{50}$ inch	62	44	52	65	70	82	79
Fine medium, smaller than $\frac{1}{25}$ inch	19	33	16	18	23	12	19
Medium, smaller than $\frac{1}{12}$ inch	11	23	11	12	6	5	2
Coarse, larger than $\frac{1}{12}$ inch	8	0	21	5	1	1	0
	100	100	100	100	100	100	100

Chemical Analyses.

Nitrogen	2.74	3.94	3.54	2.83	2.82	3.00	2.06
Phosphoric acid	15.16	21.07	25.56	27.21	26.99	26.29	30.22
Cost per ton	$....	29.00	25.00	28.00†	24.00	....	25.60*
Valuation per ton	$22.21	30.56	31.21	34.54	36.01	36.74	38.18

Tankage.

This name is applied to the sediment remaining in tanks where meat scrap and bone are cooked with water to separate the fat. After boiling or steaming, the fat rises to the surface and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage. As the analyses show, "tankage" has no definite or constant composition. In general it contains more nitrogen and less phosphoric acid than bone.

* Car lot in Yalesville. † Several ton lot.

Sampled by Station Agent.

4770. Armour's Special. Made by Armour Packing Co., Kansas City. From stock of F. C. Vibert, Hockanum.

4772. Bone Fertilizer, made by Plumb & Winton, Bridgeport. From stock of H. P. Folley, Danbury.

4547. Pulverized Tankage. Sold by L. Sanderson, New Haven.

4776. Blood, Bone and Meat. Sold by L. Sanderson, New Haven. From stock of Clifton Peck, Lebanon.

Sampled by Private Individuals.

4510. Tankage. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

4531. Tankage. Made by Plumb & Winton, Bridgeport. Sampled and sent by Dennis Fenn, Milford.

4761. Tankage. Sold by Read Fertilizer Co., New York City. Sampled and sent by Milo D. Beach, Litchfield.

4921. Tallow Scrap. Made by J. Maloney, East Haven. Sampled and sent by N. A. Haight, Fair Haven.

MECHANICAL ANALYSES.

	4770	4772	4547	4776	4510	4531	4761	4921
Fine, smaller than $\frac{1}{50}$ inch	65	57	60	64	52	65	61	52
Fine medium, smaller than $\frac{1}{25}$ inch	25	29	31	25	27	24	20	27
Medium, smaller than $\frac{1}{12}$ inch	10	14	9	11	15	11	14	14
Coarse, larger than $\frac{1}{12}$ inch	0	0	0	0	6	0	5	7
	100	100	100	100	100	100	100	100

CHEMICAL ANALYSES.

	4770	4772	4547	4776	4510	4531	4761	4921
Nitrogen	6.96	4.98	5.10	6.01	8.87	5.41	6.62	7.17
Phosphoric acid	11.62	18.61	18.49	14.88	7.29	14.40	15.30	9.61
Cost per ton	$37.00	30.00	35.00	33.00	28.00	30.00	24.20*	30.00
Valuation per ton	$32.50	32.79	33.61	32.79	33.12	30.54	33.63	28.98

DRY GROUND FISH.

This residue from the extraction of fish oil is often sprinkled with diluted oil of vitriol to hinder decay during drying, and the fish bones are as a result softened and to some extent dissolved.

* Wholesale at Litchfield.

4514. Made by G. W. Miles, Agent, Milford. Sampled by L. & S. T. Merwin, Milford.

4760. Made by G. W. Miles, Agent. Sampled from stock of Olds & Whipple, Hartford.

4878. Sold by the Quinnipiac Co., Boston. Stock of Edmund Halliday, Suffield.

4548. Sold by L. Sanderson, New Haven, to the Station.

4671. Sold by L. Sanderson, to the Conn. Tobacco Experiment Co.

4639. Made by Leander Wilcox, Mystic. Sampled from stock of Lawrence Dailey, East Windsor Hill.

ANALYSES.

	4514	4760	4878	4548	4671	4639
Nitrogen as ammonia	.80	1.28	.46	.16	----	.16
Organic nitrogen	6.83	5.84	7.30	9.35	----	8.83
Total nitrogen	7.63	7.12	7.76	9.51	9.26	8.99
Water-soluble phosphoric acid	.88	.51	.64	.51	----	.74
Citrate-soluble (reverted) phosphoric acid	5.35	6.56	4.31	5.70	----	5.98
Insoluble phosphoric acid	1.82	.48	3.07	1.08	----	1.17
Total phosphoric acid	8.05	7.55	8.02	7.29	7.36	7.89
Cost per ton	$30.00	38.00	35.00	35.00	35.00	34.00
Valuation per ton	$33.17	32.03	32.53	38.75	----	37.67

MIXED FERTILIZERS.

Here are included all those fertilizers which have been compounded of two or more fertilizer chemicals or animal matters to make a mixture which usually contains the three fertilizer ingredients, nitrogen, phosphoric acid and potash.

BONE AND POTASH.

(See also certain mixtures of bone and potash with other chemicals referred to on page 49.)

4607. Bone and Potash, Square Brand. Made by the Bowker Fertilizer Co., Boston. Stock of Geo. Punzelt, Darien, and J. A. Paine, Danielsonville.

4606. Extra Fine Bone with Potash, Circle Brand. Made by Bradley Fertilizer Co., Boston. Stock of Raymond Bros., So. Norwalk.

4713. A. I. Fertilizer. Made by C. Buckingham, Southport. Stock of N. H. Sherwood, Southport.

C. Buckingham protested that this analysis of his A. I. Fertilizer was lower than the average of the goods, which were guaranteed to contain 4 per cent. of nitrogen, 10 of phosphoric acid and 6 of potash. A second sample, No. **4859**, was therefore drawn from stock in Mr. Buckingham's possession.

4859. A. I. Fertilizer. Made by C. Buckingham, Southport. Sampled from stock of manufacturer.

4605. Ground Bone and Potash, made by the E. Frank Coe Co., New York City. Sampled from stock of E. S. Banks, Southport.

4865. Nameless Fertilizer made by the Danbury Fertilizer Co., Danbury. Sampled by Station agent from stock at the factory.

MECHANICAL ANALYSES.

	4607	4606	4713	4859	4605	4865
Fine, smaller than $\frac{1}{50}$ inch	68	60	72	68	57	76
Fine medium, smaller than $\frac{1}{25}$ inch	18	26	10	22	18	20
Medium, smaller than $\frac{1}{12}$ inch	13	14	7	8	14	3
Coarse, larger than $\frac{1}{12}$ inch	1	0	11	2	11	1
	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	1.94	2.53	2.82	3.30	2.13	4.06
Phosphoric acid	14.62	18.65	13.59	15.07	16.66	9.26
Potash, as Muriate	2.45	1.98	.60	3.21	2.27	4.76
Potash, as Sulphate			5.56	1.95		
Potash, Total	2.45	1.98	6.16	5.16	2.27	4.76
Cost per ton	$32.00	33.00	35.00	35.00	26.00	30.00
Valuation per ton	$22.48	27.50	27.56	29.90	23.18	26.00

The two following samples, though sold under the name "Bone and Potash," contain only a quarter of one per cent. of nitrogen and therefore their brand is misleading:

4873. Soluble Bone and Potash, made by the Great Eastern Fertilizer Co., Rutland, Vt. Sampled from stock of E. T. Bates, Darien, and Silas Finch, Greenwich.

4714. Animal Bone and Potash, made by Lister's Agricultural Chemical Works, Newark, N. J. Sampled from stock of A. N. Clark, Milford.

ANALYSES.

	4873	4714
Water-soluble phosphoric acid	5.36	6.72
Citrate-soluble (reverted) phosphoric acid	4.51	2.05
Insoluble phosphoric acid	1.81	.38
Total phosphoric acid	11.68	9.15
Potash, as muriate	2.01	5.28
Cost per ton	$25.00	26.00
Valuation per ton	13.92	15.22

II. NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 40 to 47 are tabulated the analyses of seventy-seven brands, made on samples collected by the Station agents.

ANALYSES REQUIRING SPECIAL NOTICE.

The Eastern Farm Supply Association, Montclair, N. J., protested that analysis **4693**, Long Island Special, and **4694**, Carteret Market Garden Manure, did not represent the average quality of these brands.

A re-test confirmed the accuracy of the Station analysis. It was not possible to get another sample of L. I. Special, but a second sample of the Market Garden Manure was analyzed and is **4906** in the table of analyses, page 40.

The Clark's Cove Fertilizer Co. protested that analysis **4743** was below their guarantee on all three ingredients. "We are positive that we have not sent goods of this grade into the market." A re-test confirmed the accuracy of our analysis. A second sample was, however drawn and analyzed, **4910**, and is given in the table, page 40. The second sample proved to be of much better quality.

The National Fertilizer Co. of Bridgeport requested another analysis of their Fish and Potash, **4849**, as the quantity of nitrogen in that sample was much lower than they expected the goods to contain.

A second analysis, **4915**, was made, see page 42, which showed .4 per cent. more nitrogen, 1.6 more phosphoric acid and 1.4 per cent. less potash.

GUARANTEES.

Of the seventy-six analyses of nitrogenous superphosphates, in the table given on pages 40 to 47, twenty-one are below the maker's minimum guarantee in respect of one ingredient, five in respect of two and one in respect of all three ingredients. Thus more than one-third of the whole number do not fulfill in all respects the maker's claim for them.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods, the actual analysis should not fall below the minimum guaranteed in any respect, particularly when wide limits are allowed in the guarantees themselves.

COST AND VALUATION.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 16.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information enables the purchaser to estimate the relative value of the different brands and the relative economy of buying mixed fertilizers, or of procuring and compounding the materials needful for a fertilizer.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an *average, or nearly average price* forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is $32.32. The average valuation is $23.37, and the percentage difference 38.2.

Last year the corresponding figures were:

Average cost $32.96, average valuation $23.30, percentage difference 41.3.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are readily available to farm crops. Chemical examination can show pretty conclusively whether this is true in respect of potash. There is less certainty regarding phosphoric acid, while chemical examination, as it is usually made, gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years engaged in a study of methods for determining approximately the relative availability of nitrogen, and on subsequent pages is given a report of the work done during the past year on this point.

While various inferior or agriculturally worthless forms of nitrogen are in the market, the main security of purchasers of mixed fertilizers is in dealing with firms which have an established reputation and in avoiding "cheap" goods offered by irresponsible parties.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4745	Potato and General Crop Fertilizer.	Chas. E. Lyman, Middlefield.	Manufacturer.	**$26.00***
4906	Market Garden Manure.	Eastern Farm Supply Association, Montclair, N. J.	Paul Thompson, West Hartford.	**32.00**
4744	Bone, Fish and Potash.	E. R. Kelsey, Branford.	Samuel A. Chalker, Saybrook.	**25.00**
4785	Unexcelled Phosphate.	Geo. W. Miller, Middlefield.	Manufacturer.	**30.00**
4800	Old Reliable Superphosphate.	L. Sanderson, New Haven.	C. O. Jelliff & Co., Southport.	**30.00**
4756	Pure Fine Bone, Dissolved in Sulphuric Acid.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	Mapes' Branch, Hartford.	**32.00**
4693	Carteret L. I. Special.	Eastern Farm Supply Association, Montclair, N. J.	N. H. Sherwood, Southport.	32.00 **34.00**
4749	Formula "A."	L. Sanderson, New Haven.	C. O. Jelliff & Co., Southport. Clifton Peck, Lebanon. Ira W. Beers, Hamden. J. Pierpont, North Haven.	**35.00** 36.00 35.00 35.00
4797	Ammoniated Dissolved Bone.	Williams & Clark Fertilizer Co., N. Y. City.	T. C. Greene, Torrington.	**26.00**
4750	Quinnipiac Market Garden Phosphate.	Quinnipiac Co., Boston, Mass.	A. P. Wakeman, Fairfield.	**36.00**
4829	IXL Ammoniated Bone Superphosphate.	Geo. W. Miles, Milford.	Manufacturer.	**26.00**
4725	Vegetable Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Meeker Coal Co., Norwalk.	**38.00**
4679	Market Garden Phosphate.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark & Sons, Milford. Geo. Punzelt, Darien.	**36.00** 36.00
4716	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	W. W. Cooper, Suffield. F. S. Bidwell, Windsor Locks.	36.00 **35.00**
4806	High Grade Fish and Potash.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	**32.00**
4696	Complete Manure for Light Soils.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford. Geo. K. Nason, Willimantic. Birdsey & Foster, Meriden. Dean & Horton, Stamford.	**42.00** 44.00 43.00 43.00
4658	Complete Manure, A Brand.	Mapes' F. & P. G. Co., N. Y. City.	Birdsey & Foster, Meriden. F.S. Bidwell, Windsor Locks. Quinnebaug Store, Danielsonville.	36.00 36.00 36.00 **35.00**
4759	Special Phosphate.	Olds & Whipple, Hartford.	Manufacturer.	**35.00**
4717	Animal Fertilizer, "G" Brand.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks. Treat & Clark, Orange.	33.00 29.00 **31.00**
4910	Great Planet "A."	Clark's Cove Fertilizer Co, Boston, Mass.	H. A. Rogers & Co., New London.	**38.00**
4694	Cartaret Market Garden Manure.	Eastern Farm Supply Association, Montclair, N. J.	N. H. Sherwood, Southport.	**32.00**
4653	Complete Manure for General Use.	Mapes' F. & P. G. Co., N. Y. City.	Geo. K. Nason, Willimantic. Birdsey & Foster, Meriden. F.S. Bidwell, Windsor Locks. Dean & Horton, Stamford.	40.00 **39.00** 40.00 39.00

* The full-face figure is the one used in calculating the percentage difference.

Analyses.

Station No.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen, Organic.	Nitrogen: Total Nitrogen: Found.	Nitrogen: Total Nitrogen: Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total: Found.	Phosphoric Acid: Total: Guaranteed.	Phosphoric Acid: Available: Found.	Phosphoric Acid: Available: Guaranteed.	Potash: Found: As Muriate.	Potash: Found: Total.	Potash: Guaranteed.
4745	$28.38	†8.3	----	----	2.47	2.47	*2.5*	3.66	5.70	1.23	10.59	----	9.36	*10.0*	10.09	10.09	*10.0*
4906	*30.56	4.7	----	2.70	1.48	4.18	*3.3*	3.15	4.86	.82	8.83	*8.0*	8.01	*7.0*	1.03	6.08	*7.0*
4744	23.32	7.2	----	.64	3.06	3.70	*3.3*	2.43	2.43	.23	5.09	*4.0*	4.86	----	.60	5.01	*4.0*
4785	27.95	7.3	----	----	2.16	2.16	*1.5*	4.27	6.58	1.39	12.24	*11.5*	10.85	----	8.79	8.79	*8.0*
4800	26.79	11.9	.13	----	2.39	2.52	*1.7*	4.75	5.29	1.65	11.69	*10.0*	10.04	*7.0*	3.13	3.13	*2.0*
4756	27.64	15.7	----	----	2.40	2.40	*2.1*	6.48	10.72	.38	17.58	----	17.20	*12.0*	----	----	----
4693	*28.91	17.6	----	----	3.26	3.26	*3.5*	4.80	4.50	.61	9.91	*8.5*	9.30	*7.5*	8.00	8.00	*8.0*
4749	29.50	18.6	.50	.59	2.93	4.02	*3.3*	3.01	5.27	2.36	10.64	*10.0*	8.28	*6.0*	6.44	6.44	*6.0*
4797	21.84	19.0	----	----	2.08	2.08	*1.7*	4.56	6.22	2.06	12.84	*9.0*	10.78	*8.0*	2.06	2.06	*2.0*
4750	30.03	19.9	.59	1.30	1.75	3.64	*3.3*	5.20	4.06	1.61	10.87	*9.0*	9.26	*8.0*	4.47	6.66	*7.0*
4829	21.59	20.4	----	.94	2.04	2.98	*2.1*	4.88	1.94	2.61	9.43	*9.0*	6.82	*8.0*	2.61	2.61	*2.0*
4725	31.19	21.8	1.05	----	4.33	5.38	*5.0*	4.96	1.70	.27	6.93	*6.0*	6.66	*5.0*	6.47	6.47	*6.0*
4679	29.22	23.2	1.23	----	1.61	2.84	*2.5*	6.24	3.10	2.98	12.32	*8.0*	9.34	*8.0*	9.03	9.03	*10.0*
4716	28.31	23.6	.30	.15	2.85	3.30	*3.0*	2.51	8.33	2.43	13.27	*10.0*	10.84	*6.0*	4.78	4.78	*4.0*
4806	25.66	24.7		.41	3.81	4.22	*3.3*	2.83	3.84	.31	6.98	*6.0*	6.67	*5.0*	4.25	4.25	*4.0*
4696	33.65	24.8	1.51	1.24	2.42	5.17	*4.9*	5.07	3.54	.40	9.01	*8.0*	8.61	*6.0*	7.12	7.12	*6.0*
4658	27.28	28.2	.45	.22	2.28	2.95	*2.5*	6.16	6.41	.61	13.18	*12.0*	12.57	*10.0*	3.24	3.24	*2.5*
4759	27.18	28.7	----	.07	3.06	3.13	*3.0*	6.68	5.27	1.58	13.53	*10.0*	11.95	*9.0*	.40	2.31	*2.0*
4717	23.92	29.5	----	.14	2.51	2.65	*1.7*	1.41	7.79	1.88	10.08	*7.0*	9.20	----	4.57	4.57	*4.0*
4910	*29.33	29.6	1.32	----	2.52	3.84	*3.3*	5.04	3.53	2.22	10.79	*9.0*	8.57	*8.0*	6.92	6.92	*7.0*
4694	*24.47	30.7	----	.60	1.84	2.44	*3.0*	3.95	6.11	1.01	11.07	*8.0*	10.06	*7.0*	4.80	4.80	*7.0*
4653	29.42	32.5	.91	.58	2.25	3.74	*3.3*	5.18	6.01	.64	11.83	*10.0*	8.92	*8.0*	4.47	4.47	*4.0*

* See note, p. 37.

† Valuation exceeds cost.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4827	Harvest Home.	H. J. Baker & Bro., N. Y. City.	S. J. Hall, Meriden.	**$27.00**
4533	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	**38.00**
4813	Standard Complete.	Standard Fertilizer Co., Boston, Mass.	I. H. Bushnell, Jewett City.	**39.00**
4791	High Grade General Fertilizer.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River.	**40.00**
4807	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic.	Browning & Gallup, New London. Mandy Gray, Poquetanuck.	34.00 32.00 **33.00**
4821	Fish and Potash, Triangle "A" Brand.	Bradley Fertilizer Co., Boston, Mass.	S. A. Billings, Meriden.	**30.00**
4805	Complete Bone Superphosphate.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	**31.00**
4618	Complete Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	**35.00**
4636	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., N. Y. City.	E. White, Rockfall. C. O. Jelliff & Co., Southport.	40.00 34.00 **35.00**
4864	Ammoniated Bone Superphosphate.	Preston Fertilizer Co., Greenpoint, L. I.	S. D. Keeler, Ridgefield.	**34.00**
4802	Fish, Bone and Potash.	Read Fertilizer Co., N. Y. City.	W. Tillinghast, Plainfield. Fred. R. Tryon, Middletown. N. S. Lee, Old Lyme.	**30.00** 28.00 32.00
4915	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport.	Manufacturer.	**32.00**
4721	Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	Geo. W. Dennison, Saybrook. A. N. Clark, Milford.	33.00 **32.00**
4652	Ammoniated Dissolved Bone or Farm and Garden Phosphate.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark & Sons, Milford. J. A. Lewis, Willimantic. Hubbell & Bradley.	28.00 37.00 32.00 **30.00**
4743	Great Planet "A."	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck	**38.00**
4722	Quinnipiac Phosphate.	Quinnipiac Co., Boston, Mass.	F. S. Bidwell, Windsor Locks Meeker Coal Co., Norwalk. G. G. Tillinghast, Vernon. A. P. Wakeman, Fairfield.	**35.00** 36.00 33.00 34.00
4699	Success Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford. E. F. Hutchinson, Andover. A. N. Clark, Milford.	31.00 30.00 26.00 **28.00**
4789	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., N. Y. City.	T. C. Greene, Torrington. Bulkley & Hanmer, Wethersfield. D. B. Wilson, Waterbury. Hale, Day & Co., So. Manchester. W. B. Martin, Rockville. John Bransfield, Portland.	34.00 **35.00** 35.00 36.00 34.00 35.00

Analyses.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$20.33	32.8	----	.61	1.17	1.78	*1.0*	5.20	4.94	1.11	11.25	*8.0*	10.14	----	2.34	2.34	*2.0*
28.51	33.2	.70	----	2.26	2.96	----	6.86	4.26	3.66	14.78	----	11.12	----	-----	4.35	----
29.05	34.2	1.30	----	2.42	3.72	*3.3*	4.80	4.34	1.48	10.62	*9.0*	9.14	*8.0*	6.71	6.71	*7.0*
29.56	35.3	.69	.61	2.42	3.72	*3.3*	4.45	4.80	1.36	10.61	*9.0*	9.25	*8.0*	6.76	6.76	*7.0*
24.32	35.6	.22	.27	2.76	3.25	*2.5*	4.56	2.93	.38	7.87	*7.0*	7.49	*6.0*	5.23	5.23	*5.0*
22.08	35.8	----	.14	2.17	2.31	*2.0*	6.08	3.33	1.48	10.89	*6.0*	9.41	*4.0*	3.16	3.16	*4.0*
22.80	35.9	.26	----	2.30	2.56	*2.0*	6.29	3.31	.70	10.30	*9.0*	9.60	*8.0*	3.29	3.29	*3.0*
25.57	36.8	.98	----	1.69	2.67	*2.2*	5.07	5.95	1.07	12.09	*10.0*	11.02	----	.47	3.87	*5.0*
25.08	39.5	.48	1.08	1.14	2.70	*2.5*	8.62	2.63	.65	11.90	----	11.25	*10.0*	2.66	2.66	*2.0*
24.01	41.6	----	.26	1.90	2.16	*2.5*	4.99	3.81	1.11	9.91	*9.0*	8.80	----	1.43	6.07	*2.0*
21.15	41.8	.10	----	2.73	2.83	*2.5*	3.55	1.66	.35	5.56	*6.0*	5.21	*4.0*	6.23	6.23	*4.0*
†22.55	41.9	----	----	2.62	2.62	*2.9*	2.72	5.89	1.73	10.34	*8.0*	8.61	----	3.86	3.86	*4.0*
22.43	42.6	----	.30	2.12	2.42	*1.9*	7.50	2.35	2.30	12.15	*12.0*	9.85	*10.0*	2.01	2.01	*1.5*
20.94	43.2	.35	----	1.53	1.88	*1.5*	6.24	3.92	2.11	12.27	*10.0*	10.16	*8.0*	1.75	2.34	*2.0*
*26.49	43.4	1.26	----	1.98	3.24	*3.3*	5.97	1.93	.63	8.53	*9.0*	7.90	*8.0*	3.61	6.85	*7.0*
24.29	44.0	.54	----	2.26	2.80	*2.5*	6.59	4.36	1.40	12.35	*10.0*	10.95	*9.0*	2.15	2.15	*2.0*
19.41	44.2	----	.22	1.40	1.62	*1.2*	7.49	2.02	2.13	11.64	----	9.51	*9.5*	2.13	2.13	*2.0*
24.22	44.5	.40	----	2.43	2.83	*2.5*	7.04	3.73	1.38	12.15	*10.0*	10.77	*9.0*	2.11	2.11	*2.0*

* See note, p. 37. † See page 38.

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4631	Farmer's New Method Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	Wilson & Burr, Middletown. J. A. Lewis, Willimantic. Quinnebaug Store. G. W. Carver, Putnam.	$32.00 33.00 34.00 31.00
4678	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	Crawford & Devine, Uncasville. W. B. Martin, Rockville. J. A. Paine, Danielsonville.	38.00 36.00 36.00
4871	Concentrated Phosphate.	Cumberland Bone Phosphate Co, Boston, Mass.	John Parker, Poquonock.	40.00
4740	Bay State Fertilizer, "G" Brand.	Clark's Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret. J. M. Burke, South Manchester.	30.00 34.00 32.00
4632	Bradley's Patent Superphosphate.	Bradley Fertilizer Co., Boston, Mass.	J. A. Lewis, Willimantic. H. H. Davenport, Pomfret. Quinnebaug Store, Danielsonville. G. W. Carver & Son, Putnam. Raymond Bros., South Norwalk. W. B. Martin, Rockville. R. A. Parker, Warehouse Pt. F. S. Bidwell, Windsor Locks W. W. Cooper, Suffield.	35.00 34.00 36.00 34.00 35.00 35.00 35.00 35.00 36.00
4847	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	Manchester Elevator Co., Manchester. T. H. Eldridge. Norwich. G. A. & H. G. Williams, E. Hartford. Andrew Ure, New Haven.	33.00 34.00 31.00 30.00 32.00
4651	High Grade Ammoniated Bone Superphosphate.	The E. Frank Coe Co., N. Y. City.	Hillhouse & Taylor, Willimantic. W. F. Palmer, Scotland. E. S. Banks, Southport.	35.00 34.00 31.00 32.00
4834	Bay State Fertilizer.	Clark's Cove Fertilizer Co, Boston, Mass.	White & Juno, Rockville.	36.00
4846	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., Boston, Mass	F. S. Bidwell, Windsor Locks	36.00
4842	Ammoniated Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. P. Little, Columbia.	35.00
4747	Alkaline Bone.	E. Frank Coe Co., N. Y. City.	J. O. Fox & Co., Putnam.	30.00
4786	Fish and Potash.	Pacific Guano Co., Boston, Mass.	Edmund Halladay, Suffield.	32.00
4794	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	Saxton & Strong, Bristol. John Bransfield, Portland. R. F. Woodford, Plainville. P. F. Walsh, Montville. T. B. Wickwire, Berlin.	36.00 35.00 35.00 34.00 38.00
4754	High Grade Triumph.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. H. Loomis, Bolton. Wm. Higgins, New London.	33.00 32.00

Analyses.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen, Organic.	Nitrogen: Total Nitrogen: Found.	Nitrogen: Total Nitrogen: Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total: Found.	Phosphoric Acid: Total: Guaranteed.	Phosphoric Acid: Available: Found.	Phosphoric Acid: Available: Guaranteed.	Potash: Found: As Muriate.	Potash: Found: Total.	Potash: Guaranteed.
$22.09	44.8	.09	----	2.22	2.31	*1.7*	6.58	2.87	1.03	10.48	*10.0*	9.45	*8.0*	3.36	3.36	*3.0*
24.79	45.2	.60	----	2.04	2.64	*2.5*	7.81	4.04	1.28	13.13	*10.0*	11.85	*9.0*	2.16	2.16	*2.0*
27.51	45.4	1.33	----	2.21	3.54	*4.0*	4.72	3.95	1.68	10.35	*10.0*	8.67	*8.0*	6.18	6.18	*7.0*
21.76	47.0	----	.13	2.25	2.38	*1.9*	7.30	2.23	.88	10.41	*10.0*	9 53	*6.5*	2.54	2.54	*2.0*
23.73	47.4	.44	----	2.31	2.75	*2.3*	7.44	2.95	.98	11.37	*11.0*	10.39	*9.0*	2.47	2.47	*1.5*
21.65	47.8	----	.22	2.10	2.32	*2.0*	1.70	8.90	.67	11.27	*9.0*	10.60	----	2.02	2.02	*2.0*
21.61	48.0	----	----	2.10	2.10	*2.0*	7.95	2.18	1.90	12.03	*9.0*	10.13	*9.0*	.18	1.91	*1.9*
23.96	50.2	.63	----	2.18	2.81	*2.5*	8.40	1.87	.86	11.13	*10.0*	10.27	*9.0*	.49	2.36	*2.0*
23.93	50.4	.43	.19	2.56	3.18	*3.3*	3.79	3.32	1.81	8.92	*5.0*	7.11	*3.0*	5.08	5.08	*4.0*
23.19	50.9	----	----	2.92	2.92	*2.9*	7.84	2.76	.34	10.94	*11.0*	10.60	*10.0*	1.07	1.07	*1.0*
19.74	51.9	----	----	1.50	1.50	*1.0*	6.80	2.79	2.49	12.08	*9.0*	9.59	*7.0*	.49	2.51	*3.0*
20.94	52.8	----	----	2.38	2.38	*2.5*	2.30	4.92	1.93	9.15	----	7.22	*6.0*	4.61	4.61	*4.0*
22.90	52.8	.26	----	2.36	2.62	*2.3*	6.51	3.80	1.41	11.72	*10.5*	10.31	*8.5*	1.98	1.98	*2.0*
20.67	54.8	----	----	2.58	2.58	*2.5*	5.68	2.48	1.24	9.40	*9.0*	8.16	*8.0*	2.34	2.34	*2.2*

Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4825	Cleveland Superphosphate.	Cleveland Dryer Co., Boston, Mass.	Chas. E. Scranton, Madison.	**$33.00**
4809	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	**34.00**
4742	King Philip Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck H. H. Davenport, Pomfret. J. M. Burke, So. Manchester.	27.00 **28.00** 29.00
4812	Standard Superphosphate.	Standard Fertilizer Co., Boston, Mass.	W. E. Truesdell & Co., Burnside.	**40.00**
4720	Ammoniated Dissolved Bone Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford.	**32.00**
4687	Smoky City.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	**32.00**
4739	Fish and Potash, "D" Brand.	Joseph Church & Co., Tiverton, R. I.	W. W. Cooper, Suffield. J. P. Barstow & Co., Norwich	32.00 30.00 **31.00**
4656	B. D. Sea Fowl Guano.	Bradley Fertilizer Co., Boston, Mass.	R. A. Parker, Warehouse Point. F. S. Bidwell, Windsor Locks W. W. Cooper, Suffield.	**35.00** 33.00 36.00
4684	New Rival Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	W. C. Latimer, So. Coventry Henry Davis, Durham Center.	34.00 27.00 **31.00**
4787	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	Hale, Day & Co., So. Manchester.	33.00 **28.00**
4793	Nobsque Guano.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River. T. B. Wickwire, Berlin. P. F. Walsh, Montville.	32.00 29.00 **30.00**
4634	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston, Mass.	W. Tillinghast, Plainfield. F. S. Bidwell, Windsor Locks Hubbell & Bradley, Saugatuck.	**30.00** 28.00 30.00
4849	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich. N. C. Barker & Co., Lebanon.	34.00 **32.00**
4798	Standard Phosphate.	Read Fertilizer Co., N. Y. City.	W. Tillinghast, Plainfield. N. S. Lee, Old Lyme. Fred. R. Tryon, Middletown.	**30.00** 32.00 28.00
4843	Farmer's Reliable.	Chicopee Guano Co., N. Y. City.	Patrick Ahern, East Windsor Hill.	**35.00**
4815	Cumberl'd Superphosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	**38.00**
4840	Fish and Potash.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	**33.00**
4796	Economical Bone Fertilizer.	Wilkinson & Co , N. Y. City.	Wales Peck, Peck Hill, Woodbridge.	**32.00**
4822	Practical Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	W. W. Sheldon, So. Woodstock.	**30.00**
4801	Standard Guano.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	**34.00**
4686	Four Fold Fertilizer.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	32.00 **30.00**
4816	Cumberland Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	**38.00**
4824	Cereal Brand.	F. L. Ludlam, N. Y. City.	J. L. Appeley, Canterbury.	†----

† Asked but not given.

Analyses.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$21.19	55.7	----	.18	2.28	2.46	*2.1*	4.59	4.29	2.17	11.05	----	9.88	*9.0*	2.11	2.11	*2.0*
21.72	56.5	----	----	2.48	2.48	*2.0*	7.30	2.03	.71	10.04	*10.0*	9.33	*8.0*	2.52	2.52	*2.0*
17.69	58.2	----	----	1.38	1.38	*1.0*	6.19	2.84	1.14	10.17	*9.0*	9.03	*8.0*	2.35	2.35	*2.0*
25.18	58.8	1.20	----	2.10	3.30	*2.5*	8.00	2.27	.57	10.84	*11.0*	10.27	*9.0*	1.56	2.43	*2.0*
20.14	58.8	----	.30	1.60	1.90	*1.7*	6.66	2.87	2.56	12.09	----	9.53	*9.0*	1.75	1.75	*2.0*
20.10	59.2	----	----	1.36	1.36	*1.2*	10.48	2.32	.33	13.13	*15.0*	12.80	*12.0*	.26	.37	*1.0*
19.44	59.4	----	.18	2.40	2.58	*2.1*	3.60	3.53	1.26	8.39	*7.5*	7.13	*6.0*	2.39	2.39	*2.0*
21.80	60.5	.39	----	1.84	2.23	*2.1*	5.15	5.55	1.86	12.56	*10.0*	10.70	*8.0*	1.70	1.70	*1.5*
18.80	64.8	----	----	1.42	1.42	*1.2*	6.77	3.67	1.25	11.69	*11.0*	10.44	*10.0*	1.61	1.61	*1.6*
16.89	65.7	----	----	1.16	1.16	*1.0*	5.12	4.26	1.21	10.59	*8.0*	9.38	*7.0*	1.94	1.94	*2.0*
17.96	67.0	----	----	1.37	1.37	*1.2*	2.03	7.51	1.74	11.28	*9.0*	9.54	----	2.27	2.27	*2.0*
17.87	67.8	.22	----	.90	1.12	*.8*	4.41	5.97	3.36	13.74	*10.0*	10.38	*8.0*	1.16	1.16	*1.0*
*19.05	67.9	----	----	2.20	2.20	*2.9*	1.58	3.11	4.03	8.72	*6.0*	4.69	----	4.34	5.25	*4.0*
17.62	70.2	----	----	1.08	1.08	*.8*	6.69	1.92	.46	9.07	*10.0*	8.61	*8.0*	4.16	4.16	*4.0*
20.21	73.1	----	----	2.10	2.10	*1.7*	6.24	2.97	2.59	11.80	*9.0*	9.21	*8.0*	1.64	1.64	*2.0*
21.27	78.6	.15	----	2.15	2.30	----	7.01	2.32	1.06	10.39	*10.0*	9.33	*8.0*	2.60	2.60	*2.0*
18.46	78.7	----	.22	2.05	2.27	*2.5*	2.99	2.86	2.27	8.12	*6.0*	5.85	*4.0*	1.81	3.33	*4.0*
17.87	79.0	----	----	1.36	1.36	*1.2*	4.86	3.59	2.50	10.95	*7.0*	8.45	*7.0*	2.89	2.89	*3.0*
16.38	83.1	----	----	1.02	1.02	*.8*	4.48	4.67	3.20	12.35	*8.0*	9.15	*8.0*	1.34	1.34	*1.0*
17.05	99.4	----	----	1.20	1.20	*1.0*	6.03	2.90	1.13	10.06	*10.0*	8.93	*8.0*	2.45	2.45	*2.0*
14.06	113.3	----	----	1.11	1.11	*.8*	5.81	1.50	1.02	8.33	*11.0*	7.31	*8.0*	1.52	1.52	*1.0*
17.60	115.9	----	----	1.08	1.08	*1.0*	4.73	5.20	1.84	11.77	*10.0*	9.93	*8.0*	2.11	2.11	*2.0*
18.78	-----	.20	----	.97	1.17	*.8*	5.84	5.00	3.16	14.00	*10.0*	10.84	*8.0*	1.34	1.34	*1.0*

* See note, p. 37.

2. *Sampled by the Manufacturer.*

In the following table are four analyses made on samples deposited with the Director of the Station by manufacturers in compliance with the requirements of the Fertilizer Law.

The brands named were not found in the Connecticut market by our sampling agents. They are the following:

4884. Anchor Brand Fish and Potash, made by Bradley Fertilizer Co., Boston.

4888. Original Coe's Superphosphate, made by Bradley Fertilizer Co., Boston.

4887. Great Eastern General Fertilizer, made by Great Eastern Fertilizer Co., Rutland, Vt.

4845. Cecrops Fertilizer, Cecrops or Dragon's Tooth Brand, made by Frederic Ludlam, N. Y.

3. *Sampled by Consumers.*

In the following table are three analyses made on samples of this kind. The Station is not responsible for the accuracy of the sampling, though in each case it holds the written statement of the sampler that the Station's directions for sampling were followed.

The three following are of goods made by the Cumberland Bone Phosphate Co., Boston, Mass., and were drawn by D. C. Spencer, Saybrook.

4689, Concentrated Phosphate; **4691,** Cumberland Superphosphate, and **4692,** Cumberland Fertilizer.

	4884	4888	4887	4845	4689	4691	4692
Nitrogen of nitrates	----	.15	----	1.39	1.53	.10	----
Organic nitrogen	3.66	2.35	1.26	1.17	2.02	2.23	1.30
Total nitrogen	**3.66**	**2.50**	**1.26**	**2.56**	**3.55**	**2.33**	**1.30**
Soluble phosphoric acid	3.31	7.44	6.89	5.12	5.42	6.75	5.09
Reverted phosphoric acid	3.00	2.61	3.20	4.44	4.75	2.72	3.98
Insoluble phosphoric acid	1.74	1.31	1.96	2.06	1.25	1.05	1.20
Total phosphoric acid	**8.05**	**11.36**	**12.05**	**11.62**	**11.42**	**10.52**	**10.27**
Potash as muriate	3.47	2.44	4.44	7.21	6.64	2.37	2.06
Potash as sulphate	.21	----	----	----	----	----	----
Total potash	**3.68**	**2.44**	**4.44**	**7.21**	**6.64**	**2.37**	**2.06**
Cost per ton	----	----	----	----	$38.00	32.00	28.00
Valuation per ton	$23.39	22.73	20.73	26.36	29.47	21.30	17.11

III. Special Manures.

For Analyses and Valuations see pages 52 to 60.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples drawn by Station Agents.*

In the tables on pages 52 to 59, are tabulated the analyses of seventy-eight brands made on samples drawn by the Station agents.

Analyses which require Special Notice.

4746. Lyman's Corn Manure is designed for use with stable manure and as supplementary to it.

Nos. **4879, 4881, 4901, 4609, 4880, 4608,** are mixtures of chemicals and ground bone and apparently contain no other forms of phosphate.

4608 consists of a mixture of ground bone and potash salts alone, and would be classed with other samples of bone and potash (see page 35) were it not branded as a fertilizer for particular crops.

The manufacturers of **4695,** Cartaret Potato Manure, protested that this analysis did not fairly represent the quality of the brand and asked that another sample be drawn from a different lot of the fertilizer. A re-test proved the correctness of the analysis. The analysis of a second sample, drawn in compliance with the manufacturer's request, No. **4905,** appears on page 52. This latter analysis contains somewhat less nitrogen than the former, and more than twice as much potash.

L. Wilcox protested that the analysis **4808,** his Potato, Onion and Tobacco Manure, did not fairly represent the average quality of this brand, which contained over 6 per cent. of potash. A re-test proved the correctness of our analysis. The Station endeavored to find other lots of this brand in market from which to draw samples, but was unable to do so.

The Bradley Fertilizer Co. protested that the per cent. of nitrogen found in analysis **4659,** Complete Manure for Potatoes and Vegetables, was below what the goods on the average contained, and requested a re-test. A re-test proved the correctness of our analysis. The Station agents drew three other samples on which analysis **4998**, page 54, was made, which showed about .3 per cent. more nitrogen, and a per cent. less of phosphoric acid.

The Bradley Fertilizer Co. also protested that analysis **4837**, High Grade Tobacco Manure, showed less nitrogen than the goods were calculated to contain. A re-test confirmed the analysis, but the Station agents were not able to find other samples on which another analysis could be made.

The Niagara Fertilizer Works protested that the analysis of **4752**, Potato, Hop and Tobacco Fertilizer, misrepresented the quality of the goods, which contained over three times the quantity of nitrogen reported (.54 per cent.). A re-test of the sample proved the correctness of our analysis. Nitrogen was therefore determined in three other samples drawn from as many different stocks. The percentages of nitrogen found (.48, .56 and .47) were essentially the same as found in the first analysis.

M. E. Wheeler & Co. protested that analysis No. **4874**, Grain and Oats Fertilizer, totally misrepresented the average quality of the brand and led them to think that our sampling agent drew something which was not their goods. Re-test confirmed the accuracy of our analysis. The sampling agents were unable to find other samples of this brand in market, but an analysis was made of the sample deposited by the manufacturer earlier in the season, with the results given on page 60, No. **4914**. This latter analysis is much higher both in phosphoric acid and potash than the former.

GUARANTEES.

Of the seventy-eight brands of special manures here tabulated nineteen are below the manufacturers' guarantee in respect of one ingredient and ten in respect of two ingredients, so that in all, considerably more than one-third of the whole number do not in all respects fulfill the manufacturers' claims.

COST, VALUATION AND PERCENTAGE DIFFERENCE.

Rejecting from calculation the last three analyses in the tables, the average cost of 75 Special Manures was $37.33 per ton. The average valuation was $27.94. The difference, $9.39, is equivalent to a "percentage difference"* of 33.6.

Last year the corresponding figures were, average cost $38.13, average valuation 28.62, percentage difference 33.2.

* See page 38.

As will be seen by reference to page 6, Messrs. Mason, Chapin & Co., of Providence, R. I., have entered six brands of fertilizers for sale in this State. Our sampling agents were able to find only three of them, of which the analyses are given on pages 58 and 59. As the manufacturers failed to deposit sealed samples at the Station, it has not been possible to make analyses of the other three brands.

2. *Sampled by Manufacturers*, and 3. *Sampled by Consumers.*

Analyses on page 60.

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law, and were analyzed because no samples of the brands named were found in market by our sampling agents.

4886. Special Conn. Tobacco Manure, made by the Crocker Fertilizer Co., Buffalo. The manufacturer protests that the per cent. of nitrogen found is lower than the goods on the average contain. Re-test proved the correctness of our analysis.

4883. Garden and Lawn Fertilizer, made by L. B. Darling Fertilizer Co., Pawtucket.

4885. Lister's Special Tobacco Fertilizer, made by Lister's Agricultural Chemical Works, Newark, N. J.

4914. Grass and Oats Fertilizer, made by M. E. Wheeler & Co., Rutland, Vt.

3. *Sampled by Consumers.*

The Station is not responsible for the accuracy of samples of this kind, though it holds the written statement of the sampler that the sampling was done according to the Station's directions.

4690. Cumberland Potato Manure, made by Cumberland Bone Phosphate Co., Boston. Sampled and sent by D. C. Spencer, Saybrook.

4610, Fairchild's Formula for Corn and General Crops. **4611**, The Rogers & Hubbard Co.'s Fertilizer for Oats and Top Dressing. **4619**, Soluble Tobacco Manure, and **4620**, Soluble Potato Manure, all made by the Rogers & Hubbard Co., Middletown. Sampled and sent by F. H. Lockwood, New Canaan.

Special Manures, Sampled by the Station.

Analyses.

Station No.	Name or Brand.	Manufacturer	Dealer.	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen: Nitrogen as Nitrates.	Nitrogen: Nitrogen as Ammonia.	Nitrogen: Nitrogen, Organic.	Nitrogen: Total Nitrogen. Found.	Nitrogen: Total Nitrogen. Guaranteed.	Phosphoric Acid: Soluble.	Phosphoric Acid: Reverted.	Phosphoric Acid: Insoluble.	Phosphoric Acid: Total. Found.	Phosphoric Acid: Total. Guaranteed.	Phosphoric Acid: Available. Found.	Phosphoric Acid: Available. Guaranteed.	Potash: Found. As Muriate.	Potash: Found. Total.	Potash: Guaranteed.
4746	Corn Manure.	Chas. E. Lyman, Middlefield	Manufacturer.	$21.00	$22.44*	† 6.4	----	----	----	----	----	5.90	6.46	.43	12.79	*12.0*	12.36	*11.0*	8.98	8.98	*10.0*
4616	High Grade Fertilizer for Oats and Top-Dressing.	Rogers Mfg. Co., Rockfall.	Manufacturer.	42.00	38.29	9.6	4.07	----	2.23	6.30	*5.5*	3.63	5.58	.47	9.68	*9.0*	9.21	----	8.91	8.91	*7.5*
4879	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	S. E. Frisbie, Milford. J. P. Barstow & Co., Norwich.	46.00 48.00	41.34*	11.2	3.82	----	1.88	5.70	*5.5*	----	----	----	13.13	*12.0*	----	----	12.67	12.67	*12.5*
4866	Rogers & Hubbard Co's Soluble Tobacco Manure.	Rogers & Hubbard Co, Middletown.	S. E. Frisbie, Milford.	42.00	37.41	12.2	1.33	.14	3.70	5.17	*5.0*	2.05	5.54	3.10	10.69	*10.0*	7.59	----	.68	10.48	*10.0*
4881	Seeding Down Manure.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	37.50	33.38*	12.3	.54	----	2.63	3.17	*2.5*	----	----	----	15.82	*18.0*	----	----	11.92	11.92	*10.0*
4901	Rogers & Hubbard Co's Grass and Grain Fertilizer	Rogers & Hubbard Co., Middletown.	Manufacturer.	36.50	32.34*	12.8	----	----	----	3.06	*2.5*	----	----	---	16.25	*16.5*	----	----	11.82	11.82	*12.5*
4617	Soluble High Grade Potato and General Crop Manure.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00	33.67	12.8	1.55	----	2.36	3.91	*3.5*	4.38	5.19	.31	9.88	*9.0*	9.57	----	.79	9.77	*8.8*
4609	High Grade Corn Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	46.00	40.72*	12.9	3.37	----	1.63	5.00	*5.5*	----	----	----	12.78	*12.0*	----	----	15.42	15.42	*12.5*
4905	Potato Manure.	Eastern Farm Supply Association, Montclair, N. J.	Paul Thompson, West Hartford,	30.00	26.11*	14.8	----	.24	2.40	2.64	*2.5*	1.12	6.48	1.94	9.54	*7.5*	7.60	*6.5*	1.25	7.84	*6.0*
4872	Potato Fertilizer.	Danbury Fertilizer Co., Danbury.	Manufacturer. E. Baker, Greens Farms.	35.00 32.00 33.50	29.07	15.2	----	----	4.04	4.04	*3.0*	----	5.47	3.18	8.65	*8.0*	5.47	----	8.45	8.45	*7.0*
4867	Rogers & Hubbard Co's Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	John Bransfield, Portland. J. P. Barstow, Norwich. S. E. Frisbie, Milford. G. M. Smith & Co., Rocky Hill.	38.00 40.00 38.00 38.00	32.81	15.8	1.46	.16	3.60	5.22	*5.0*	1.87	5.76	2.81	10.44	*10.0*	7.63	*7.0*	.89	6.09	*5.0*
4880	Rogers & Hubbard Co's Fertilizer for Oats and Top-Dressing.	Rogers & Hubbard Co., Middletown.	John Bransfield, Portland. S. E. Frisbie, Milford.	50.00 50.00	42.90*	16.5	7.44	----	1.53	8.97	*9.0*	----	----	----	8.62	*8.0*	----	----	8.45	8.45	*8.5*
4635	Complete Potato Manure.	H. J. Baker & Bro., N. Y. City.	C. O. Jelliff & Co., Southport. E. White, Rockville.	38.00 40.00	31.95	18.9	.39	1.36	2.25	4.0	*3.3*	5.66	.94	.18	6.78	----	6.60	*5.8*	4.54	10.58	*10.0*
4680	Onion Manure.	H. J. Baker & Bro., N. Y. City.	D. N. Benton, Guilford. C. O. Jelliff & Co., Southport.	40.00 38.00 39.00	32.67	19.3	.39	1.74	2.33	4.46	*4.9*	4.45	1.76	.25	6.46	----	6.21	*4.5*	5.69	10.33	*9.0*
4715	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks	38.00	31.41	20.9	.41	.15	3.08	3.64	*3.0*	2.48	8.80	2.70	13.98	*10.0*	11.28	----	.81	5.56	*7.0*
4828	Special Tobacco Manure.	H. J. Baker & Bro., N. Y. City.	W. F. Andross, East Hartford.	40.00	32.95	21.3	----	2.66	1.80	4.46	*4.3*	4.59	1.30	.46	6.35	----	5.89	*4.0*	.76	9.68	*10.0*
4718	Tobacco Grower.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks	40.00	32.79	21.0	----	.26	2.92	3.18	*4.9*	2.08	7.62	2.33	12.03	*10.0*	9.70	----	1.57	10.11	----
4657	Stockbridge Top-Dressing.	Bowker Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville. J. A. Paine, Danielsonville.	40.00 40.00	32.50	23.0	3.19	----	1.98	5.17	*5.0*	4.32	3.95	1.15	9.42	*6.0*	8.27	*4.0*	7.12	7.12	*6.0*
4758	Tobacco Manure, Wrapper Brand.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	48.00	38.74	23.9	1.56	2.60	2.22	6.38	*6.2*	.27	4.53	1.01	5.81	*4.5*	4.80	----	.73	10.97	*10.5*
4757	Tobacco Starter.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	35.00	28.23	23.9	1.35	.64	1.15	3.14	*2.5*	6.09	6.66	.50	13.25	*12.0*	12.75	----	.67	3.12	*2.5*
4608	High Grade Fertilizer for Grass and Grain.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00	30.41*	24.9	----	----	---	3.48	*3.0*	----	----	----	16.72	*17.0*	----	----	10.65	10.65	*12.5*
4830	Havana Tobacco Fertilizer.	Quinnipiac Co., Boston, Mass.	O. S. Olmstead, Melrose.	47.50	37.92	25.2	----	2.94	2.72	5.66	*5.8*	.59	3.46	.71	4.76	*6.0*	4.05	*5.0*	1.20	12.80	*10.0*
4823	Special Tobacco and Potato Manure.	G. B. Alderman, Suffield.	Manufacturer.	36.00	28.70	25.4	.63	----	2.55	3.18	*2.9*	2.02	4.89	.66	7.57	*6.0*	6.91	----	.26	9.88	*10.0*
4848	Complete Manure for Corn and Grain.	Bradley Fertilizer Co:, Boston, Mass.	C. H. Baker, Andover.	37.00	29.46	25.5	1.32	----	2.0	3.32	*3.3*	3.79	7.99	2.61	14.39	*13.0*	11.78	*12.0*	5.02	5.02	*3.0*
4836	Stockbridge Tobacco Manure.	Bowker Fertilizer Co., Boston, Mass.	J. E. Collins, Wapping.	50.00	39.78	25.6	3.16	----	2.92	6.08	*5.8*	1.06	4.92	6.75	12.73	*6.0*	5 98	----	.53	10.82	*10.0*

* See remarks on this analysis, page 49.

† Valuation exceeds cost.

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

ANALYSES.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
4660	Potato Special.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center. Meeker Coal Co., Norwalk.	$36.00 40.00 **38.00**	$28.29	34.3	----	----	3.76	3.76	*3.7*	6.74	2.00	1.30	10.04	*9.0*	8.74	*8.0*	5.63	5.63	*5.4*
4838	Fine Wrapper Tobacco Grower.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	**50.00**	36.88	35.6	----	3.50	2.34	5.84	*5.8*	2.74	2.19	.93	5.86	----	4.93	*5.0*	.87	9.78	*10.0*
4839	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	E. B. Clark & Sons, Milford. A. Y. Beach, Seymour. A. P. Wakeman, Fairfield. Manchester Elevator Co., Manchester.	38.00 40.00 38.00 41.00 **39.00**	28.63	36.2	----	1.35	2.11	3.46	*3.7*	4.56	5.42	.68	10.66	*10.0*	9.98	*8.0*	5.52	5.52	*6.0*
4795	Quinnipiac Onion Manure.	Quinnipiac Co., Boston, Mass.	F. S. Bidwell, Windsor Locks	**40.00**	29.17	37.1	1.30	----	2.44	3.74	*3.3*	5.18	2.85	1.90	9.93	*9.0*	8.03	*8.0*	7.89	7.89	*7.0*
4655	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville. J. A. Lewis, Willimantic. W. Tillinghast, Plainfield. J. A. Paine, Danielsonville.	**40.00** 40.00 30.00 40.00	29.07	37.5	1.58	----	1.81	3.39	*2.5*	6.77	3.08	.81	10.66	*8.0*	9.85	*6.0*	7.26	7.26	*5.0*
4724	Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center.	**30.00**	21.53	39.3	----	----	2.24	2.24	*2.1*	7.58	2.84	1.09	11.51	*11.0*	10.42	*10.0*	1.64	1.64	*1.6*
4817	Potato, Tobacco and Hop.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	**33.00**	23.41	40.9	----	----	2.44	2.44	*2.1*	6.40	3.76	1.67	11.83	*9.0*	10.16	*8.0*	3.19	3.19	*3.0*
4654	Vegetable, Vine and Tobacco Manure.	Great Eastern Fertilizer Co., Rutland, Vermont.	Wm. Burr & Son, Fairfield. E. T. Bates, Darien. Silas Finch, Greenwich.	**33.00** 36.00 32.00	23.37	41.2	----	----	2.22	2.22	*2.1*	6.60	2.19	.57	9.36	*9.0*	8.79	*8.0*	6.09	6.09	*6.0*
4534	Swift Sure Potato Fertilizer.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	**38.00**	26.75	42.0	.58	----	1.92	2.50	*2.5*	4.59	5.09	5.24	14.92	*11.0*	9.68	*8.0*	6.07	6.07	*6.0*
4683	High Grade Potato Manure.	E. Frank Coe Co., N. Y. City.	F. L. Hallock & Co., Birmingham. D. N. Benton, Guilford. J. O. Fox & Co., Putnam.	38.00 34.00 **35.00**	24.41	43.3	----	.38	1.83	2.21	*1.9*	6.91	2.19	2.25	11.35	*9.0*	9.10	*8.0*	.41	5.16	*6.0*
4723	Potato Manure.	Quinnipiac Co., Boston, Mass.	A. P. Wakeman, Fairfield. G. G. Tillinghast, Vernon. Meeker Coal Co., Norwalk. F. S. Bidwell, Windsor Locks F. M. Raymond, Westport.	34.00 33.00 36.00 37.00 **35.00**	24.34	43.7	----	.59	2.17	2.76	*2.5*	3.65	4.10	1.78	9.53	*7.0*	7.75	*6.0*	4.51	5.79	*5.0*
4820	High Grade Potato Manure.	M. E. Wheeler & Co., Rutland, Vermont.	Wm. M. Owen, No. Haven. P. B. Moffitt, Pomfret. C. A. Loomis, Andover.	33.00 **34.00** 35.00	23.62	43.9	.10	----	2.30	2.40	*2.1*	6.78	1.93	.58	9.29	*9.0*	8.71	*8.0*	5.82	5.82	*3.8*
4819	Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vermont.	P. B. Moffitt, Pomfret. C. A. Loomis, Andover. Wm. M. Owen, No. Haven.	**32.00** 33.00 32.00	22.10	44.7	1.00	----	1.90	2.90	*1.7*	7.07	1.90	.65	9.62	*10.0*	8.97	*8.0*	2.22	2.22	*2.0*
4682	Top-Dressing for Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	Raymond Bros., S. Norwalk.	**37.00**	25.07	47.5	4.96	----	----	4.96	*4.9*	1.62	4.36	1.04	7.02	*6.0*	5.98	*5.0*	.59	2.97	*2.5*
4826	Cleveland Potato Phosphate.	Cleveland Dryer Co., Boston, Mass.	Chas. E. Scranton, Madison.	**34.00**	22.93	48.2	----	.14	2.18	2.32	*2.1*	6.84	3.22	1.43	11.49	*10.0*	10.06	*8.0*	3.22	3.22	*3.0*
4741	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck J. M. Burke, So. Manchester.	32.00 36.00 **34.00**	22.84	48.8	----	----	2.28	2.28	*2.1*	6.03	4.12	1.58	11.73	*9.0*	10.15	*8.0*	3.24	3.24	*3.0*
4790	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	John Bransfield, Portland. W. B. Martin, Rockville. Geo. Beaumont, Wallingford. Hale, Day & Co., So. Manchester. A. M. Clark, Scotland. D. B. Wilson, Waterbury. G. C. Greene, Torrington. S. A. Flight, Highwood.	35.00 34.00 **35.00** 36.00 32.00 36.00 34.00 33.00	23.43	49.3	.40	.13	2.31	2.84	*2.5*	3.44	3.97	1.55	8.96	*7.0*	7.41	*6.0*	5.57	5.57	*5.0*

Special Manures, Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4660	Potato Special.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center. Meeker Coal Co., Norwalk.	$36.00 40.00 **38.00**
4838	Fine Wrapper Tobacco Grower.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	**50.00**
4839	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	E. B. Clark & Sons, Milford. A. Y. Beach, Seymour. A. P. Wakeman, Fairfield. Manchester Elevator Co., Manchester.	38.00 40.00 38.00 41.00 **39.00**
4795	Quinnipiac Onion Manure.	Quinnipiac Co., Boston, Mass.	F. S. Bidwell, Windsor Locks	**40.00**
4655	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville. J. A. Lewis, Willimantic. W. Tillinghast, Plainfield. J. A. Paine, Danielsonville.	**40.00** 40.00 30.00 40.00
4724	Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center.	**30.00**
4817	Potato, Tobacco and Hop.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	**33.00**
4654	Vegetable, Vine and Tobacco Manure.	Great Eastern Fertilizer Co., Rutland, Vermont.	Wm. Burr & Son, Fairfield. E. T. Bates, Darien. Silas Finch, Greenwich.	**33.00** 36.00 32.00
4534	Swift Sure Potato Fertilizer.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	**38.00**
4683	High Grade Potato Manure.	E. Frank Coe Co., N. Y. City.	F. L. Hallock & Co., Birmingham. D. N. Benton, Guilford. J. O. Fox & Co., Putnam.	38.00 34.00 **35.00**
4723	Potato Manure.	Quinnipiac Co., Boston, Mass.	A. P. Wakeman, Fairfield. G. G. Tillinghast, Vernon. Meeker Coal Co., Norwalk. F. S. Bidwell, Windsor Locks F. M. Raymond, Westport.	34.00 33.00 36.00 37.00 **35.00**
4820	High Grade Potato Manure.	M. E. Wheeler & Co., Rutland, Vermont.	Wm. M. Owen, No. Haven. P. B. Moffitt, Pomfret. C. A. Loomis, Andover.	33.00 **34.00** 35.00
4819	Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vermont.	P. B. Moffitt, Pomfret. C. A. Loomis, Andover. Wm. M. Owen, No. Haven.	**32.00** 33.00 32.00
4682	Top-Dressing for Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	Raymond Bros., S. Norwalk.	**37.00**
4826	Cleveland Potato Phosphate.	Cleveland Dryer Co., Boston, Mass.	Chas. E. Scranton, Madison.	**34.00**
4741	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck J. M. Burke, So. Manchester.	32.00 36.00 **34.00**
4790	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	John Bransfield, Portland. W. B. Martin, Rockville. Geo. Beaumont, Wallingford. Hale, Day & Co., So. Manchester. A. M. Clark, Scotland. D. B. Wilson, Waterbury. G. C. Greene, Torrington. S. A. Flight, Highwood.	35.00 34.00 **35.00** 36.00 32.00 36.00 34.00 33.00

Analyses.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen. Nitrogen as Nitrates.	Nitrogen. Nitrogen as Ammonia.	Nitrogen. Nitrogen, Organic.	Nitrogen. Total Nitrogen. Found.	Nitrogen. Total Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found. As Muriate.	Potash. Found. Total.	Potash. Guaranteed.
$28.29	34.3	....	....	3.76	3.76	*3.7*	6.74	2.00	1.30	10.04	*9.0*	8.74	*8.0*	5.63	5.63	*5.4*
36.88	35.6	....	3.50	2.34	5.84	*5.8*	2.74	2.19	.93	5.86	....	4.93	*5.0*	.87	9.78	*10.0*
28.63	36.2	....	1.35	2.11	3.46	*3.7*	4.56	5.42	.68	10.66	*10.0*	9.98	*8.0*	5.52	5.52	*6.0*
29.17	37.1	1.30	....	2.44	3.74	*3.3*	5.18	2.85	1.90	9.93	*9.0*	8.03	*8.0*	7.89	7.89	*7.0*
29.07	37.5	1.58	....	1.81	3.39	*2.5*	6.77	3.08	.81	10.66	*8.0*	9.85	*6.0*	7.26	7.26	*5.0*
21.53	39.3	....	....	2.24	2.24	*2.1*	7.58	2.84	1.09	11.51	*11.0*	10.42	*10.0*	1.64	1.64	*1.6*
23.41	40.9	....	....	2.44	2.44	*2.1*	6.40	3.76	1.67	11.83	*9.0*	10.16	*8.0*	3.19	3.19	*3.0*
23.37	41.2	....	....	2.22	2.22	*2.1*	6.60	2.19	.57	9.36	*9.0*	8.79	*8.0*	6.09	6.09	*6.0*
26.75	42.0	.58	....	1.92	2.50	*2.5*	4.59	5.09	5.24	14.92	*11.0*	9.68	*8.0*	6.07	6.07	*6.0*
24.41	43.3	....	.38	1.83	2.21	*1.9*	6.91	2.19	2.25	11.35	*9.0*	9.10	*8.0*	.41	5.16	*6.0*
24.34	43.7	....	.59	2.17	2.76	*2.5*	3.65	4.10	1.78	9.53	*7.0*	7.75	*6.0*	4.51	5.79	*5.0*
23.62	43.9	.10	....	2.30	2.40	*2.1*	6.78	1.93	.58	9.29	*9.0*	8.71	*8.0*	5.82	5.82	*3.8*
22.10	44.7	1.00	....	1.90	2.90	*1.7*	7.07	1.90	.65	9.62	*10.0*	8.97	*8.0*	2.22	2.22	*2.0*
25.07	47.5	4.96	....	....	4.96	*4.9*	1.62	4.36	1.04	7.02	*6.0*	5.98	*5.0*	.59	2.97	*2.5*
22.93	48.2	....	.14	2.18	2.32	*2.1*	6.84	3.22	1.43	11.49	*10.0*	10.06	*8.0*	3.22	3.22	*3.0*
22.84	48.8	....	....	2.28	2.28	*2.1*	6.03	4.12	1.58	11.73	*9.0*	10.15	*8.0*	3.24	3.24	*3.0*
23.43	49.3	.40	.13	2.31	2.84	*2.5*	3.44	3.97	1.55	8.96	*7.0*	7.41	*6.0*	5.57	5.57	*5.0*

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4801	Vegetable, Vine and Fruit Manure.	Read Fertilizer Co., N. Y. City.	R. W. Keeler, Ridgefield. Wm. M. Bulkley, Fairfield.	$36.00 33.00 **34.50**
4814	Potato Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	W. F. Palmer, Scotland.	**34.00**
4818	General for Grass and Grain.	Great Eastern Fertilizer Co., Rutland, Vermont.	J. A. Foster, Stafford.	**34.00**
4755	Wheat and Corn Producer.	Niagara Fertilizer Co., Buffalo, N. Y.	Wm. H. Loomis, Bolton. Wm. Higgins, New London.	30.00 **29.00** 28.75
4688	Potato Special, Welcome Brand.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	**38.00**
4831	Grass Fertilizer.	Quinnipiac Co., Boston, Mass.	O. S. Olmstead, Melrose.	**35.00**
4751	Corn Manure.	Quinnipiac Co., Boston, Mass.	Ansel A. Champion, Black Hall.	**34.00**
4633	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville. J. A. Lewis, Willimantic. Quinnebaug Store, Danielsonville. G. W. Carver & Son, Putnam Raymond Bros. So. Norwalk R. A. Parker, Warehouse Point. L. F. Judson, Stratford.	36.00 37.00 38.00 34.00 **36.00** 38.00 37.00
4753	Grass and Grain Grower.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. Higgins, New London. Wm. H. Loomis, Bolton.	26.00 28.00 **27.00**
4844	Grass Manure.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	**36.00**
4792	Special Potato Manure.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River. T. B. Wickwire, Berlin. R. F. Woodford, Plainville. P. F. Walsh, Montville.	38.00 38.00 35.00 36.00 **37.00**
4832	Bay State Potato Manure.	Clark's Cove Fertilizer Co., Boston, Mass.	White & Juno, Rockville.	**38.00**
4697	Special Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford. E. F. Hutchinson, Andover.	32.00 34.00 **33.00**
4803	Potato and Tobacco Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	**38.00**
4841	Chicopee A 1, Vegetables and Potatoes.	Chicopee Guano Co., N. Y. City.	Jno. Ahern, Windsor Locks.	**40.00**
4752	Potato, Tobacco and Hop Fertilizer.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. H. Loomis, Bolton. Wm. Higgins, New London.	33.00 **32.00**
4833	Big Bonanza, Tobacco Special.	Walker, Stratman & Co., Pittsburgh, Pa.	J. T. Ball, Unionville.	**36.00**
4874	Grass and Oats Fertilizer.	M. E. Wheeler & Co., Rutland, Vermont.	Wm. M. Owen, No. Haven.	**28.00**
4869	Lawn and Grass.	Mason, Chapin & Co., Providence, R. I.	Cadwell & Jones, Hartford.	**50.00**
4870	"Potato."	Mason, Chapin & Co., Providence, R. I.	Cadwell & Jones, Hartford.	**50.00**
4868	Corn Fertilizer.	Mason, Chapin & Co., Providence, R. I.	Geo. K. Nason, Willimantic.	**50.00**

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
					Total Nitrogen.					Total.		Available.		Found.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$22.87	50.9	----	----	1.94	1.94	*1.7*	5.34	2.03	.43	7.70	*7.0*	7.37	*6.0*	8.51	8.51	*8.0*
22.52	50.9	----	----	2.16	2.16	*2.0*	6.08	4.23	1.17	11.48	*11.0*	10.31	*9.0*	3.30	3.30	*3.0*
22.49	51.1	----	----	2.93	2.93	*2.9*	7.12	1.89	.42	9.43	*9.0*	9.01	*8.0*	2.26	2.26	*2.0*
19.18	51.1	----	----	1.60	1.60	*1.2*	6.37	2.78	2.10	11.25	*9.0*	9.15	*8.0*	2.62	2.62	*2.2*
25.00	52.0	----	----	2.20	2.20	*1.7*	7.82	2.80	.47	11.09	*13.0*	10.62	*9.0*	----	4.85	*5.0*
22.85	53.1	4.30	----	----	4.30	*3.9*	2.53	2.90	1.09	6.52	*6.0*	5.43	*5.0*	.76	3.24	*2.0*
21.57	57.6	----	.14	2.30	2.44	*2.1*	5.44	3.96	1.82	11.22	*10.0*	9.40	*9.0*	2.04	2.04	*1.5*
22.79	57.9	.51	----	2.24	2.75	*2.5*	4.22	3.06	1.13	8.41	*8.0*	7.28	*6.0*	5.54	5.54	*5.0*
16.83	60.4	----	----	.97	.97	*0.8*	4.75	5.13	2.75	12.63	*8.0*	9.88	*7.0*	1.32	1.32	*1.1*
22.27	61.6	4.12	----	----	4.12	*3.9*	2.62	2.58	1.09	6.29	*6.0*	5.20	*5.0*	.53	3.40	*2.0*
22.55	64.0	.26	.17	2.25	2.68	*2.5*	3.36	3.92	1.89	9.17	*7.0*	7.28	*5.0*	5.12	5.12	*5.0*
23.02	65.0	.26	----	2.41	2.67	*2.5*	4.32	3.89	1.12	9.33	*7.0*	8.21	*6.0*	4.87	4.87	*5.0*
19.83	66.4	----	.24	1.52	1.76	*1.7*	6.19	2.54	2.31	11.04	*8.0*	8.73	----	3.09	3.09	*3.0*
22.17	71.4	----	----	2.30	2.30	*2.3*	7.17	2.29	.80	10.26	*10.0*	9.46	*9.0*	3.49	3.49	*3.0*
23.22	72.2	----	----	2.46	2.46	*2.9*	7.33	1.73	1.20	10.26	*8.0*	9.06	*7.0*	4.35	4.35	*5.0*
17.95*	78.3	----	----	.54	.54	*1.6*	7.52	2.78	1.29	11.59	*9.0*	10.30	*8.0*	3.97	3.97	*2.7*
19.88	81.0	----	----	1.88	1.88	*1.7*	5.24	3.78	2.07	11.09	*15.0*	9.02	*11.0*	2.67	2.67	*2.0*
12.84*	118.0	----	----	----	----	----	4.20	5.16	1.35	11.71	*12.0*	9.36	*10.0*	1.75	1.75	*2.0*
19.62	154.8	4.28	---	----	4.28	*5.4*	.25	2.93	7.12	10.30	*5.0*	3.18	----	.45	.45	*1.0*
17.17	181.3	3.88	----	----	3.88	*3.3*	.43	1.43	9.81	11.67	*10.0*	1.86	----	.13	.13	*1.0*
15.70	218.4	2.50	----	----	2.50	*3.0*	----	1.62	12.45	14.07	*11.0*	1.62	----	1.60	1.60	*2.8*

* See remarks on this analysis, page 50.

ANALYSES.

	4886	4883	4885	4914	4690	4610	4611	4619	4620
Nitrogen as Nitrates	trace	trace	----	----	.19	4.03	7.54	1.27	1.51
as Ammonia	----	----	----	----	----	----	----	.12	.16
Organic	5.26	3.90	2.20	----	2.25	2.09	1.48	3.81	3.49
Total	*5.26*	*3.90*	*2.20*	none	*2.44*	*6.12*	*9.02*	*5.20*	*5.16*
Guaranteed	**5.7**	----	**1.7**	none	**2.0**	**5.5**	**8.8**	**5.0**	**5.0**
Phosphoric acid, soluble.	5.57	4.22	8.40	4.77	4.88	----	----	1.46	1.82
reverted	1.02	4.59	3.18	5.73	3.96	----	----	8.10	7.60
insoluble	.25	3.98	1.03	2.49	1.16	----	----	.98	.90
Total	*6.84*	*12.79*	*12.61*	*12.99*	*10.00*	*12.52*	*8.69*	*10.54*	*10.32*
Guaranteed	**6.0**	----	----	**12.0**	**11.0**	**12.0**	**7.9**	**10.0**	**10.0**
Potash as Muriate	.67	1.01	3.84	2.42	4.49	12.49	8.99	.78	1.03
as Sulphate	10.55	3.59	----	----	----	----	----	9.88	5.03
Total	*11.22*	*4.60*	*3.84*	*2.42*	*4.49*	*12.49*	*8.99*	*10.66*	*6.06*
Guaranteed	**10.0**	----	**4.0**	**2.0**	**3.0**	**13.0**	**8.4**	**10.0**	**5.0**
Cost per ton	----	----	----	----	$32.00	46.00	50.00	42.00	38.00
Valuation per ton	$36.94	29.25	24.71	15.20	22.72	42.08	43.70	38.94	33.75

MISCELLANEOUS FERTILIZERS AND MANURES.

COTTON HULL ASHES.

In the table on page 61 are given 23 analyses of these ashes. Samples **4916** and **4917** were drawn from the same car lot, the former from sacks containing ashes of a reddish color, the latter from sacks in which the ashes were light gray.

Allowing 6, 5½ and 2 cents per pound respectively for soluble, reverted, and insoluble phosphoric acid, the price of actual potash in twenty samples of cotton hull ashes has ranged from 4.3 cents to 13 cents per pound, the average being 6.1 cents.

The ashes sold in 1895 have been of better average quality than those sold in the previous year.

"UNLEACHED WOOD ASHES."

In the table page 62 are given 16 analyses of this article. The per cent. of soluble potash ranges from 1.52 per cent. to 7.40, being on the average 4.34 per cent., while the average content of phosphoric acid was 1.55.

These ashes contain on the average between 45 and 50 per cent. of carbonate of lime, and some 14 per cent. of coal, sand and earth.

ANALYSES OF COTTON HULL ASHES.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash costs per pound in cents.
4624	G. A. Douglass, Thompsonville	E. M. Barnes, Thompsonville	2.43	7.40	.48	26.14	$33.75	$38.70	*4.3*
4525	I. L. Spencer, Suffield	F. B. Hathaway, Windsor Locks	3.41	8.98	1.30	28.35	40.00	44.25	*4.5*
4477	Planters Cotton Seed and Crushing Association, Greenville, Tenn	T. Soule & Co., New Milford	.50	5.09	1.11	24.64	30.00	32.51	*4.7*
4916	W. F. Andross, East Hartford	Edmund Halliday, Suffield	1.30	5.52	.60	27.80	36.00	37.06	*5.1*
4588	Olds & Whipple, Hartford	Olin Wheeler, Buckland	1.28	3.24	.57	37.41	45.00	44.61	*5.3*
4526	I. L. Spencer, Suffield	E. S. Seymour, Windsor Locks	2.71	9.39	1.42	24.35	40.00	39.71	*5.3*
4640	Olds & Whipple, Hartford	Station Agent	3.26	7.00	.20	30.61	45.00	43.83	*5.4*
4561	G. A. Douglass, Thompsonville	C. D. Woodworth, Thompsonville	.80	7.82	.53	22.17	33.75	33.05	*5.4*
4734	W. W. Cooper, Suffield	Alfred Griffin, Granby	1.50	8.79	.66	25.40	40.00	38.40	*5.5*
4568	L. Sanderson, New Haven	Chas. H. Wells, Suffield	.91	8.21	.41	27.16	40.00	38.80	*5.5*
4500	W. W. Cooper, Suffield	G. A. Harmon, Suffield	1.42	9.69	.44	24.89	40.00	38.68	*5.5*
4584	Olds & Whipple, Hartford	Wm. S. Pinney, Suffield	.99	10.08	.44	24.44	40.00	38.12	*5.6*
4571	J. C. Eddy, Simsbury	David L. Brockett, Suffield	.77	8.00	.44	26.35	40.00	37.57	*5.7*
4917	W. F. Andross, East Hartford	Edmund Halliday, Suffield	1.33	7.60	.78	21.37	36.00	32.71	*6.0*
4476	F. W. Brode & Co., Memphis, Tenn.	T. Soule & Co., New Milford	.45	5.44	2.17	17.24	30.00	25.49	*6.5*
4572	Edmund Halliday, Suffield	David L. Brockett, Suffield	1.01	6.53	.55	20.12	35.00	29.74	*6.5*
4663	R. A. Parker, Warehouse Point	John E. Thompson, Warehouse Point	2.03	6.53	.59	21.92	40.00	32.88	*6.8*
4615	R. A. Parker, Warehouse Point	Joseph Watson, Enfield	1.97	6.58	1.03	20.37	40.00	31.40	*7.3*
4768	Troknee Mills, Spartanburg, S. C.	E. A. Wildman, New Milford	.74	5.04	.45	17.07	35.00	24.53	*8.3*
5001	Olds & Whipple, Hartford	Olin Wheeler, Buckland	----	4.48	1.11	15 24	45.00	21.37	*13.0*
4539	Southern Mills	Edward Austin, Suffield	.58	9.44	.93	26.92	----	39.72	----
4540	Southern Mills	Edward Austin, Suffield	----	----	----	27.89	----	----	----
4674	Eli Hough, for Tobacco Exp't. Co.	Station Agent	----	----	----	24.11	----	----	----

ANALYSES OF "UNLEACHED WOOD ASHES."

Station No.	Dealer.	Sampled and sent by	Phosphoric Acid.	Potash Soluble in Water.	Lime.	Carbonic Acid.	Sand and Earth.	Coal.	Cost per ton.
4475	Allison & Frost, New York City	J. E. Larmer, Jr., Norwalk	1.80	5.59	33.90	23.07	12.13	2.28	$10.50
4995	Allison & Frost, New York City	L. S. Ellsworth, Simsbury	1.15	5.09	33.20	20.01	6.43	1.50	10.50
4515	Forest City Wood Ash Co., Boston	T. J. Stroud, Shaker Station	1.68	3.95	24.11	14.81	17.33	2.96	10.50
4900	Forest City Wood Ash Co., Boston	Ard Welton, Plymouth	.64	1.52	30.46	19.29	24.62*	----	10.50
4523	A. L. Hartness, Detroit	N. S. Platt, Cheshire	2.28	7.40	30.35	18.15	10.44	1.40	10.00
4465	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	1.78	4.45	35.12	23.78	8.17	2.11	11.50
4485	Monroe, Lalor & Co., Oswego, N. Y.	J. N. Barnes, Yalesville	1.43	3.40	38.75	21.08	8.89	1.46	11.00
4538	Monroe, Lalor & Co., Oswego, N. Y.	Edward Austin, Suffield	1.84	4.27	42.15	22.86	3.93	1.46	11.00
4626	Monroe, Lalor & Co., Oswego, N. Y.	W. F. Whitney, Yalesville	1.25	4.88	36.45	20.65	7.73	2.52	10.00
4766	Monroe, Lalor & Co., Oswego, N. Y.	T. S. Gold, West Cornwall	1.15	3.40	38.77	22.96	5.03	1.43	11.50
4925	Monroe, Lalor & Co., Oswego, N. Y.	S. D. Woodruff & Sons, Orange	1.41	3.57	36.15	20 65	8.50	1.88	11.00
4999	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	.70	3.78	36.33	24.21	15.11	1.77	----
5000	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	1.25	4.07	27.89	19.58	26.88	2.17	----
4590	J. W. Waller, Long Hill	L. N. Mallett, Long Hill	1.71	5.31	30.58	18.16	10.11	1.21	11.00
4644	Seymour Brass Co., Seymour	M. L. Coleman, Ansonia	2.25	4.52	42.38	23.85	4.34	.74	----
4673		Conn. Tobacco Exp't. Co., Poquonock	2.43	4.28	29.25	14.95	26.11	4.32	----

* Includes charcoal.

The same fertilizing ingredients can be bought vastly cheaper in other forms.

One ton of cotton hull ashes, for instance, costing $40.00, will supply as much potash and phosphoric acid as six tons of these wood ashes, costing $63.00. The six tons of wood ashes, however, carry 3,260 pounds of lime in excess of the lime in a ton of cotton hull ashes.

Under some conditions, no doubt, this lime is worth more on the soil than the potash and phosphoric acid themselves, and cannot, perhaps, be purchased to better advantage than in the form of wood ashes. In many other cases the cotton hull ashes contain all the alkali that the soil requires.

HOME MIXTURES.

The fact that cotton seed meal and dissolved phosphate rock sold at very low prices during the last winter and spring, induced many farmers to mix their own fertilizers who had not previously done it.

Fifteen samples of these home mixtures have been analyzed at this Station. In the following tables are given the formulas by which they were compounded and their chemical analyses and valuations. These fertilizers as a rule have a higher percentage of nitrogen and of potash than the average of factory-mixed goods and considerably less phosphoric acid.

The *valuations* are calculated on the same basis as in factory-mixed goods.

The *cost* covers the materials alone *at regular market rates unless otherwise stated*, and does not include cost of mixing. Perhaps from one dollar to one and a half dollars per ton should be allowed for this.

The *mechanical condition* of these home-mixtures has been uniformly good, and not noticeably different from that of factory-mixed goods.

Considerable objection has been made to home-mixing according to such formulas as are given in the table, on the following grounds:

1st. That mixtures made with dissolved rock phosphate would cake or set in the bags, making their application to land difficult.

2d. That the soluble and reverted phosphoric acid of dissolved rock phosphate was not so available to crops as that of dissolved bone black.

3d. That the nitrogen of cotton seed meal was not so available to crops as that of animal matter.

4th. That cotton seed meal would not run through a fertilizer drilling machine.

5th. That no money could be saved by home-mixing.

As has been repeatedly stated in previous reports of this Station, there is no evidence nor any reason to suppose that the soluble and reverted phosphoric acid of dissolved rock is any less available than that of dissolved bone black. It is certain that most factory-mixed goods are made with the former rather than the latter.

Careful experiments indicate that the nitrogen of cotton seed meal is as readily available as the best forms of animal matter, and decidedly more available than that of fish or tankage. When the nitrogen of blood or of tankage costs fifteen cents a pound, and that of cotton seed meal only twelve cents, it is a waste of money to use the former instead of the latter.

The other objections against these formulas may best be met by the statements of those who have had some years' experience in mixing their own fertilizers in this State.

"Mixtures of nitrate of soda, muriate of potash and dissolved rock soon grow hard by standing, but by using, say two hundred pounds or more of dry material, as tankage or bone, I have no trouble. I have used no factory-mixed goods in years, for I save eight to ten dollars per ton over agent's prices by mixing my own."

"The mixture of acid phosphate, nitrate of soda and muriate of potash would not go through the fertilizer attachment of an Aspenwall Potato Planter. It seemed to work right up into a paste by the agitator. With the addition of 400 pounds of cotton seed meal to the ton it went through all right, though not as well as when 400 pounds of dry, rather coarse raw bone were added to the ton, in place of cotton seed meal. Home mixtures have certainly given good satisfaction and it has paid me to make my own mixtures."

"I have never had any trouble on account of caking even if kept over until the next season. This year a mixture containing 600 pounds of (dissolved) South Carolina rock per ton, mixed about May 1st, was in good condition when the last was used, July 10th. I did not use a drill, but cotton seed meal gave no trouble in a hand distributor or 'Eclipse' Corn Planter. I most decidedly think it has paid me to do my own mixing. It is some

FORMULAS AND ANALYSES OF HOME MIXTURES.

Station No.	Made by	Formula, pounds per ton of mixture. Nitrate of Soda.	Cotton Seed Meal.	Tankage.	Bone.	Dissolved Bone Black.	Dissolved Rock Phosphate.	Sulphate of Potash.	Muriate of Potash.	Analyses. Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost (unmixed) and Valuation. Cost per ton.	Valuation per ton.
4527	S. D. Woodruff & Sons, Orange		1150				600		250		4.28	4.28	3.09	3.07	1.12	7.28	7.15	$19.28*	$29.82
4860	S. D. Woodruff & Sons, Orange		1150				600		250		4.08	4.08	3.57	3.54	.48	7.59	6.36	19.28*	27.54
4649	J. H. Webb, Hamden		1200				500		300		4.27	4.27	2.67	2.22	.14	5.03	7.99	22.50	26.98
4850	Clifton Peck, Lebanon	400		600		1000				2.97	2.03	5.00	9.82	2.42	.83	13.07	.49	33.90	30.85
4851	Dennis Fenn, Milford	200		800	400	400			200	1.31	3.35	4.66	3.82	4.79	3.93	12.54	4.78	34.25	30.70
4852	G. H. Bartlett, North Guilford	200	400	700	400	300			400	1.59	3.77	5.36	2.70	3.28	1.73	7.71	10.42	30.15	34.13
4853	Andrew Ure, New Haven		800				800		400		2.93	2.93	5.04	3.15	.19	8.38	7.04	22.50	25.61
4854	M. D. Beach, Litchfield	320	260	260			680		480	2.62	1.96	4.58	2.58	3.59	1.07	7.24	10.79	30.19	31.52
4855	J. P. Phelps, Hamden	600					1100		300	4.64		4.64	5.97	1.42	.08	7.47	9.34	29.00	31.08
4856	R. H. Tucker, Saybrook			600	1080				320		4.34	4.34				14.58	8.10	31.10†	28.66
4857	G. F. Platt & Son, Milford	200		700	300	700			100	1.40	3.74	5.14	4.10	4.00	2.26	10.36	2.39	36.25	28.91
4858	G. F. Platt & Son, Milford	200		700	300	700			100	1.52	3.28	4.80	2.53	5.60	3.38	11.51	3.45	36.25	29.04
4876	W. H. Olcott, South Manchester		1200				500		300		4.08	4.08	2.16	3.16	.69	6.01	8.18	....	27.17
4877	W. H. Olcott, South Manchester		1200				500	500			4.14	4.14	2.03	3.16	.72	5.91	7.97	....	28.24
4920	J. H. Webb, Hamden				1800				200		3.70	3.70				21.73	3.86	34.00	33.39

* Car lot quantities. † Special rates on bone and tankage.

trouble, but the actual cost has never exceeded $1.25 per ton and has averaged less than $1.00."

"I had no trouble from caking of the acid phosphate used. I had no trouble in using the mixture in any way. The cotton seed fertilizer has given me as good satisfaction as any factory-mixed I ever used. It has paid me extremely well to make home-mixtures."

"When used soon after mixing we had no trouble from caking. A small lot after standing two months was somewhat caked. I applied the cotton seed mixture at the same rate per acre as I commonly apply the factory-mixed. The crops seem as good and there was a saving of about $15.00 per ton in favor of home-mixture."

"There was no trouble whatever from caking. We never handled a fertilizer which worked better, all the constituents being fine-ground and smooth. We tested the mixture by the side of two well known high grade brands of fertilizer, and the result showed that the mixture was fully as effective as the factory-mixed goods. The only way in which the factory goods worked better in our trials was that the crops started a little quicker. The home-mixture was a little slow in starting.

We consider this due to the fact that we used no nitrate of soda. This is one of the things we think we have learned by our experience.

We think the home-mixture has paid us as well as any experiment we ever tried. We shall mix all our own fertilizers in the future."

Swamp Muck.

4585. From J. P. Newton, Saybrook. Dug in the fall and sample taken from heap which had been exposed through the winter.

4637. "Pond muck." Dried under cover. From Samuel Wilson, Wolcott.

4646. Swamp muck, partially dried. From Miss M. A. Neale, Southington.

4667. Pond muck and aquatic weeds taken from the pond in the fall and let lie over winter in heaps. From Frank B. Ashton, Middletown.

Analyses.

As received.

	4585	4637	4646	4667
Water	67.43	4.68	39.90	55.82
Organic matter	18.50	17.40	33.89	12.27
Ash	14.07	77.92	26.21	31.91
	100.00	100.00	100.00	100.00
Sand and soil	12.83	73.20	19.03	25.92
Nitrogen	.44	.60	1.24	.75

Water-free.

	4585	4637	4646	4667
Organic matter	56.80	18.27	56.30	27.85
Ash	43.20	81.73	43.70	72.15
	100.00	100.00	100.00	100.00
Sand and soil	39.39	76.86	31.58	58.83
Nitrogen	1.35	.63	2.06	1.70

These samples show the usual variations in quality. From one-third to three-fourths of the weight of the dry material consists of sand and soil, but there is a considerable quantity of nitrogen in three of the samples, probably of some value as a fertilizer though the nitrogen of swamp muck is usually rather inert.

Marine Mud.

This material is much used as a fertilizer and amendment on shore farms, and is believed in some cases to be equal in value to stable manure, load for load.

Its quality as a fertilizer is found to vary with the locality from which it is taken, and these differences in fertilizing value are not indicated or explained by chemical analysis.

4482. Taken from the surface to depth of one foot.

4484. Taken from 12 to 24 inches below the surface.

4483. Taken from 24 to 36 inches below the surface.

All of the above were taken by C. Q. Eldridge, Old Mystic, from a mud flat in the Mystic River.

4919. Mud deposited by a small river. Sent by D. C. Spencer, Saybrook.

ANALYSES.

As received.

	4482	4484	4483	4919
Water	27.33	37.78	46.14	30.18
Organic matter	3.18	3.42	4.40	7.18
Ash	69.49	58.80	49.46	62.64
	100.00	100.00	100.00	100.00
Sand and soil	67.01	55.42	45.10	55.53
Nitrogen	.08	.11	.13	.25
Phosphoric acid	.05	.04	.05	....

Water-free.

	4482	4484	4483	4919
Organic matter	4.36	5.47	8.36	10.27
Ash	95.64	94.53	91.64	89.73
	100.00	100.00	100.00	100.00
Sand and soil	91.80	88.67	85.69	79.40
Nitrogen	.11	.18	.24	.36
Phosphoric acid	.07	.06	.10	....

BEEF SCRAPS.

4648. A sample of this material was sent by F. J. Hamilton, Thompsonville. It consists of waste gathered from meat markets, steamed or boiled to extract the grease and pressed into large cakes after removing the larger bones. It is used chiefly as a poultry food, but was sent to the Station to determine its fertilizer value.

The sample contained

Moisture	23.17
Nitrogen	7.22
Phosphoric acid	3.78

It contains, even in its damp state, as much nitrogen and more phosphoric acid than cotton seed meal. But owing to its mechanical condition it would be difficult to use it directly as a fertilizer. It should be composted with other material.

ANTHRACITE COAL ASHES.

4524. A sample of the finest part of coal ashes deposited in the ash box and flues of boilers in a large steam-heating plant. Sampled and sent by J. F. Barnard, North Haven.

It contained 83.56 per cent. of matters insoluble in strong acid, 3.16 per cent. of phosphoric acid and .12 per cent. of potash.

While its value as a fertilizer must be very small, it is quite possible that a heavy application of this material might greatly improve a very light, sandy soil.

REVIEW OF THE FERTILIZER MARKET.

FOR THE YEAR ENDING NOVEMBER 1ST, 1895.

BY E. H. JENKINS.

NITROGEN.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in this form was 13.2 cents in November, 1894. It fell steadily to 10.3 cents in April and since then has risen gradually to 11.7 cents in October, 1895.

The average of the monthly quotations (given on page 74) shows that nitrate of soda has ruled lower this year than for some years previously. The figures are as follows:

Year	1895	1894	1893	1892	1891	1890
Average quotation	11.4	13.0	12.7	12.1	12.9	11.5

The *retail* price of nitrogen in nitrate in this State at freight centers has been about 15½ cents per pound.

Ammonic Nitrogen.

The *wholesale* New York quotations of nitrogen in the form of sulphate of ammonia have been very much lower than in 1894, when they were practically prohibitory on its use as a fertilizer. The monthly quotation in November 1894 was 16.4 cents per pound. It fell to 15 cents in January, held that figure till April and has fallen steadily ever since, being quoted in October, 1895, at 12.2.

The average of the year's monthly quotations has been 14.3.

The corresponding averages for the years 1894, 1893, 1892, 1891 and 1890, were respectively 17.3, 15.7, 14.5, 15.6, and 16 cents, so that sulphate of ammonia has ruled lower this year than in any year since 1889.

Sulphate of ammonia has not figured in the Connecticut retail market.

Organic nitrogen.

The *wholesale* New York quotations of nitrogen in the forms of red blood, black or low grade blood and concentrated tankage for each month in the year are shown in the table on page 74. Azotin has not been quoted since February.

It will be seen that nitrogen in all these forms of animal matter has been cheaper than in the years 1893 and 1894, and that both high grade and low grade blood have steadily declined in price since January.

But these forms of organic nitrogen do not often appear in our retail market.

Low grade tankage, fish, bone, and cotton seed meal are the forms most used by those who depend on home-mixing or the use of fertilizer chemicals rather than on factory mixtures.

PHOSPHATIC MATERIALS.

Rough bone and ground bone have been quoted uniformly at $19.50 and $22.75 per ton, wholesale, through the whole year.

Ground Charleston rock has also been quoted at $8.12½ per ton till September and since then at much lower rates.

Sulphuric acid quotations have remained unchanged through the year.

Available phosphoric acid in dissolved rock phosphate has been quoted during the season at prices ranging from 2.62 to 3.5 cents per pound *wholesale.*

Dissolved phosphate rock has during the past year figured somewhat in our retail market, and there will no doubt be a further demand for it the coming season. For analyses and further remarks on the subject, see pages 25 and 64.

POTASH.

Muriate of Potash.

Since January potash in this form has been quoted *at wholesale* from 3.54 to 3.60 cents per pound, half a cent lower than during the last six months of 1894.

The retail price in Connecticut has ranged from 4 to 4½ cents per pound.

The Double Sulphate of Potash and Magnesia.

Since January, 1895, this has been quoted, *at wholesale*, at 4.32 cents per pound, somewhat lower than last year.

It has cost at retail in Connecticut about 5.3 cents per pound.

High Grade Sulphate of Potash.

The *wholesale* New York quotation of potash in this form has been about 4.2 cents for the year, more than half a cent per pound lower than in 1894.

It has retailed in this State at prices ranging from 4.9 to 5.8 cents per pound.

The review of the market quotations indicates in general that nitrogen in all forms has ruled considerably lower this year than last, that potash salts have been somewhat cheaper, and that there has been no great change in the cost of available phosphoric acid.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.35 =$ $19.13.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given :

Ammonia at	$3.00	per unit is equivalent to Nitrogen at	18.2	cts. per lb.
"	2.90	" "	17.6	"
"	2.80	" "	17.0	"
"	2.70	" "	16.4	"
"	2.60	" "	15.8	"
"	2.50	" "	15.2	"
"	2.40	" "	14.6	"
"	2.30	" "	14.0	"
"	2.20	" "	13.4	"
"	2.10	" "	12.8	"
"	2.00	" "	12.2	"
"	1.90	" "	11.6	"
"	1.80	" "	11.0	"

Commercial sulphate of ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At	4.00	cents per pound, Nitrogen costs	19.5	cents per lb.
"	3.95	" "	19.3	"
"	3.90	" "	19.0	"
"	3.85	" "	18.8	"
"	3.80	" "	18.5	"
"	3.75	" "	18.3	"
"	3.70	" "	18.0	"
"	3.65	" "	17.8	"
"	3.60	" "	17.5	"
"	3.55	" "	17.3	"
"	3.50	" "	17.1	"
"	3.45	" "	16.8	"
"	3.40	" "	16.6	"

Commercial Nitrate of Soda averages 95 per cent. of pure sodium nitrate or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per pound, Nitrogen costs	18.8	cents per lb.
"	2.9	" "	18.2	"
"	2.8	" "	17.5	"
"	2.7	" "	16.9	"
"	2.6	" "	16.2	"

If quoted at	2.5	cents per pound, Nitrogen costs	15.6	cents per lb.
"	2.4	" "	15.0	"
"	2.3	" "	14.4	"
"	2.2	" "	13.8	"
"	2.1	" "	13.2	"
"	2.0	" "	12.5	"
"	1.9	" "	11.9	"
"	1.8	" "	11.3	"
"	1.7	" "	10.6	"

Commercial Muriate of Potash and also High Grade (98 per cent.) Sulphate of Potash usually contain 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.60	cents per lb., Potassium Oxide costs	5.15	cents per lb.
"	2.50	" " "	4.95	"
"	2.40	" " "	4.75	"
"	2.30	" " "	4.55	"
"	2.25	" " "	4.45	"
"	2.20	" " "	4.35	"
"	2.15	" " "	4.25	"
"	2.10	" " "	4.15	"
"	2.05	" " "	4.06	"
"	2.00	" " "	3.96	"
"	1.95	" " "	3.86	"
"	1.90	" " "	3.76	"
"	1.85	" " "	3.66	"
"	1.80	" " "	3.56	"
"	1.75	" " "	3.46	"
"	1.70	" " "	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00	cents per lb., Potassium Oxide costs	3.77	cents per lb.
"	1.05	" " "	3.96	"
"	1.10	" " "	4.15	"
"	1.15	" " "	4.34	"
"	1.20	" " "	4.53	"
"	1.25	" " "	4.72	"
"	1.30	" " "	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1891. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of pure salt.

Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in			
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1891.	November	12.6	12.3	11.5	----	13.5	14.7	3.68	4.53	4.33	3.69
	December	12.4	12..	11.5	----	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	----	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	----	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	----	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11.2	----	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	----	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	----	10.0	14.7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	----	11.1	14.7	3.78	4.77	4.48	3.69
	August	12.3	12.1	11.2	----	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	----	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	----	12.9	14.0	3.78	4.77	4.48	3.30
	November	14.1	13.8	13.7	----	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14.2	14.8	----	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12.3	13.8	14 0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19.3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15.4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4.32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4.16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3.75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3.75	4.32	4.16	3.09
	October	16.2	15.3	15.3	17.1	11.9	16.4	3.75	4.32	4.16	3.09
	November	16.6	15.7	16.6	16.3	11.7	16.4	3.74	4.33	4.15	3.09
	December	16.1	15.3	16.1	16.3	11.3	16.4	3.74	4.33	4.15	3.09
1894.	January	15.9	14.7	16.0	15.9	12.0	16 7	3.58	4.30	4.18	3.09
	February	15.9	15.2	15.9	15.4	11.7	18 4	3.71	4.44	4.28	3.09
	March	15.5	14.6	15.5	15.4	13 0	18.5	3.71	4.44	4.28	3.09
	April	14.5	13.9	14.2	13.3	14.0	17.6	3.84	4.54	4.39	2.98
	May	14.5	13.8	14.2	12.2	14.4	16.7	4.13	5.04	4.85	3.00
	June	13.2	12.6	13.1	12.2	14.3	16.7	4.13	5.04	4.85	3.00
	July	12.6	12.6	12.9	12.2	13.8	16.8	4.13	5.04	4.85	3·00
	August	13.3	12.6	13.3	12.3	13.7	17.7	4.13	5.04	4.85	3.09
	September	15.7	14.5	15.4	12.3	13.5	18.3	4.13	5.04	4.85	3.12
	October	15.1	14.4	15.2	12.4	12.9	17.5	4.13	5.04	4.85	3.12
	November	14.1	13.1	14.0	12.3	13.2	16.4	4.13	5.04	4.85	3.00
	December	13.5	12.4	13.1	12.3	12.9	16.0	4.13	5.04	4.85	3.10
1895	January	12.7	12.2	13.0	12.3	12.1	15.0	3.54	4 24	4.13	3.50
	February	11.9	11.2	----	12.3	11.4	15.0	3.54	4.24	4.13	3.37
	March	12.1	10.5	----	12.3	10.4	15.0	3.59	4.32	4.20	3.37
	April	11.7	10.6	----	12.3	10.3	15.0	3.59	4.32	4.20	3.37
	May	12.1	10.8	----	12.3	10.5	14.3	3.59	4.32	4.20	3.37
	June	11.7	10.9	----	12.3	11.0	13.6	3.59	4.32	4.20	3.37
	July	11.6	10.7	----	12.3	10.9	13.4	3.60	4.32	4.20	3.37
	August	11.5	10.2	----	12.3	10.8	13.1	3.60	4.32	4.20	3.37
	September	11.8	10.2	----	12.3	11.3	13.0	3.60	4.32	4.20	3.23
	October	11.8	10.2	----	12.3	11.7	12.2	3.60	4.32	4.20	2.62

ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING-HOUSE CROPS.

EXPERIMENTS WITH TOMATOES.

By E. H. Jenkins and W. E. Britton.*

CONTENTS.

* The general plan of this work, the arrangement of its details and the preparation of this paper, are our joint work. The horticultural work has been done wholly by Mr. Britton. The chemical work involved has been done by Messrs. Winton and Ogden.

The use of commercial fertilizers in forcing houses has apparently received little attention from horticulturists. Bulletins Nos. 10 and 15 of the Massachusetts Hatch Station, Bulletin 43 of the Ohio Station and Bulletins 28 and 32 of the New York Cornell Station, contain the only references to work or observations on this subject, which we have been able to find.

Yet to those who are raising or contemplate raising winter crops under glass, the question of substituting fertilizers for manure, in part at least, is a very important one. Forcing-house soil, as it is usually prepared, consists of rich garden soil or rotted turf, composted with from one-fourth to one-half its bulk of horse manure. Aside from the labor of hauling and of repeatedly working over this material to secure the fine mellow condition which is desired, the cost formerly was not great. But the general introduction of electric cars has cut down enormously the production of horse manure in cities which has been the main dependence of our market gardeners. In consequence, the preparation of suitable soil for forcing-houses is increasingly expensive. Besides this it is found that even a rich natural soil cannot carry forcing-house tomatoes to their highest productiveness, and therefore liquid manure is often used to water the soil after the plants have come into bearing.

The admirable work on the use of commercial fertilizers on field tomatoes, done at the New Jersey Station, has proved that the ripening of the crop may be very materially hastened by the proper use of fertilizer chemicals, especially of nitrate of soda.

To hasten the ripening of crops under glass, where the expense of growing them is so much greater than in the field, must greatly increase the profits of the business.

These considerations have led us to endeavor to determine with all possible accuracy how much plant food various forcing-house crops take from the soil during their growth, and whether commercial fertilizers can be used instead of stable manure, wholly or in part, to supply this plant food.

A further question also connected with these, is, whether the humus of rotted manure, generally regarded as necessary to regulate the storage and circulation of moisture in the soil under natural conditions, can be replaced by some cheap substitute, or dispensed with altogether in forcing-house culture, where the supply of soil moisture can be well regulated by artificial means.

With the resources at our command, only a beginning could be made with the work, in 1895.

Experiments with Tomatoes.

Our first endeavor was to find out how much *nitrogen* tomato plants raised under glass take from the soil, in their fruit and vines, and how much nitrogen needs to be in the soil to meet fully this demand of the plants.

These questions we studied by raising tomatoes in plots on the forcing-house benches which were filled with a soil known to be practically free from available nitrogen, bnt believed to contain all other ingredients necessary for a maximum tomato crop. To these plots were added known quantities of nitrogen in form of nitrate of soda.

The weight of the fruit harvested, and of the vines which bore it, with the chemical analyses of both, furnish the means of determining how much nitrogen, phosphoric acid and potash a crop of tomatoes takes from the soil. Comparison of the quantities of nitrogen applied to the several plots, with the weights of the crops and of their nitrogen, gives some indication of the amount of nitrogen necessary to apply in order to secure a maximum crop.

To fix the initial quantities of fertilizing ingredients to be used, in the absence of all data, was necessarily guess work, and another season's tests, at least, will be needed to fully solve the questions proposed. But the experiments of 1895 have yet done much towards solving them and have furnished, incidentally, valuable results and suggestions.

We give herewith a full description of the method adopted and the course of the experiment, both being necessary to any judgment of its value.

The Forcing House.

The house was newly erected and designed by ourselves. It is a sash-bar structure made for a general-purpose house, being three-quarters span (nearly), sixteen feet wide by forty feet long, running east and west, and a partition across the centre divides the house into two apartments of equal size. The north and south benches run the entire length but the centre bench is shorter to allow for walks at the ends. The walks are two feet in width. This house is heated by steam, from a boiler which is used for heating all the Station buildings, and which carries a uniform pressure of five pounds of steam, day and night. Entering the house by an overhead flow, the steam passes the length of the house, then downward, and returns through coils of pipe under the benches. There are two coils under each of the three benches in either division of the house. Each coil is provided with a valve, so that steam may be passed through any or all of the six different coils, or may be shut off entirely; an arrangement which gives perfect control of the house temperature, even in extremely variable weather.

Ventilation is secured by a continuous line of ventilating sash along the south side, hinged at the ridge.

The north and south walls are both solid (containing no glass). The height of the former is twenty-one inches above the top of the bench, and that of the latter thirty-eight inches. This house has proven to be well adapted for forcing crops which need a high temperature.

Benches and Plots.

The bench selected for our experiments, because thought to have the most favorable exposure, was the centre bench in the east end. This bench runs east and west and is nine inches deep, having a bottom of six inch boards laid three-fourths of an inch apart for drainage. The spaces between the boards were covered with coarse peat, so that none of the soil could escape when the benches were filled. The bench was divided into five plots, each three feet, six and one-half inches by three feet eleven inches, and having an area of 1997½ square inches or 13.87 square feet.

The soil filled the plots to a depth of about eight inches, leaving abundant room after settling for watering. Six plants were set in each plot.

Preparation of the Artificial Soil.

The soil for each plot was separately mixed as follows: 300 pounds of anthracite coal ashes, sifted to pass a wire screen with four meshes to the inch, were spread on a cement floor, and nine pounds of peat moss, such as is sold in the cities for stable bedding, screened like the ashes, were scattered over them. To these were added three and one-half ounces of precipitated carbonate of lime, to neutralize a slight acidity of the peat and give to the whole a mild alkaline reaction. These materials were shoveled over twice carefully and then spread as before.

The fertilizers designed for the plot were sprinkled over this mixture and the whole was carefully shoveled over twice again to secure as perfect a mixture as possible of fertilizers and soil

and then carried in a hand-barrow to the designated plot in the forcing house.

The north bench in the same division of the house was filled with a rich soil prepared by composting good thick turf with one-third its bulk of stable manure. Plants were set in this bench mainly to make a rough comparison between crops grown on the two radically different soils. The exposure of the two benches is slightly different, that of the north bench being, perhaps, somewhat less favorable as regards light. The plants set in the north bench were also much closer together. The fertilizers used on the several plots may be seen from the table given on page 82.

Plants.

Three varieties were used: Ignotum, Acme and Dwarf Champion, two plants of each variety being set in each plot, and all receiving the same treatment.

The plants were grown from seed sown in flats about September 1st. The seedlings were potted in due time and later shifted to four inch pots, where they remained till they could be set in the plots of the forcing house benches. The earth about the roots was not disturbed in transplanting to the plots, but was sunk in the artificial soil with the plant, so that about two inches of the stem was covered with the soil. Plants were set in the plots of natural soil on December 7th, but could not be set in the artificial soil, plots 4–8, till December 31st, 1894, and January 1st, 1895.

Owing to delay in building the forcing house, the plants were all somewhat "drawn," or "leggy," when placed in the plots. They, however, outgrew their legginess in a large measure, developing into fairly normal specimens, with every appearance of thrift (where the plant food was sufficient) and bearing fruit satisfactorily.

Care during Growth.

The method of training adopted was the "single stem" system, which has been used successfully at the New York Cornell Station. By this system plants can be set closer, and while the yield may be much less *per plant* than under other systems of training, it is as large or larger per square foot of bench-area devoted to the crop.

The plants blossomed soon after setting. The first pollinating was done January 5th. Pollination was effected by holding a spoon directly under each flower and gently tapping the upper part of the blossom with a pencil or small stick. Pollen is thus shaken into the spoon and at the same time the stigma is driven into the mass of loose pollen in the bottom of the spoon. The stigmatic surface which is on the end of the style is thus coated with pollen, and as flower after flower is visited on many different plants, cross-fertilization is insured. Flowers were pollinated about every other day throughout the blossoming period.

The plants in all the plots grew finely for a time, though as early as January 8th a slight difference of color was noticeable between the plants in plot 4, which had received no nitrate of soda, and the others; the former being lighter in color. This difference increased through the season.

Plants of the Acme variety were the first to blossom; the others followed next day.

In January a slight curling of the young leaves upon the tips of the most vigorous plants was quite marked. More air and less water righted the difficulty, so that apparently no injurious results followed. This curling was more marked upon plants grown in the natural soil, than upon those grown in the artificial soil.

February 12, the plants growing in plots 6, 7 and 8 were slightly darker in color than those in plot 5. A very slight attack of rot (*Macrosporium tomato*) was first noticed on plants grown in natural soil.

February 24th: A gradation in the color of the plants was very noticeable, being darker green in each successive plot where the amount of nitrate of soda added was greater.

February 27th: The first tomatoes were harvested; three Ignotums from plot 5 and one from plot 8 (artificial soil), and two Ignotums and three Acmes from plot 1 (natural soil).

It was necessary to trim the plants from time to time to give them air and sunlight, as well as for greater convenience in cultivating the soil and gathering the fruit.

The trimmings were saved, and later, together with the plants (stems and foliage), submitted to the chemists for examination.

The plots were watered by the gardener's rule, "Water a plant when it needs it." Judgment alone must determine this. Water was applied from a hose on the surface of the soil and at no time was the soil drenched, so that any loss of fertilizers would occur by leaching. The soil was cultivated every few days with a hand weeder to loosen up the surface and check evaporation. In

order to keep the atmosphere moist, the walks were wet down every day between nine and ten o'clock, and again in the afternoon on warm sunny days. The plants were never syringed.

The temperature of the house ranged from 60° to 65° Fahr. during the night and from 10° to 15° higher through the day. On warm sunny days the thermometer often registered 85° and even 90°.

Harvesting.

While the color, size and general appearance of the plants give valuable indications, yet as the tomato is grown for its fruit alone, it is in the fruit that we must look for the measure of the practical value of application of fertilizers.

In order to collect all the necessary data on this point, an accurate record of each plant was kept, with the weight and measure of each individual tomato produced by it and with additional notes regarding form, color, etc. Each plant was numbered and each tomato was weighed, the weight (in grams) recorded, and the greatest circumference, determined by passing a measuring tape around the tomato in a plane at right angles to the axis of the fruit, was also recorded.

Chemical Analyses of the Crops.

When the plants were all bearing freely, a number of fruits of both the Acme and Ignotum variety were separately gathered from plants on each of the plots, 4, 5, 6, 7 and 8, and analyzed to determine the amounts of nitrogen, phosphoric acid and potash removed from the several plots in the crops, and incidentally to see if there were any marked differences in the composition of the two varieties of tomatoes or in the composition of the crops on the several plots.

At the close of the experiment the vines and leaves, with the leaves that had been trimmed out during the growing season, were also analyzed, to determine how much nitrogen, phosphoric acid and potash remained in them. It was impracticable to analyze the roots, as no satisfactory separation could be made from the ashes and peat, which do not separate nearly as readily from root fibers as soil.

Tabular Statement of the Plan of the Experiments and the Results.

We give below in tables the statements of yields and composition of tomatoes and vines, followed by a discussion of them.

TABLE I.—TOMATO EXPERIMENT. FERTILIZERS APPLIED AND CROPS HARVESTED.

Fertilizers applied in grams.	Plot 4.	Plot 5.	Plot 6.	Plot 7.	Plot 8.
Nitrate of Soda	none.	68.1	113.5	158.9	204.2*
Equivalent Nitrogen	----	10.9	18.2	25.4	32.7
Dissolved Bone Black	none.	47.9	47.9	47.9	47.9
Equivalent Phosphoric Acid	----	8.1	8.1	8.1	8.1
Muriate of Potash	none.	58.6	58.6	58.6	58.6
Equivalent Potash	----	29.3	29.3	29.3	29.3
Total yield of fruit, grams	316	4840	8331	10505	12522

Variety	Plot 4. Ignotum.	Plot 4. Acme.	Plot 4. Dwarf Champion.	Plot 5. Ignotum.	Plot 5. Acme.	Plot 5. Dwarf Champion.	Plot 6. Ignotum.	Plot 6. Acme.	Plot 6. Dwarf Champion.	Plot 7. Ignotum.	Plot 7. Acme.	Plot 7. Dwarf Champion.	Plot 8. Ignotum.	Plot 8. Acme.	Plot 8. Dwarf Champion.
Yield of each variety, 2 plants, grams	120	155	41	1934	1853	1053	2285	3870	2176	3081	4421	3003	4194	5205	3123
Average yield per plant, grams	60	77.5	20.5	967	926.5	526 5	1142.5	1935	1088	1540.5	2210.5	1501.5	2097	2602.5	1561.5
" " " pounds	.13	.17	.04	2.13	2.04	1.16	2.52	4.27	2.40	3.40	4.88	3.31	4.63	5.74	3.44
Average number fruits per plant	1	1.5	.5	8	12.5	6	8	18.5	11.5	12	19.5	19.5	23.5	23.5	16
Average weight per fruit, grams	60	51.6	41	120.8	74.1	87.7	142.8	104.6	94.6	124.2	113.3	77	89.2	110.7	97.5
Average number of double fruits	0	0	0	0	0	0	.5	1	0	3	.5	.5	0	1.5	.5
" " perfect shaped fruits	0	1.5	.5	0	4.5	2	4	3.5	3.5	3	10.5	7.5	3	11.5	4
Per cent. of perfect shaped fruits	0	100	100	0	36	33	50	19	30	25	51	38	13	48	25
Average yield per square foot of bench area grams	25.95	32.52	8.86	418.34	400.82	227.77	494.26	837.11	470.69	666.45	956.30	649.58	907.20	1125.89	675.52
Average yield per square foot of bench area, pounds	.057	.074	.012	.92	.88	.50	1.09	1.84	1.03	1.47	2.11	1.21	2.00	2.48	1.48

* One-half mixed with the soil at setting time, the rest spread on the surface, Feb. 11.

TABLE III.—COMPOSITION OF TOMATO VINES AND LEAVES AND OF FRUIT.

	Air-Dry Tomato Vines and Leaves. Plot 4. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Fresh Tomato Fruit. Acme Variety. Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Ignotum Variety. Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Average of 18 Maryland Analyses.*	Average of 12 New Jersey Analyses.†
Water	3.92	7.57	7.90	7.81	8.02	93.41	94.07	94.17	94.81	93.97	94.53	94.54	94.79	94.75	
Phosphoric Acid	1.85	.92	.64	.49	.51	.066	.052	.052	.053	.062	.057	.061	.059		
Potash	2.69	3.84	3.88	3.58	3.44	.356	.295	.334	.287	.339	.338	.345	.303		
Nitrogen	.73	.95	1.00	1.12	1.38	.079	.089	.118	.139	.082	.099	.118	.145		
Water-Free.															
Phosphoric Acid	1.91	.99	.70	.53	.56	1.00	.87	.90	1.02	1.03	1.04	1.11	1.13	1.01	1.13
Potash	2.80	4.15	4.21	3.90	2.65	5.40	4.97	5.73	5.53	5.62	6.19	6.32	5.81	5.93	4.31
Nitrogen	.76	1.03	1.09	1.21	1.50	1.20	1.50	2.03	2.68	1.36	1.81	2.16	2.78	3.35	2.09

* Md. Sta. Bull. 11. Raised in field.

† N. J. Sta. Bull. 63. Raised in field.

TABLE IV.—QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH, TAKEN FROM EACH PLOT BY CROP (IN GRAMS).

	Plot 4.			Plot 5.			Plot 6.			Plot 7.			Plot 8.		
	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.
Nitrogen	.25	.30	.55	3.88	2.46	6.34	7.64	3.61	11.25	12.40	4.61	17.01	17.66	5.57	23.23
Phosphoric Acid	.20	.75	.95	3.12	2.38	5.50	4.45	2.31	6.76	5.74	2.02	7.76	6.89	2.06	8.95
Potash	1.11	1.09	2.20	16.90	9.95	26.85	25.56	13.99	39.55	35.43	14.73	50.16	36.61	9.85	46.46

TABLE II.—YIELD OF AIR-DRY VINES AND OF FRESH FRUIT ON EACH PLOT (IN GRAMS).

	Vines.	Fruit.
Plot 4	40.5	316
" 5	259.0	4,840
" 6	360.5	8,331
" 7	411.5	10,505
" 8	403.5	12,522

DISCUSSION OF THE CHEMICAL DATA OF THE EXPERIMENT.

1. The artificial soil of itself contained very little, if any, nitrogen available to tomatoes. Six plants with their fruit growing on it contained only half a gram (seven and one-half grains) of nitrogen, and a portion of this came from the young plants and their adhering earth, which were set in this artificial soil.

2. The four plots, 5, 6, 7, 8, with regularly increased applications of nitrogen, show an increasing yield of fruit, of average number of fruits per plant, and of nitrogen, phosphoric acid and potash* in the crop. Table V. presents these facts :

TABLE V.—STATISTICS REGARDING THE CROPS OF TOMATOES (FRUIT AND VINES) ON THE FIVE PLOTS OF ARTIFICIAL SOIL.

	Amount of Nitrogen added. Grams.	Weight of Fruit Grams.	Average number of Fruits per plant. Grams.	Average weight of a single Fruit. Grams.	Yield of Crops in Nitrogen. Grams.	Phos. Acid. Grams.	Potash. Grams.
Plot 4	0.0	316	1.0	50.8	.55	.95	2.20
Plot 5	10.9	4840	8.8	99.6	6.34	5.50	26.85
Plot 6	18.2	8331	12.6	112.5	11.25	6.76	39.55
Plot 7	25.4	10505	17.0	103.1	17.01	7.76	50.16
Plot 8	32.7	12522	21.0	99.1	23.23	8.95	46.46

It is altogether probable that the tomato plants in this experiment needed more than the quantity of nitrogen applied to plot 8, in order to yield their maximum crop. Of the total nitrogen added, at least 58 per cent. was taken by the crop on plot 6, 65 per cent. on plot 7, and 69 per cent. on plot 8. This increased per cent. of assimilation also indicates that the plants that received most nitrogen still had no excess.

3.—It appears also that the quantities of both phosphoric acid and potash which were added to the plots in fertilizers, were

* Excepting Plot 8.

entirely insufficient for the needs of the maximum tomato crop, but that the plants were able to obtain some phosphoric acid and very considerable quantities of potash from the coal ashes. The following statement shows this:

TABLE VI.—QUANTITIES OF PHOSPHORIC ACID AND POTASH IN THE FERTILIZER AND IN THE CROP (FRUIT AND VINES).

	Plot 5. Grams.	Plot 6. Grams.	Plot 7. Grams.	Plot 8. Grams.
Phosphoric Acid applied	8.14	8.14	8.14	8.14
Phosphoric Acid harvested	5.50	6.76	7.76	8.95
Potash applied	29.30	29.30	29.30	29.30
Potash harvested	26.85	39.55	50.16	46.46

On three of the plots the potash added in fertilizers was certainly insufficient, and on two at least phosphoric acid was deficient.

Whether the chemical fertilizers and the coal ashes together supplied all the potash and phosphoric acid which the crops needed, or whether the plants on plot 8 suffered for lack of potash or phosphoric acid as well as of nitrogen, cannot now be determined.

It is not certain that the available potash and phosphoric acid came from the coal ashes themselves. Possibly the kindlings or waste, which is sometimes burned in the furnace in very small amount, supplied them.

4.—Tomato plants grown in artificial soil, under the conditions of our experiment, actually removed from the soil in fruit, vines, and leaves:

	Per Plant. Grams.	Per 100 square feet of bench. Grams.
Nitrogen	3.87	167.5
Phosphoric Acid	1.49	64.5
Potash	8.36	361.7

These are equivalent to the following quantities of nitrate of soda (16 per cent. nitrogen), dissolved bone black (17 per cent. available phosphoric acid) and muriate of potash (50 per cent. potash).

	Per Plant. Grams.	Ounces.	Per 100 square feet of bench. Pounds and Ounces.
Nitrate of Soda	24.2	.86	2 and 5
Dissolved Bone Black	8.8	.31	0 and 13
Muriate of Potash	16.7	.59	1 and 9

These are the quantities actually contained in the crop, exclusive of the root system.

If the soil used were quite free from all available nitrogen, phosphoric acid and potash, from one-third to one-half or even more than the quantities named might be needed to produce the crop, because, as our vegetation experiments and those of others have indicated, plants are not able to assimilate, even in extreme cases, more than 75 or 80 per cent. of the soluble plant food in the soil, and because in these observations no account has been taken of the fertilizing materials contained in the roots.

5.—The composition of the two varieties of tomatoes as respects ingredients named in the table, is very nearly alike, the Ignotum in every case having a very slightly higher percentage of nitrogen, phosphoric acid and potash, than the Acme.

The average of twelve analyses of the dry matter of tomatoes raised in the field, differently fertilized, New Jersey Agricultural Station Bulletin 63, and also the average of eighteen analyses, Maryland Agricultural Station, Bulletin 11, are given in the table on page 83. The comparison shows that as far as these four ingredients were concerned normal fruit was raised in this artificial soil with commercial fertilizers.

6.—Every 100 pounds of ripe tomatoes removed from the soil the equivalent of:

400 grams or 14 ounces of Nitrate of Soda.
147 grams or 5 ounces of Dissolved Bone Black.
266 grams or 10 ounces of Muriate of Potash.

DISCUSSION OF THE HORTICULTURAL DATA.

The increase of weight of the crops of each variety, with each successive increase in the nitrogen added in the fertilizer, and the like increase in the average number of fruits per plant of each variety, have already been discussed.

1.—The highest average weight per fruit of the Ignotum variety was on plot 6, of the Acme on plot 7, and of the Dwarf Champion on plot 8.

2.—The tendency to bear double flowers, which produced irregular-shaped fruit, seemed to bear no relation to the quantity of nitrogen applied, nor to the variety. The same plant produced both single and double blossoms.

3.—The number of perfect fruits was absolutely larger on the plots receiving most nitrogen, but there was no very marked relative increase in number.

Bailey found*, however, that plots which were most highly fertilized gave the smoothest fruit.

4.—Comparison of the three varieties shows that Acme gave the largest yield in artificial soil, but the yield of Ignotum was considerably the largest of the three, when grown in rich garden soil.

Acme gave the greatest average number of tomatoes per plant, while the average weight per fruit of Ignotum was considerably greater than that of the other varieties.

5.—The Dwarf Champion proved to be an unprofitable variety in this test.

6.—Tomatoes from the unfertilized plot (Plot 4) were small, smooth and of good shape, but the color was not normal. They were too light in color and slightly rusty-looking,—having a faded appearance. The flesh of the tomato was very dry, and sweet to the taste—much sweeter than tomatoes from other plots.

Tomatoes of best form, size and color grew upon plots 6 and 7. Those from plot 8 (and a few from plot 7) ripened very unevenly, and were green about the stem when the other side of the fruit was of good color and apparently ripe. These tomatoes had a decided tendency toward softness while still green; the form and size were very good.

Comparison of Plants Grown in Natural Soil with those Grown in Artificial Soil.

As has been noted above, there were, in the same house with the experimental plots, a considerable number of plants grown in natural soil prepared as described on page 79. These were set much closer in the bench than those grown in artificial soil. The latter had a bench space of 2.31 square feet per plant, the former about 1.15 square feet.

The plants in soil had three weeks the start of those in ashes and peat, being set in the beds on December 7th, while the plants were not set in the ashes and peat until December 31st.

These facts render any very strict comparison of the two impossible, nor was strict comparison intended when the experiment was begun.

* Cornell Station Bulletin No. 10, page 116.

The following facts, however, deserve notice. In what follows we refer only to the crops grown on plots 7 and 8. The others, 4, 5 and 6, had no adequate supply of nitrogen, and it must also be borne in mind that plots 7 and 8 in all probability did not have a full supply of either nitrogen, phosphoric acid or potash. The tomatoes grown in ashes and peat grew and fruited much more rapidly than those in natural soil, and then suddenly stopped their growth and bearing, the leaves turned brown and the plants appeared to be dead. They were not dead, however, by any means, and after cutting back to near the roots and *supplying more fertilizers*, they made a new and vigorous growth and fruited again.

The plants grown in natural soil, however, kept bearing a little fruit till the following July, when they were thrown out to make room for other experiments.

We believe the plants in peat and ashes fruited more quickly and abundantly, because they had at first a larger supply of soluble plant food than those in natural soil :—that when that was exhausted, they had no resource and died back in consequence :—that if they had been sufficiently fertilized, they would have proved far more prolific and profitable than those in natural soil. To decide this will be one point in next year's experiments.

The following statement gives the average yield per plant of the three varieties (4 plants of each) on plot 8 in artificial soil with commercial fertilizers, also the average yield per plant (an equal number of each of the three varieties was used to calculate this) of the three varieties grown in rich natural soil up to April 17th, the date when, as already described, the plants in artificial soil died back for lack of nourishment. Up to this date the plants had been growing in the natural soil three weeks longer than in the artificial soil. The total yield of the plants in natural soil, up to July 16th, is also given, though after the middle of April there is little or no profit in forcing-house tomatoes.

Table VII.—Average Yield per Plant in Natural and in Artificial Soils.

	Peat and Ashes with Fertilizers. To April 17th.	Natural Soil. To April 17th.	Natural Soil. To July 16th.
Yield per Plant (grams)	2087	976	1820
Yield per Plant (pounds)	4.59	2.15	4.00
Number of Fruits per Plant	21	10.4	22.7
Weight of Fruits (grams)	99.1	91.7	82.4
Yield per square foot (grams)	904	847.0	1583
Yield per square foot (pounds)	1.99	1.86	3.5

The table shows that up to the time when the fertilizers in the artificial soil were proved (by the chemical analyses) to be exhausted, the plants in artificial soil had produced, per square foot of bench space, seven per cent. more tomatoes than those in the natural soil, while the latter had, up to that time, three weeks more of growing season.

It is possible that the plants in natural soil, if they had been set further apart, would have, in the same time, made a larger crop per foot of bench space. It is possible too, that with an increased supply of fertilizers the plants in artificial soil would have given a largely increased yield. We cite these figures only to show that the tomato crop can be successfully grown in a soil made of ashes and peat, such as we have described, with the aid of commercial fertilizers.

SUMMARY.

1.—A forcing-house tomato crop yielding about two pounds of fruit for each square foot of bench room, takes in the vines and fruit, for every hundred square feet of bench space, not less than:

	Grams.		Pounds.	Ounces.
Nitrogen	168	Equivalent to Nitrate of Soda	2	5
Phosphoric Acid	65	" " Dissolved Bone Black	0	13
Potash	362	" " Muriate of Potash	1	9

Of this from a fourth to a fifth only is in the vines.

2.—To enable the plants to get these fertilizer elements as required, there should be a large excess of them in the soil, perhaps double the quantity given above.

3.—Every 100 pounds of tomato fruit takes from the soil approximately:

	Ounces.		Ounces.
Nitrogen	2.2	Equivalent to Nitrate of Soda	14
Phosphoric Acid	0.9	" " Dissolved Bone Black	5
Potash	4.6	" " Muriate of Potash	10

4.—It is possible to grow a crop of forcing-house tomatoes, amounting to two or more pounds per square foot of bench space, perfectly normal in size, color, taste and chemical composition, by the aid of commercial fertilizers alone, and in soil composed of coal ashes and peat.

The scope of these experiments has been considerably enlarged and they will be continued during the season of 1895 and 1896.

THE USE OF AN ARTIFICIAL SOIL AND COMMERCIAL FERTILIZERS IN FORCING-HOUSES.

By E. H. Jenkins and W. E. Britton.

We are not at present prepared to recommend any departure from those methods of raising a forcing-house crop of tomatoes which experience has approved.

The experiments of a single season and of a single observer, and on the very small scale made necessary by our limited space, are necessarily quite inconclusive.

Moreover these experiments were not undertaken with the object of learning whether artificial soil could be generally used in forcing-houses as a substitute for natural soil, but solely to determine how much nitrogen in the soil was necessary for the full development of the tomato plant.

Yet we feel justified in calling attention to certain apparent advantages in using the artificial soil which we have described.

Cost.

For every 100 square feet of bench space, about 2200 pounds of sifted coal ashes and 63 pounds of dried peat or leaf mold is required to fill the bench eight inches deep with soil. Experiments are now in progress to determine whether the use of peat is necessary.

About 10 pounds of commercial fertilizers are needed for this bench space, costing, at present ruling ton rates, less than 21 cents. The cost of these things is to be compared with the cost of providing a considerably greater weight of rich compost containing a large relative amount of stable manure.

In very many cases, the cost of filling the benches with the artificial soil must be very much less than the cost of filling them with rich garden soil.

Early Maturing of Crop.

The greatest expense in running a forcing-house is the artificial heat required, and for this reason, quick growth and early maturity are extremely desirable. Regarding the relative availability of the potash and phosphates in compost and in commercial fertilizers, we know little, but it is very certain that the nitrogen of composts is slowly available as compared with the nitrogen of nitrates.

Our tomato tests above described showed too, very clearly, that plants in natural soil made much slower growth and were slower in fruiting than those in artificial soil supplied with nitrates. Though the former were set fully three weeks earlier, both began fruiting at the same time. These facts have already been shown on page 89.

Freedom from Insects and Fungi.

The coal ashes, which constitute about 97 per cent. of the artificial soil, are of course absolutely free from all forms of life, when taken for forcing-house use. This is, by itself considered, an advantage.

The peat, while by no means free from low forms of life, is yet far less adapted to their existence and growth than the rich garden soil. It was noticed, when the benches were cleared out in the summer, that the wood under the artificial soil was hard and sound, while under the natural soil it had decayed quite perceptibly in a single season through the agency of the microbe life in the soil, of which the artificial soil was comparatively destitute.

Freedom from Nematodes in Particular.

Tomatoes grown under glass are usually attacked at the root by a species of small worms known as Nematodes (*Heterodera radicicola*), which induces the well known root-galls.

The soil becomes so infested with these worms that it cannot be used two seasons in succession for tomatoes.

The practice, therefore, is to throw it out and let it lie over one winter. Freezing the soil greatly diminishes the number of the nematodes, so that it can be used in the forcing-house again the third season.

Wherever natural soil was used in our tests, we found the roots thoroughly infested with nematodes and covered with galls. On the contrary, where artificial soil was used, no root-galls whatever were found beyond the ball of earth set with the plant. In this they were quite abundant.

ON THE CHEMICAL COMPOSITION OF LETTUCE GROWN IN THE FORCING-HOUSE.

By E. H. Jenkins and W. E. Britton.

Experiments of the same kind as those fully described in the previous paper, page 75 of this Report, have been made with lettuce.

Extended notice of them is deferred till further tests are completed, but the following data have value apart from their connection with our special line of work and are accordingly given here.

The house was not well adapted for growing lettuce, being fitted with benches and bottom heat instead of solid beds.

Each plot, 3 feet 11 inches by 2 feet 11½ inches, had an area of 11⅗ square feet and 200 pounds of the peat and ashes mixture filled it to the depth of six inches. The mixture contained five per cent of peat moss.

The variety of lettuce grown was Simpson's White Seeded Tennis Ball. The seed was sown in flats and as soon as the plants were large enough to handle they were pricked out four inches apart each way on the bench. They remained here until ready to be transferred to the experimental plots, when they were set eight inches apart each way, making thirty plants in each plot.

The quantities of plant food added to this soil are shown in the table, which also presents in detail the results of the experiment.

When the crop was harvested, the lettuce heads were cut close to the surface of the soil, immediately weighed in their fresh condition, and dried for analysis.

The roots were pulled and the soil separated as well as could be, but as is seen by the large amount of matter "insoluble in acid" the separation was quite imperfect and a part of the fertilizing elements found on analysis had not really entered the roots, but was in the adhering soil. The chemical analyses were made by Messrs. Winton and Ogden.

TABLE I.—FERTILIZERS APPLIED AND CROPS HARVESTED (IN GRAMS).

Fertilizers applied.	Plot 38.	Plot 39.	Plot 40.	Plot 41.
Nitrogen	7.11	11.85	16.59	21.34
Equivalent Nitrate of Soda	44.4	74.0	103.7	133.4
Phosphoric Acid	6.80	6.80	6.80	6.80
Equivalent dissolved Bone Black	40.0	40.0	40.0	40.0
Potash	24.24	24.24	24.24	24.24
Equivalent Muriate of Potash	48.5	48.5	48.5	48.5
Crops harvested.				
Lettuce Heads	1232.8	2217.6	2720.6	3083.1
Lettuce Roots*	219.6	361.3	368.4	368.5
Total	1452.4	2578.9	3089.0	3451.6
Dry Substance of Crop	205.5	346.2	349.56	358.33

TABLE II.—COMPOSITION OF THE FRESH PLANTS.

	Plot 38.		Plot 39.		Plot 40.		Plot 41.	
	Roots.	Heads.	Roots.	Heads.	Roots.	Heads.	Roots.	Heads.
Water	60.66	90.33	53.84	91.89	60.16	92.56	60.82	93.06
Nitrogen	.196	.186	.237	.221	.235	.236	.229	.247
Phosphoric Acid	.148	.100	.130	.088	.102	.076	.103	.073
Potash	.292	.563	.293	.564	.321	.566	.317	.566
Insoluble in Acid	20.76	....	27.69	....	22.31	....	21.87	....

TABLE III.—THE QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH TAKEN UP BY THE CROPS (IN GRAMS).

	Plot 38.			Plot 39.			Plot 40.			Plot 41.		
	Roots.	Heads.	Total.	Roots.	Heads.	Total.	Roots.	Heads.	Total.	Roots.	Heads.	Total.
Nitrogen	.43	2.29	2.72	.86	4.90	5.76	.87	6.41	7.28	.85	7.63	8.48
Phosphoric Acid	.32	1:22	1.54	.47	1.94	2.41	.37	2.07	2.44	.38	2.25	2.63
Potash	.64	6.94	7.58	1.06	12.52	13.58	1.18	15.40	16.58	1.17	17.46	18.63
Ratio of Phosphoric Acid to Nitrogen and Potash	1:1.8:4.9			1:2.4:5.6			1:3.0:6.8			1:3.2:7.0		

The facts which this experiment has developed may be summarized as follows:

1. Lettuce of good quality can be grown under glass in an artificial soil such as we have described, with the use of commercial fertilizers.

We are not prepared to say at present that its quality is as good as the best lettuce grown in rich, natural soil.

2. A crop of forcing-house lettuce, raised as above described, takes from the soil in roots and heads, per 1000 heads, not less than:

	Grams.		Pounds.	Ounces.	
Nitrogen	**282.6**	**Equivalent to**	**3**	**15**	**Nitrate of Soda**
Phosphoric Acid	**87.7**	**"**	**1**	**2**	**Dissolved Bone Black.**
Potash	**621.0**	**"**	**2**	**10**	**Muriate of Potash.**

* With much adhering soil.

3. To supply this plant food to the soil under the conditions of our experiment, it was necessary to add to the soil the following quantities of fertilizers per 1000 plants, or per 387 square feet, the area used in our experiment for 1000 plants.

	Pounds.	Ounces.	Costing cents.
Nitrate of Soda	**9**	**13**	**25**
Dissolved Bone Black	**2**	**15**	**4**
Muriate of Potash	**3**	**8**	**7**
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Loss of Fertilizer-Nitrogen.

It may not be out of place, in a discussion of the nitrogen-supply for the soil of forcing houses, to call attention to some recent observations regarding the loss of nitrogen, not only from stable manure itself, but from nitrogenous fertilizers of various kinds, nitrates, ammonia salts, urine, fresh vegetable matter, etc., when they are used in connection with stable manure.

It has been known for some time that in full access of air, the nitrogen of nitrates as well as that of organic matters occurring in manure, may be lost as nitrogen gas by the action of microbes.

That losses similar in kind, if much less considerable in amount, may occur in soils, is perhaps not as fully established, but seems quite probable.

Wagner, as the result of carefully made vegetation experiments, concludes that the nitrogen of *well rotted* stable manure is very much less readily available to plants than has been generally supposed. In Wagner's trials the availability of the nitrogen of nitrates being taken as 100 per cent., that of the nitrogen of rotted stable manure was about 45 per cent., while that of various other organic matters commonly used as fertilizers ranged from 60 to 70 per cent.

On the other hand, Kühn found as a result of somewhat similar tests, that if the availability of the nitrogen of sulphate of ammonia (itself a little less quickly available than nitric nitrogen perhaps) was called 100 per cent., that of *fresh* cattle dung was 92 per cent.

This disagreement between the observations of the two experimenters is to be explained probably by differences in the kind of microbe life of the soil or manure, or in the conditions affecting this microbe life, during the course of the experiment, depending on the age and keeping of the stable manure or dung.

In connection with his experiments, Wagner observed that nitrates dissolved in a water-extract of *fresh* horse dung, were destroyed with liberation of free nitrogen. When its microbes are killed dung does not have this effect.

What is particularly new and striking in Wagner's observations, however, is that *fresh* dung used with nitrates or with green vegetable substances as a fertilizer, may so depress their fertilizing effect, that the increase of crops secured by the horse dung and nitrates, etc., together, may be less than is produced by the nitrates, etc., alone. The following statement of the yields, in one of his experiments, shows this fact :

No. of Experiment.		Fertilizer used.	Dry matter of Crop (grams).	Of 100 parts of nitrogen in fertilizer there was recovered in the Crops
1	Without fresh horse-dung.	No added nitrogen	13.5	
2		1 gram nitrogen added as nitrate	85.7	65
3		1 gram nitrogen added as green vegetable matter	74.6	38
4	With fresh horse-dung, supplying 2 grams nitrogen.	No added nitrogen	2.9	----
5		1 gram nitrogen added as nitrate	50.7	10
6		1 gram nitrogen added as green vegetable matter	15.1	4

Here it appears that soil, to which were added three grams of nitrogen, viz: two grams in form of *fresh* horse dung and one gram in form of nitrate of soda, yielded a very considerably smaller crop than the same soil to which one gram of nitrate nitrogen was added *without* dung.

This, according to Wagner, is explained by the fact that the microbes in the *fresh* dung expelled nitrogen in the gaseous form, both from the dung itself and from the nitrate, before vegetation could assimilate it.

While the horse dung applied in Wagner's trials was fresh and the quantities were much larger than are ordinarily used in farm practice, yet the facts above cited have a very important bearing on the use of fresh stable manure and possibly on the value of composts, such as are used for forcing-house soil, in which the proportion of stable manure is approximately near to that which was used in Wagner's tests, where a large loss of nitrogen was observed.

It might, therefore, happen that applications of nitrates or other nitrogenous fertilizers to the soil of the forcing-house, would have no marked effect on the crop, while nevertheless available nitrogen was deficient and the crop suffering in consequence. This result might at least be expected to follow the use of fresh-manure water.

A few observations made at this Station bearing on this subject may here be recorded :

Fifty grams of surface soil from the Station garden, (which is annually dressed liberally with mixed cow and horse manure and with fertilizer chemicals), 50 grams of fresh cow dung and 50 grams of fresh horse dung were stirred up with water, each in a separate vessel and the muddy liquids were strained through tufts of glass wool. This was repeated till the volume of the filtered liquid amounted in each case to 750 c. c. To each was then added five grams of sodium nitrate and water to make 1000 c. c.

Nitrogen as nitrates was immediately determined in each solution. The flasks were tightly stoppered and kept in a closet, nearly dark. From time to time nitrogen was again determined, as shown in the following statement, which gives the weight of nitric nitrogen (in grams) found in 25 c. c. of these solutions on the dates named and the corresponding per cent. loss of nitrogen:

	Nitrate with extract of garden earth.		Nitrate with extract of fresh horse-dung.		Nitrate with extract of fresh cow-dung.	
	Nitrogen.	Per cent. loss.	Nitrogen.	Per cent. loss.	Nitrogen.	Per cent. loss.
March 23	.0195	----	.0190	----	.0192	----
March 30	.0196	----	.0172	*9.5*	.0178	*7.3*
April 5	.0193	*1.0*	.0166	*12.6*	.0180	*6.3*
April 23	.0190	*2.6*	.0160	*15.8*	.0171	*10.9*
May 24	.0195		.0155	*18.4*	.0173	*9.9*
Nov. 20	.0193	*1.0*	.0160	*15.8*	.0165	*14.1*
Jan. 28	.0186	*4.6*	.0167	*12.1*	.0162	*15.6*

It appears that in the extract of garden soil, very little nitrogen was lost through reduction of nitrates during ten months.

The extracts of fresh horse dung and fresh cow dung, caused considerable loss of nitrogen from the nitrates by reduction. The reduction by the extract of cow dung was in this experiment somewhat slower and less in amount than that of the horse dung.

While the gains and losses of nitrate nitrogen in several cases are within the limits of analytical error, it is probable that in the extract of horse-dung after May 24, nitrates began to increase by nitrification of the organic nitrogen.

In a further experiment two extracts were prepared in precisely the way above described, the one from 50 grams of fresh horse dung, the other from 50 grams of a potting soil prepared for use in the forcing house. This was made of pasture sod and the soil just beneath, composted with about one-third their bulk of mixed horse and cow manure. The mixture made in the summer of 1894 had stood in a conical compact pile, exposed till the fall of 1895. The soil for this experiment was taken from the interior of this pile at a depth of 2-3 feet.

To each of the extracts prepared as above and measuring 1000 c.c., five grams of nitrate of soda were added.

The following table shows the quantity of nitrogen as nitrates and the losses found at various dates in these two preparations:

	Extract of Potting Soil. Nitrogen.	Per cent. loss.	Extract of fresh horse-dung. Nitrogen.	Per cent. loss.
Nov. 22	.0201		.0200	...
Dec. 21	.0194	*3.5*	.0192	*4.0*
Jan. 28	.0186	*7.5*	.0164	*18.0*

While the surface soil of the garden referred to on page 94, although heavily dressed each year with stable manure, had little or no effect in destroying nitrates, the potting earth (made by composting contiguous pasture sod and a few inches of underlying soil with stable manure), reduced nitrates to about half the extent caused by fresh horse dung.

This result is in accord with familiar facts. The surface soil of tilled ground is commonly or always charged with oxidizing and nitrifying organisms. Fresh and damp compost heaps where vegetable or animal matters are abundant and the soil of forests, low meadows and bogs, contain little or no nitrates, and their bacterial growths are of the deoxidizing or reducing kinds. It is probable that, near the surface of the heap of potting earth, nitrifying organisms were abundant at the very time when the sample taken from the interior was found to have a denitrifying effect.

Accordingly the use of potting earth from the exterior of a compost heap may occasion no loss of nitrate-nitrogen, while earth from the interior of the heap may reduce nitrates and cause serious waste of any nitrate that is applied as a fertilizer.

It is therefore advisable, sometime before using potting compost, to place it under cover away from rain, and to intermix it thoroughly and frequently and to keep it in rather shallow heaps.

VEGETATION EXPERIMENTS ON THE AVAILABILITY OF NITROGEN IN CERTAIN NITROGENOUS MATERIALS.

BY S. W. JOHNSON, W. E. BRITTON AND E. H. JENKINS.

CONTENTS.

The experiments here described are a continuation of work done in previous years, references to which are given in the Eighteenth Report of this Station, 1894, page 73.

Mr. Britton has had entire charge of the preparation of the seed and soil, filling the pots and caring for the crops through the whole period of growth.

All the chemical work involved has been done by Messrs. Winton and Ogden, chemists of the Station.

SCOPE OF THE VEGETATION EXPERIMENTS OF 1895.

In 1894 we studied the availability of nitrogen by vegetation experiments with maize, grown in pots of artificial soil, and supplied with relatively small quantities of nitrogen in various fertilizers.

The availability of the nitrogen in each case was measured by the quantity of nitrogen which the crop took from the fertilizer.

The artificial soil itself contained only traces of available nitrogen, but all the other elements of plant food were present in excess of the crop requirements.

If from 10 grams of nitrogen in form of nitrate, growing maize takes up 6 grams, while under exactly the same conditions from the same quantity of nitrogen in form of blood it takes up but 5 grams, the comparative availability of nitrate-nitrogen and blood-nitrogen is as 6 to 5 or as 100 to 83.3.

But a single crop cannot take all the nitrogen even of a nitrate from the soil, because, for one reason, the plant roots do not reach every particle of the soil. 73 per cent. is the largest proportion of the soil-nitrogen which a single crop has been able to secure in our experiments.

Still less can one crop take all the nitrogen from those animal or vegetable matters which decompose but slowly in the soil. In any case therefore more or less fertilizer-nitrogen fails to enter the crop.

In the case just given, 4 grams of nitrate nitrogen and 5 grams of blood nitrogen remain in the stubble, roots and soil, or pass into the air. The question at once arises, may not the 5 grams of blood nitrogen supply more nitrogen to the next crop than the 4 grams of nitrate nitrogen? If so, the results of a single year's cropping do not give the full value of blood-nitrogen as compared with nitrate nitrogen. The after-effects of both must be studied.

To do this, additional quantities of the same forms of nitrogen were mixed with the soil of the pots that had been used in the tests of 1894, and in 1895 they were made to bear a crop of oats followed by a crop of maize. From the quantities of nitrogen which these crops contained is calculated the availability of nitrogen as before.

Now if in the second year for every 6 grams of nitrogen taken by the crop from nitrate, 5½ grams are taken by the crop from blood, instead of 5 as in the first year, this extra ½ gram must have come from nitrogen applied the previous year, which had become available to the second year's crop, and the relative availability of the two forms of nitrogen is by so much nearer alike.

The artificial soil in our experiments was impregnated with a watery infusion of rich garden earth, but the conditions affecting microbic life may be quite different in a mixture of peat and ashes from those which obtain in natural soils, and it is likely that the relative availability of nitrogen in various vegetable and animal matters may differ in different kinds of soil, because the rapidity with which a nitrogenous organic substance decomposes

and yields its nitrogen to plants largely depends on the character and activity of the microbes within the soil, which appear to be much influenced by texture, tillage and various conditions.

These considerations led us to make two parallel series of vegetation experiments in addition to those here described; one with soil taken from under old pasture turf which had not been broken up for thirteen years, nor top-dressed for ten years; the other with soil from a plot planted to corn for five years in succession without being dressed during that time with either manure or fertilizers.

Before publishing any results of these experiments with natural soils, we desire to repeat them with improvements suggested by recent experience and hope to make some report of them a year or two hence.

The Apparatus and Method.

These have been fully described in our Report for 1894, page 74, and in all points not specially noted in the following pages the same apparatus and method were employed in both years.

Vegetation Experiments in Artificial Soil. 1895.

A. Oat Crop.

These include those pots used in 1894, numbered from 5 to 21, 23 to 27, 102 to 117, 123 to 130, 135 to 137, 142 to 147. (See pages 83 to 86, Report of 1894.)

Soil and Fertilizers.—The pots, after the harvest in 1894, stood in a very dry cellar through the winter.

Just before planting time in the spring of 1895 the soil, consisting of coal ashes and peat with the roots of the crop of 1894, was poured out of each pot, such roots as had not decayed were pulverized and mixed with the soil, and after incorporating the fertilizers also with the soil, the whole was filled into the pot on the layer of gravel as described on page 78, Report of 1894.

Each pot received 5 grams of phosphate of potash, .25 gram of sodium chloride, .5 gram of sulphate of magnesia and 16 grams of carbonate of lime. The phosphate of potash contained 49.27 per cent. of potash and 35.82 per cent. of phosphoric acid, so that in 1895 each pot acquired 2.46 grams of potash and 1.79 grams of phosphoric acid. This, in addition to the amount of these ingredients left in the soil from the application made in 1894, could hardly have failed to provide both potash and phosphoric acid in excess of the crop requirements, for the largest crops harvested in 1895, from pots 12 and 13, took but .56 and .60 grams of phosphoric acid and 2.18 and 2.20 grams of potash respectively, from the soil.

The nitrogenous matters used in these experiments were the following:

Commercial Nitrate of Soda, slightly dried to facilitate grinding and weighing and containing 16.15 per cent. of nitrogen. This was a part of the same preparation which was used in 1894.

Dried Blood, bought from a dealer in fertilizers, which contained 11.4 per cent. nitrogen.

Castor Pomace, No. **4546,** a ground residue left after the removal of oil from the castor bean (*Ricinus*). The sample contained 4.98 per cent. of nitrogen.

Castor Pomace, No. **4545,** another sample, containing 4.78 per cent. of nitrogen.

Cotton Seed Meal. Bright yellow meal from the Connecticut market, containing 8.39 per cent. of nitrogen.

Dry Ground Fish, containing 9.51 per cent of nitrogen.

Ground Horn and Hoof from Chicago. Said to be made from horns and hoofs steamed under high pressure, which renders them brittle and easily reducible to a fine powder. The sample contained 15.59 per cent. of nitrogen and is part of the same preparation which was used in 1894.

"Bone Tankage," bought in New Haven, which contained 5.10 per cent. of nitrogen.

Linseed Meal, used extensively in this State as a cattle food but also, among tobacco growers, as a fertilizer. It contained 6.48 per cent. of nitrogen.

Raw Leather, **4581,** Steamed Leather, **4622,** Roasted Leather, **4623,** and Dissolved Leather, **4625,** have already been described on page 20 of the present Report.

All of the above materials were pulverized to pass circular holes $\frac{1}{50}$ inch in diameter.

The arrangement of the series of tests and the quantities of nitrogen used in them are shown in Table I, p. 105.

Before planting, the pots received the maximum quantity of water which was to be supplied to them during the test, together with the soil-infusion already spoken of.

Seed and Planting.—From a large quantity of seed oats, kernels were selected which weighed between .03 and .04 gram each. After they had sprouted, 10 kernels were planted in each pot.

To do this, 650 grams (one pound and seven ounces) of soil were removed from the pot, the kernels were placed at regular distances apart on the surface thus prepared and the removed soil was replaced, covering the seeds to a depth of about one inch. The ten kernels contained .0066 grams of nitrogen.

The planting was done on the 22d, 23d, and 24th of April.

On the 26th the oats began to come up.

Care during Growth.—After planting, the pots were removed to the summer vegetation house described in our last Report.

The water supply was kept between 80 and 60 per cent. of the water-holding capacity of the soil (see foot-note page 108) by the means fully described in the last Report, page 87.

Soon after the plants had developed a single leaf, a number of them became unhealthy, but only in those pots which received the larger quantities of organic nitrogenous matters. The soil in some of these pots acquired a musty smell.

Plants supplied with quickly available organic nitrogen, dried blood, for instance, were more sickly in appearance than those supplied with tankage or roasted leather. Plants in the pots having 2.4 grams of nitrate-nitrogen were perfectly healthy and dark green, while those having the same quantity of blood-nitrogen were yellow and sickly.

Plants having .8 gram of blood-nitrogen were thrifty in appearance, those having double that quantity had paler leaves, those with three times that quantity were very sickly.

The plants with the smaller quantities of nitrogen recovered and made good growth and all fruited well, those with the larger quantities remained backward and sickly and in some cases died.

It appeared quite certain that the rapid decay within the soil of such large quantities of nitrogenous matter had injured or poisoned the growing plants.

No such effect had been anticipated because, in 1894, the same *kinds and quantities* of nitrogen had been used with the same soil and pots, and the maize crop grown in them was healthy through the season. Oats thus appear to be more susceptible to injuries from such decaying matters than maize.

Harvesting.—On July 9th the crops were separately cut, air-dried, and weighed. Determinations of moisture and of nitrogen were made in the air-dry crops. These figures are presented and discussed on subsequent pages.

B. Maize Crop.

The pots from which the oat crops had been cut were afterward planted to maize, without the addition of any fertilizer and without disturbing the soil.

Three selected kernels of Early Canada Corn, each weighing between .40 and .44 gram, and containing in the aggregate about .0067 gram nitrogen, were soaked in water until the swelling radicles were perceptible under the seed coats but had not broken through, and planted in each pot.

Holes an inch and a half deep were made in the soil with a peg, in each hole a kernel was placed and the soil pressed together over it.

The planting was done on July 24th. On the 28th most of the plants were up. The crops grew satisfactorily and appeared healthy until the nitrogen supply in the soil gave out. In those pots where the oat crop had been a failure on account of the poisoning of the plants by the rapidly decomposing organic matter, the maize crop was thriftiest and largest, because in these the oat crop had taken off but little of the nitrogen.

The maize crops were harvested on October 3, 1895.

In Table I are given the weights of the separate crops and of the nitrogen in them. A discussion of the results follows.

The following explanations are referred to by small numerals in their appropriate places in the table:

2. .8 gram at planting time, .8 gram later.

3. .8 gram at planting time and same quantity at each of two intervals during growth.

4. The water in the pot was kept between 80 and 60 per cent. of the water-holding capacity of the soil.

5. The water in the pot was kept between 70 and 50 per cent. of the water-holding capacity of the soil.

6. The water in the pot was kept between 60 and 40 per cent. of the water-holding capacity of the soil.

7. The water in the pot was kept between 80 and 40 per cent. of the water-holding capacity of the soil.

Table I—Vegetation Experiments of 1895. Artificial Soil.

Number of Pot.	Nitrogen supplied to the Oat Crop.		Oat Crop.				Maize Crop (following the Oat Crop without additional fertilizer).			
	In form of	Quantity of Nitrogen supplied. (Grams.)	Weight of air-dry Crop, exclusive of roots (grms).	Weight of Water-free Crop (grms).	Per cent. of Nitrogen in the air-dry Crop.	Total Nitrogen of Crop, exclusive of roots (grms).	Weight of air-dry Crop, exclusive of roots (grms).	Weight of Water-free Crop, exclusive of roots (grams).	Per cent. of Nitrogen in the air-dry Crop.	Total Nitrogen of Crop, exclusive of roots (grms).
5	Ground Horn and Hoof	.8	34.90	31.57	.87	.304	14.07	12.73	.57	.080
6	" " " "	1.6	64.60	57.65	.96	.620	25.13	22.87	.63	.158
7	" " " "	2.4	30.81	27.31	2.30	.709	60.14	54.25	.59	.355
8	" " " "	3.2	45.26	40.20	2.06	.932	76.18	68.90	.62	.472
9	Nitrate of Soda	.8	78.17	69.68	.83	.649	1.53	1.40	.58	.009
10	" "	1.6	87.94	76.86	1.40	1.231	10.29	9.24	.51	.053
11	" "	.8 + .8[2]	84.88	73.55	1.44	1.222	9.05	8.04	.49	.043
12	" "	2.4	69.60	60.48	2.18	1.517	67.88	61.04	.70	.475
13	" "	.8 + .8 + .8[3]	88.27	77.09	2.00	1.765	64.96	58.35	.47	.305
14	Dried Blood	.8[4]	52.64	47.39	.95	.500	4.46	4.10	.69	.031
15	" "	1.6[4]	74.39	66.64	1.30	.967	11.76	10.99	.55	.065
16	" "	.8[5]	67.71	60.10	.60	.406	5.03	4.57	.63	.032
17	" "	1.6[5]	61.70	55.22	1.38	.852	19.56	17.89	.43	.084
18	" "	.8[6]	61.34	53.55	.80	.491	2.73	2.47	.91	.025
19	" "	1.6[6]	65.04	56.98	1.33	.865	12.40	11.36	.52	.064
20	" "	.8[7]	65.48	58.36	.80	.524	3.99	3.67	.71	.028
21	" "	1.6[7]	57.71	50.87	1.45	.837	23.76	21.70	.44	.105
23	" "	1.6	52.52	40.07	1.54	.809	17.84	16.35	.49	.087
24	" "	2.4	19 97	17.80	2.71	.541	99.83	90 65	.64	.639
25	" "	2.4	47.35	42.41	2.32	1.099	38.85	35.18	.49	.190
26	" "	3.2	10.11	8.87	2.98	.301	95.74	87.08	.87	.833
27	" "	3.2	5.66	5.06	3.03	.171	106.12	95.05	.92	.976
102	Castor Pomace No. 4545	.8	50.19	45.12	.94	.472	3.51	3.17	.68	.024
103	" " " "	1.6	48.44	43.52	1.71	.828	33.39	30.07	.42	.140
104	" " " "	2.4	50.83	45.49	2.37	1.205	47.29	42.96	.48	.227
105	" " " "	3.2	18.23	16.26	3.16	.576	130.94	118.43	.72	.943
106	Castor Pomace No. 4546	.8	58.85	53.01	.84	.494	2.83	2.58	.57	.016
107	" " " "	1.6	63.43	57.17	1.29	.818	23.20	21.54	.48	.113
108	" " " "	2.4	59.02	53.23	1.94	1.145	41.37	37.65	.49	.203
109	" " " "	3.2	.50	.45	----	----	144.34	130.17	.70	1.010
110	Cotton Seed Meal	.8	52.12	46.40	.88	.459	8.87	8.13	.61	.054
111	" " "	1.6	49.91	44.53	1.59	.794	28.34	25.89	.47	.133
112	" " "	2.4	42.35	37.76	2.34	.991	63.40	57.55	.38	.241
113	" " "	3.2	18.07	16.30	3.13	.566	117.53	106.91	.47	.552
114	Dry Fish	.8	56.63	51.10	.71	.402	3.62	3.34	.58	.021
115	" "	1.6	59.58	53.06	1.40	.834	14.18	13.02	.50	.071
116	" "	2.4	19.45	17.05	2.66	.517	79.91	72.61	.43	.344
117	" "	3.2	.24	.21	----	----	156 90	144.58	.63	.988
123	Tankage	.8	46.11	41.49	.73	.337	3.62	3.34	.63	.023
124	"	1.6	79.22	71.44	.70	.554	8.59	7.92	.62	.053
125	"	2.4	98.43	88.44	1.02	1.004	21.37	19.46	.46	.098
126	"	3.2	107.20	94.52	1.24	1.329	38.50	34.99	.45	.173
127	Linseed Meal	.8	47.02	42.17	.84	.395	7.49	6.83	.59	.044
128	" "	1.6	61.56	55.11	1.38	.850	29.78	27.17	.46	.137
129	" "	2.4	67.95	60.53	1.65	1.121	37.55	33.95	.45	.169
130	" "	3.2	6.20	5.53	2.84	.176	132.93	121.07	.57	.758
135	Raw Leather	.8	1.12	1.00	.82	.009	1.99	1.83	.57	.011
136	" "	1.6	1.10	.99	----	----	1.84	1.69	.59	.011
137	Dissolved Leather	.8	27.49	24.80	1.34	.368	5.61	5.09	.71	.040
142	Steamed Leather	.8	11.27	10.20	.59	.067	2.48	2.29	.55	.014
143	" "	1.6	17.84	16.00	.66	.118	3.09	2.83	.57	.018
144	" "	2.4	25.11	22.77	.68	.171	6.50	5.92	.53	.034
145	" "	3.2	31.93	28.80	.72	.230	6.77	6.13	.55	.037
146	Roasted Leather	.8	5.18	4.69	.90	.047	2.46	2.26	.63	.015
147	" "	1.6	12.15	10.91	.88	.107	5.23	4.76	.53	.028

TABLE II.—VEGETATION EXPERIMENTS OF 1894 AND 1895. ARTIFICIAL SOIL. ONE CROP (MAIZE) IN 1894, TWO CROPS (OATS FOLLOWED BY MAIZE) IN 1895.

AVAILABILITY OF NITROGEN FROM DIFFERENT RAW MATERIALS.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantity of Fertilizer-Nitrogen (grams).	Quantity of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in per cent. of Fertilizer-Nitrogen.	Yearly average from Figures of preceding column.	Corrected yearly average excluding Figures in brackets.	Corrected average for the two years.
5	Horn and Hoof	Maize.	1894	.8	.307	38.4			
6	" " "	"	"	1.6	.561	35.1			
7	" " "	"	"	2.4	1.015	42.3	38.9	38.9	
8	" " "	"	"	3.2	1.278	39.9			
5	" " "	Oats and Maize.	1895	8	.384	48.0			42.5
6	" " "	"	"	1.6	.778	48.6			
7	" " "	"	"	2.4	1.064	44.3	46.2	46.2	
8	" " "	"	"	3.2	1.404	43.9			
9	Nitrate of Soda	Maize.	1894	.8	.384	48.0			
10	" "	"	"	1.6	.867	54.2			
11	" "	"	"	.8+.8	.797	49.8	54.6	54.6	
12	" "	"	"	2.4	1.376	57.3			
13	" "	"	"	.8+.8+.8	1.531	63.8			
9	" "	Oats and Maize.	1895	.8	.658	82.2			68.4
10	" "	"	"	1.6	1.284	80.2			
11	" "	"	"	.8+.8	1.265	79.1	82.2	82.2	
12	" "	"	"	2.4	1.992	83.0			
13	" "	"	"	.8+.8+.8	2.070	86.3			
22	Dried Blood	Maize.	1894	.8	.334	[41.8]			
23	" "	"	"	1.6	.604	37.7			
24	" "	"	"	2.4	.931	38.8			
25	" "	"	"	2.4	1.030	42.9	40.1	39.8	
26	" "	"	"	3.2	1.287	[40.2]			
27	" "	"	"	3.2	1.261	[39.4]			
22	" "	----	1895	....	...	...			46.3
23	" "	Oats and Maize.	"	1.6	.896	56.0			
24	" "	"	"	2.4	1.180	49.1			
25	" "	"	"	2.4	1.289	53.1	46.0	52.9	
26	" "	"	"	3.2	1.134	[35.4]			
27	" "	"	"	3.2	1.147	[35.9]			
102	Castor Pomace No. 4545	Maize.	1894	.8	.351	43.9			
103	" " "	"	"	1.6	.680	42.5			
104	" " "	"	"	2.4	1.211	50.4	45.9	45.6	
105	" " "	"	"	3.2	1.499	[46.8]			
102	" " "	Oats and Maize.	1895	.8	.496	62.0			53.1
103	" " "	"	"	1.6	.968	60.5			
104	" " "	"	"	2.4	1.432	59.7	57.4	60.7	
105	" " "	"	"	3.2	1.519	[47.5]			
106	Castor Pomace No. 4546	Maize.	1894	.8	.315	39.4			
107	" " "	"	"	1.6	.505	31.6			
108	" " "	"	"	2.4	.945	39.4	36.6	36.8	
109	" " "	"	"	3.2	1.148	[35.9]			
106	" " "	Oats and Maize.	1895	.8	.510	63.5			48.0
107	" " "	"	"	1.6	.931	58.2			
108	" " "	"	"	2.4	1.348	56.2	52.4	59.3	
109	" " "	"	"	3.2	1.010	[31.6]			

TABLE II.—VEGETATION EXPERIMENTS OF 1894 AND 1895. ARTIFICIAL SOIL. ONE CROP (MAIZE) IN 1894, TWO CROPS (OATS FOLLOWED BY MAIZE) IN 1895.—*Continued.*

AVAILABILITY OF NITROGEN FROM DIFFERENT RAW MATERIALS.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantity of Fertilizer-Nitrogen (grams).	Quantity of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in per cent. of Fertilizer-Nitrogen.	Yearly average from Figures of preceding column.	Corrected yearly average excluding Figures in brackets.	Corrected average for the two years.
110	Cotton Seed Meal	Maize.	1894	.8	.330	41.3			
111	" " "	"	"	1.6	.589	36.8	40.3	41.6	
112	" " "	"	"	2·4	1.126	46.9			
113	" " "	"	"	3.2	1.157	[36.1]			49.7
110	" " "	Oats and Maize.	1895	.8	.513	64.1			
111	" " "	"	"	1.6	.927	57.9	52.1	57.8	
112	" " "	"	"	2.4	1.232	51.3			
113	" " "	"	"	3.2	1.118	[35.0]			
114	Dry Fish	Maize.	1894	.8	.297	37.1			
115	" "	"	"	1.6	.531	33.2	35.5	35.2	
116	" "	"	"	2 4	.929	[38.7]			
117	" "	"	"	3.2	1.062	[33.2]			45.0
114	" "	Oats and Maize.	1895	.8	.423	52.9			
115	" "	"	"	1.6	.905	56.6	44.0	54.8	
116	" "	"	"	2.4	.861	[35.8]			
117	" "	"	"	3 2	.988	[30.9]			
123	Tankage	Maize.	1894	.8	.282	35.3			
124	"	"	"	1.6	.590	36.9	37.2	37.2	
125	"	"	"	2.4	1.024	42.7			
126	"	"	"	3.2	1.077	33.7			40.5
123	"	Oats and Maize.	1895	.8	.360	45.0			
124	"	"	"	1.6	.607	37.9	43.9	43.9	
125	"	"	"	2.4	1.102	45.9			
126	"	"	"	3.2	1.502	46.9			
127	Linseed Meal	Maize.	1894	.8	.330	41.2			
128	" "	"	"	1.6	.635	39.7	35.2	37.5	
129	" "	"	"	2.4	.755	31.5			
130	" "	"	"	3.2	.909	[28.4]			47.1
127	" "	Oats and Maize.	1895	.8	.439	54.9			
128	" "	"	"	1.6	.987	61.7			
129	" "	"	"	2.4	1.290	53.8	49.9	56.8	
130	" "	"	"	3.2	.934	[29.9]			
135	Raw Leather	Maize.	1894	.8	.014	1.8	1.1	1.1	
136	" "	"	"	1.6	.009	.5			1.4
135	" "	Oats and Maize.	1895	.8	.020	2.5	1.6	1.6	
136	" "	"	"	1.6	.011	.7			
137	Dissolved Leather	Maize.	1894	.8	.308	38.5	38.5	38.5	44.7
137	" "	Oats and Maize	1895	.8	.408	51.0	51.0	51.0	
142	Steamed Leather	Maize.	1894	.8	.047	5.9			
143	" "	"	"	1.6	.053	3.3	4.1	4.1	
144	" "	"	"	2.4	.088	3.7			
145	" "	"	"	3.2	.116	3.6			6.5
142	" "	Oats and Maize.	1895	.8	.081	10.1			
143	" "	"	"	1.6	.136	8.5	8.8	8.8	
144	" "	"	"	2.4	.205	8.5			
145	" "	"	"	3.2	.267	8.3			
146	Roasted Leather	Maize.	1894	.8	.040	5.0	4.7	4.7	
147	" "	"	"	1.6	.071	4.4			6.5
146	" "	Oats and Maize.	1895	.8	.062	7.8	8.2	8.2	
147	" "	"	"	1.6	.135	8.5			

Determination of Nitrogen in the Oat Crops.

Presence of Nitrates.

Many of the crops contained nitrates, and some of them very considerable quantities. The Jodlbauer-Kjeldahl method was therefore used in all cases for determining nitrogen.

Direct determinations of nitrate-nitrogen in some of the air-dry crops gave the subjoined results :

Pot No.		In air-dry crops Nitrogen as Nitrates.
5	Not more than	.05 per cent.
6	" " "	.05 "
7		.56 "
8		.44 "
13		.46 "
24		1.00 "
25		.50 "
104		.65 "
129	Not more than	.12 "

It is well known that when nitrates are abundant in the soil they often enter plants more rapidly than they can be assimilated, and sometimes accumulate in large amount. Striking instances are to be found in Annual Report of this Station for 1888, p. 62, and especially in Kansas Exp. St. Bulletin No. 49.

The nitrate nitrogen, no less than the organic nitrogen, found in the crops under notice, we must assume to have been furnished by the fertilizers that were used and therefore should be credited to these fertilizers.*

Discussion of Tables I and II.

The Water Supply.

Four pairs of pots, fertilized with Dried Blood, were watered differently for the purpose of observing the most suitable proportions of water to provide in these experiments.

In pots 14 and 15, Table I, the water in the soil was maintained between 80 and 60 per cent. of the water-holding capacity of the soil;† in pots 16 and 17 between 70 and 50 per cent.; in pots 18 and 19 between 60 and 40 per cent., and in pots 20 and 21 betweeen 80 and 40 per cent.

In other pots, the water supply was maintained between 80 and 60 per cent., but was to be changed at any time, if the growth in either series of pots 14 to 19, appeared better. The results show that in 1895, as in 1894, the largest assimilation of nitrogen was in pots where the soil had a water content of 80 to 60 per cent., the amount used in all the other series.

* Various evidence has indeed been adduced of late years, going to show that fungoid vegetation or microbes are able to assimilate free atmospheric nitrogen, but our knowledge of the extent and conditions of this alleged assimilation is as yet too uncertain to warrant introducing this possibility into our discussion.

† The quantity of water which the perfectly saturated soil in a vegetation pot holds, measures the "water-holding capacity" of this soil. In these experiments this quantity of water was 3892 grams or 8.57 pounds. 80 per cent. of this is 3113 grams, or 110 ounces.

Availability of the Fertilizer-Nitrogen.

Our own experiments illustrate what has been abundantly demonstrated by others, that the weight of *dry matter* harvested (water-free crop) is no certain measure of the nitrogen assimilated by the crop.

The different crops vary greatly in the per cent. of nitrogen which they contain, or otherwise expressed, an ounce of nitrogen taken by the crop in one case causes a much larger production of dry matter than in another, particularly if other factors which control growth are not alike.

To illustrate : Pots 5, 6, 7 and 8, Table I, page 105, received .8, 1.6, 2.4 and 3.2 grams of nitrogen* respectively, in form of horn and hoof. As none of these quantities was excessive, and the other fertilizer ingredients were present in abundance, it might be expected that the dry matter harvested from the two crops together, would show an increase somewhat corresponding to the increase of nitrogen. But they do not.

The dry matter of the crops is 31.7, 57.8, 27.7 and 40.7.† From this it appears that 0.8 gram of fertilizer nitrogen produced more dry matter than 2.4 grams, and 1.6 grams of fertilizer nitrogen produced more than 3.2 grams. These figures *in themselves* would be puzzling and worthless.

But, the determination of the nitrogen actually taken up by the crops from the fertilizer, makes the results intelligible. The

* The Fertilizer-nitrogen ratios are 10, 20, 30, 40.
† The Dry Crop ratios are 10, 18, 9, 13.
‡ The Crop-nitrogen ratios are 10, 20, 28, 36½.

In 1894 there was a much closer correspondence among ratios of the same order, viz:

In 1894 the Fertilizer-nitrogen	ratios were,	10, 20, 30, 40
" " Dry Crop	"	10, 16, 18, 19
" " Crop-nitrogen	"	10, 18, 33, 41.

quantities are .384, .778, 1.064 and 1.404 respectively,‡ being a regular increase of nitrogen assimilated, corresponding to the increase in nitrogen supplied. This increase is not necessarily proportional to the increase of nitrogen supplied, for as the quantity of nitrogen in the fertilizer approaches the greatest amount which the plants can utilize, the increase of crop-nitrogen with each successive increase of fertilizer-nitrogen must grow less and less, till there comes a point where increase of fertilizer-nitrogen gives no increase of crop-nitrogen.

In considering the relative availability of the different forms of nitrogen, as shown by these tests, we shall notice, therefore, only the quantities of nitrogen which the crops took from the fertilizer supplied to them.

It is seen that the unequal development and unhealthy condition of the oat plants in the pots having the larger doses of quickly decomposing organic fertilizers, renders any conclusions from the oat crop alone unsatisfactory.

The maize crop of 1895 was also very irregular, but in all cases where the oat crop failed, or was small, the following maize gave a large yield: Nos. 26, 27, 105, 109, 113, 117 and 130. It is likewise to be remarked that the large oat crops, in every instance, were followed by small (and usually the largest by the smallest) maize crops. This fact indicates that the final maize crops probably almost or completely exhausted the nitrogen available at the termination of the experiment. Therefore, a comparison of the fertilizer-nitrogen supplied in the two applications of 1894 and 1895 with the crop-nitrogen obtained in the three harvests of those years, will probably furnish a trustworthy estimate of both the absolute and relative availability of the fertilizer-nitrogen.

Table II gives a complete view of all the results of 1895 and of 1894, which are fairly comparable. The last columns give the averages based upon these data.

A considerable number of experiments made with Dried Blood as a source of nitrogen, to study the effects of increased or diminished supply of water, potash or phosphoric acid, are excluded from Table II, because they are not strictly comparable with the others in a discussion of the availability of different forms of nitrogen. Most of them, however, gave the same result as that stated in Table II for the six pots there included.

Certain exceptional results, which in Table II are enclosed in brackets, are excluded from the "corrected averages."

‡ See foot-note on p. 109.

The crop-nitrogen in both pots 26 and 27, which received 3.2 grams of nitrogen in Dried Blood, was less than in pots 24 and 25, which received only three-fourths as much nitrogen. This is explained by the fact already mentioned on page 103, viz: that the oat crop was seriously damaged by the rapid decay of the nitrogenous matter within the soil. A portion of the nitrogen of the decaying matter was possibly set free or made inaccessible to the following maize crop. These two results should, therefore, be excluded from the final average.

Since the crop-nitrogen expressed in per cent. of the fertilizer-nitrogen (which in this paper we shall call the "per cent. availability" or "per cent." simply), was much larger in 1895 than in 1894, we must exclude the corresponding experiments in 1894 (pots 28 and 27) from a general average of the results of both years, in order to give the results in 1895 and 1894 their true relative value in the average.

The same remarks apply to the crops in pots 105, Castor Pomace No. **4545**; 113, Cotton Seed Meal; 116, Dry Fish; and 130, Linseed Meal.

While the crop-nitrogen in pot 117 is larger than in 116 or 115, it bears no just proportion to the increase of fertilizer-nitrogen, the oat crop in this pot being almost a total failure.

The results in the instances cited have been accordingly excluded from the last two columns of averages.

In the column headed "Crop-nitrogen expressed in per cent. of fertilizer-nitrogen" (Table II), we have a set of figures obtained, in the first instance (pot 5), by the arithmetical proportion .8 : 100 : : .307 : 38.4, which signifies that of 100 parts of fertilizer-nitrogen, in this case supplied by horn and hoof, 38.4 parts have been taken into the crop which was harvested from that pot.

The "crop" here, be it remembered, does not include roots.

The column headed, "Yearly average from figures of preceding column," gives the average of *all* the figures from the preceding column, *including those inclosed in brackets.*

For reasons just mentioned, the figures in brackets are excluded from the final averages, which are stated in the last two columns. It will be noticed that the greatest difference between the mean of the "yearly averages" and that of the "corrected yearly averages" occurs in case of Dry Fish, and there amounts to 5.3 per cent. The other differences are for Linseed Meal, 4.6 per cent.;

Cotton Seed Meal and Castor Pomace No. **4546**, each 3.5 per cent.; Dried Blood, 3.3 per cent.; and Castor Pomace No. **4545**, 1.5 per cent.

It is thus plain that the disaster to the Oat Crop and the consequent irregularities in the growth of the following maize crop have very nearly compensated each other in respect to the total acquisition of fertilizer-nitrogen.

In the following statements the various fertilizers are arranged in the order of their efficiency (expressed in round numbers) as sources of nitrogen to the maize and oat crops in our experiments of 1894 and 1895.

	Per cent. of available Nitrogen reckoned on total Nitrogen.	Per cent. of available Nitrogen reckoned on the available Nitrogen of Nitrate of Soda.
Nitrate of Soda	68	100
Castor Pomace No. **4545**	53	77
Average of Castor Pomace Nos. **4545** and **4546**	50.5	74
Cotton Seed Meal	49.5	72
Castor Pomace No. **4546**	48	70
Linseed Meal	47	69
Dried Blood	46.5	68
Dry Fish	45	66
Dissolved Leather	44.5	64
Horn and Hoof	42.5	62
Tankage	40.5	59
Steamed Leather	6.5	9
Roasted Leather	6.5	9
Raw Leather	1.5	2

Since in all cases the roots of the plants remained in the soil and we have no ready means of learning how much nitrogen the roots contain, our experiments show only what the "crops," i. e., the cropped stems, leaves and fruit, have taken up and not what the vegetation as a whole has made use of.

As is well known, the roots of many plants make at first a relatively greater growth than the tops, and in the flowering and fruiting processes there is an extensive and rapid transfer of vegetable substance from the roots to the tops.*

* The quantity of roots in per cent. of the entire plant in the dry state, was found by Schubart to be as follows:

Winter wheat, last of April	40	per cent.
" " May	22	"
Peas, four weeks after sowing	44	"
" at time of blossom	24	"

—How Crops Grow, p. 264.

This is one reason why the increase of crop-nitrogen does not keep regular pace with the increase of fertilizer-nitrogen. That the increase of crop-nitrogen is not always parallel with that of dry substance, probably depends in part on the fact that in different stages, or under different conditions of growth, the proportion of nitrogen in the roots is now greater and now smaller than in the tops.

Looking now at the item Nitrate of Soda, we find that of 100 parts of its nitrogen applied as a fertilizer, 68½ parts were recovered in the three crops. There remains of course in the soil a residue of nitrogen in the form of maize roots, but since the nitrogen of all the last maize crops was less than one-sixth that of the oat crops, we may infer that the available residue is not large.

The strikingly greater availability of nitrate nitrogen in 1895, 82 per cent., over that found in 1894, 55 per cent., is evidently in part due to the fact that while the first maize crops practically had no source of nitrogen except the nitrate, each of the second year's crops had, besides the nitrate applied directly to the oats, some residue of the first year's supply, perhaps unused nitrate and certainly nitrogen of the roots of the first year's crop, which became available the second year.

Another reason of the larger availability shown in the second year lies in the fact that the soil then bore two crops and was more than twice as long in possession of active vegetation. The maize crop of 1894 occupied the pots 68 days. The oat crop of 1895 was 75 days and the maize crop of that year 68 days (on the average) between seeding and harvest.

We observe, in Table II, that, in general, the availability of nitrate nitrogen increased somewhat, as the quantity used was greater. In 1894 the increase was large, rising from 48 to 64. In 1895 it was slight, rising from 74 to 79. In both years, however, pot 11 yielded less than pot 10, apparently because the small applications, which were the same in total amount, were better utilized, when applied at once, than when given in two doses. In pot 10 the 1.6 gram of nitrogen would seem to have given the young plants a better start, developed a stronger root system and enabled the plants to forage more effectually.

On the other hand, 13 surpassed 12 both years, three applications of 0.8 gram each, giving slightly greater yield, than one of 2.4 grams.

The oat crops supplied with nitrate had a healthy appearance throughout the season. At harvest the nitrate oat crops averaged from 42 to 48 inches in height, each pot bore from 23 to 38 stalks, an average of 30, of which 26 were headed.

Castor Pomace No. **4545** stands second in order of nitrogen-availability. Of 100 parts of nitrogen, supplied in this form, the crops in two years assimilated 53 parts.

Crops 102, 103, 104 while evidently injured at the outset as already described, had a fair color and growth on June 19, while crop 105, which as early as May 9th was inferior to the others, on June 19th was stunted and yellow and had but three plants (bearing 17 stalks) remaining. These were green and still growing at harvest. Crop 105 is excluded from the average.

The other crops had 14, 20 and 30 stalks, bearing 14, 17 and 17 heads respectively, and were from 45 to 48 inches high.

Next in order of nitrogen-availability stands Cotton Seed Meal, 49.5.

While all the crops in this series were yellow in color at first, 110 recovered, made good growth and had a dark green color by June 5. 111 and 112 were longer in recovering, but made fair growth later, while 113 was stunted and pale in color through the season, and has been excluded from the average. The number of stalks in the several crops was 15, 32, 27, 14; the number of heads, 15, 20, 15, 3. Crop 110, which had least nitrogen, was the tallest, 47 inches; the others were 40, 38 and 27 inches.

It is seen that for 1895 the nitrogen-availability was greatest in crop 110, and diminishes regularly and rapidly in the three other crops. We believe that this was caused by damage to the oat crops, which was not, as in other cases, fully compensated by the increase in following maize crop. If this be true, the relative availability of the nitrogen of Cotton Seed Meal is somewhat greater than shown by our results.

Castor Pomace, No. **4546,** has an availability of 48. Crop 106 had a healthy appearance and growth through the season. Crops 107 and 108, which were sickly at first, recovered early in June and made fair growth. Crop 109 was unthrifty and stunted from the outset and at last died completely. It is excluded from the average.

The other crops bore 13, 18 and 25 stalks respectively, with 13, 15 and 19 heads. The heights were 42, 45 and 36 inches respectively.

The experiments of the two years indicate a decided superiority of the Castor Pomace No. **4545.**

Whether the inferiority of the Castor Pomace No. **4546** is due to presence of more oil or to greater heat used in preparation whereby the albuminoids have been more thoroughly coagulated or more hardened by drying, is not at present known.

Scarcely less than the availability of this kind of Castor Pomace is that of Linseed Meal, 47, and Dried Blood, 46.5.

The oat crops in both series were badly injured at the start; crop 130 which received Linseed Meal and crops 26 and 27 which received Dried Blood remained stunted and sickly through the season, and were excluded from the average. The oat crops raised with Dried Blood had 21, 16, 26, 18 and 10 stalks of 45, 35, 44, 24 and 22 inches in length, and with 19, 7, 14, 8 and 3 heads respectively; those raised with Linseed Meal had 15, 29, 33 and 9 stalks of 50, 48, 42 and 26 inches length, and with 14, 21, 23 and 3 heads.

Dried Fish had an availability of 45. Only two crops, 114 and 115, are considered in making this average, because of the damage sustained by the oat crops in the other pots early in the season.

Dissolved Leather, Horn and Hoof, and Tankage follow, with availabilities of 44.5, 42.5 and 40.5 respectively.

The method of preparing the Dissolved Leather has been already described on page 20 of this report.

The Leather was heated with about one and a half times its weight of oil of vitriol in a manner that probably has not been attempted on a commercial scale. Crops 137 demonstrated that the nitrogen of Leather can be made as available to plants as is that of Dry Fish, Blood or Tankage.

It will be noticed that in these experiments Tankage has shown a lower availability than any other of the approved forms of fertilizer-nitrogen, and that Fish and Horn and Hoof have a lower availability than Blood, or the vegetable forms of organic nitrogen. Their solubility in pepsin-solution as observed in last year's Annual Report follows the same order as their nitrogen-availability here recorded.

Steamed or Roasted Leather is a slowly acting fertilizer, but in these experiments, its nitrogen was nearly four to five times more available than that of Raw Leather, and was twice as available the second year as the first, a result doubtless due to the multiplication in the soil of the microbes that are essential to decay, whereby the nitrogen of leather is converted into forms that can feed vegetation.

In our last Report, 1894, p. 97, it was stated that "Extended discussion of these results is reserved till the tests have been repeated under varying conditions."

The experiments of 1895 just described do not by any means conclude the subject, but are rather a report of progress and have been purposely described so as to present fully their defects. The investigation will be continued during the coming season.

The indications of the present year's tests agree with those of 1894 in these respects, that the nitrogen of Castor Pomace No. 4545 has shown the highest availability of any form of organic nitrogen, that Fish, Horn and Hoof, and Tankage have manifested the lowest availability, Leather excepted. While Cotton Seed Meal, Castor Pomace No. 4546, Linseed Meal and Dried Blood stand intermediate, with no very striking difference between the four.

In conclusion we refer to the tabulated statements on page 112, as giving the results of our vegetation experiments during 1894 and 1895, on the actual and relative availability of Fertilizer-Nitrogen.

THE COMPARATIVE EFFECTS OF MURIATE AND SULPHATE OF POTASH ON THE POTATO CROP.

By E. H. Jenkins.

The muriate is at present the cheapest source of potash, of which it contains 50 per cent., and costs at retail about $42.50 per ton, while the high grade sulphate, having also 50 per cent. of potash, costs from $50 to $55 per ton. The double sulphate of potash and magnesia, commonly called "low grade sulphate," selling for about $30 per ton, contains from 26 to 28 per cent. of potash, and is quite as expensive a source of potash as the high grade sulphate.

The muriate is, therefore, chiefly used, unless for special reasons.

German field experiments have shown, in many instances, that muriate of potash, on potato land, especially when applied in the spring, more or less increases the proportion of water and correspondingly diminishes the per cent. of starch and other solids in the crop of tubers. These effects are most marked when kainit (advertised as a sulphate but containing a large amount of muriates) is used as the source of potash.

Watery potatoes are well known to be inferior for cooking as well as for feeding purposes and, accordingly, it is often advised to apply sulphate of potash and to avoid using either the muriate of potash or kainit upon potato fields, although the yield of tubers is generally increased by the muriate of potash more than by the sulphate.

The only experiments made in this country bearing on this subject, report of which has come under our observation, are those made at the New Jersey Station.

The soils on which the tests were made were first, a heavy and gravelly clay loam, with clay subsoil, not specially adapted to potatoes; second, a fertile sandy loam, with open subsoil, well suited to potatoes; and third, a light sandy loam, of medium fertility. Each plot received 200 lbs. nitrate of soda, 320 lbs. dissolved bone black and 160 lbs. of either muriate or sulphate of potash or else 640 lbs. of kainit.

The results of the three series of tests were concordant and showed that the yield of tubers from muriate was four to six per cent. greater than from sulphate; that the tubers raised without fertilizer had the highest per cent. of dry matter; and that the average decrease of dry matter and of starch in the tubers, attributable to the different form of potash, were as follows:

	Decrease, per cent. Dry Matter.	Starch.
Sulphate of potash	3.1	4.3
Muriate of potash	7.1	7.7
Kainit	11.8	12.7

The potatoes raised with sulphate of potash, while not so large, were more uniform in size and had a smoother skin than the others. Samples of the three sorts were cooked alike and persons unacquainted with their origin, selected without hesitation, as the best, those grown with sulphate.

Four similar field-tests made under the supervision of this Station, are described in the following pages.

Experiment on Land of Mr. G. F. Platt, Milford, Ct.

The field is situated on the second terrace of the bank of a small stream, and the soil is light and gravelly. The trial was made in 1888. Over the whole field had been broadcast, at the rate of 1000 lbs. per acre, a home mixture containing 4.8 per cent. of nitrogen, 10.5 per cent. of phosphoric acid and 8.5 per cent. of potash in form of mixed sulphate and muriate of potash (163 lbs. of high grade sulphate of potash and 120 lbs. of muriate per ton of fertilizer).

There were sown in addition, on one measured acre, 200 lbs. of muriate of potash, and on another acre 200 lbs. of high grade sulphate of potash (51 per cent. actual potash). "Beauty of Hebron" potatoes, medium size tubers, were planted whole about the 15th of May. All of the acre plots had precisely the same cultivation and care. During growth no striking differences were noted, except that in the last week of July the tops on the muriate plot looked a little yellow, as if more mature.

On September 9th the potatoes were dug and weighed by us and samples drawn for analysis.

The crop from every fifth row, making six rows on each acre, was weighed, and from these the acre-yield was calculated. The potatoes were almost entirely free from rot.

Following are the yields per acre:

		Yield in bushels.	Per cent. of Starch in potatoes.	Pounds of Starch per acre.	Pounds of Starch per bushel of potatoes.
A	Home-mixture and muriate of potash	163⅜	17.0	1675	10.2
B	Home-mixture and sulphate of potash	178	17.9	1909	10.7
C	Home-mixture alone	186½	17.6	1971	10.6
D	No fertilizer	100¾	18.1	1096	10.9

On D, without fertilizer, the potatoes were very inferior, not more than one-half of them marketable. If we call the yield of potatoes and of starch on the unfertilized plot 100 per cent. the other crops will stand as follows:

		Per cent. yield.	Starch.
A	Home-mixture and muriate	162	153
B	Home-mixture and sulphate	176	174
C	Home-mixture alone	185	180
D	No fertilizer	100	100

It appears that the addition of potash salts depressed the yield slightly, the sulphate less than the muriate, and that the yield of starch to the bushel of potatoes was largest with no fertilizer, next with sulphate of potash and with home-mixture, and least with muriate.

Evidently Mr. Platt's home-mixture contained all the potash that the crop required in this season and on this land.

Analyses of Potatoes raised by Mr. Theron E. Platt, of Newtown, Ct., in 1887.

Two samples of White Flower potatoes were sent to this Station by Mr. Platt for examination, with the statement that the one was raised with help of 200 lbs. of sulphate of potash per acre, the other represented the crop grown with 200 lbs. of muriate, the other fertilizers being alike.

Their specific gravities and per cent. composition were as follows:

	Potatoes raised with Sulphate of Potash.	Potatoes raised with Muriate of Potash.
Specific gravity	1.091	1.082
Water	76.77	77.39
Starch	18.38	17.99
Ash	.93	.98
Total nitrogen	.38	.35
Starch in the dry matter	79.10	79.60

In this case the potatoes raised with muriate contained .6 per cent. more water and .39 per cent. less starch than those raised with sulphate, but the DRY MATTER of the latter contained half a per cent. less of starch.

Experiment Conducted by Mr. W. H. Olcott, South Manchester. 1895.

In connection with observations on the prevention of potato scab, described elsewhere in this Report, Mr. Olcott tested the comparative effects of sulphate and muriate of potash.

The soil of the experiment field is a very light sandy loam.

The field for ten years previous to 1894 had not been fertilized at all. In 1894 potatoes were grown with about the same kind of fertilizers as in 1895.

In 1895 the land received per acre 1500 pounds of a home-mixture, described on page 65 of this Report.

One of the plots had mixture **4876,** containing 120 pounds of potash as muriate, the other had mixture **4877,** containing the same quantity of potash as sulphate.

Samples of the crops raised with the two fertilizers contained per cent.

	Potatoes raised with Muriate of potash.	Potatoes raised with Sulphate of potash.
Water	78.29	77.83
Dry matter	21.71	22.17
Starch	14.14	14.34
Starch in the dry matter	65.10	64.70

The potatoes grown with muriate in this test contained nearly half a per cent. more water and correspondingly less starch than those raised with sulphate. The dry matter of the potatoes raised with muriate, however, contained more starch than those grown with sulphate by about .4 per cent.

Experiment conducted by the Station on Land of J. H. Webb, Hamden, 1895.

The soil was a light sandy loam, in good condition as regards fertility.

The whole piece received a light dressing of stable manure, which was plowed in. It was then divided into four plots, each 410 by 27 feet and containing a quarter of an acre. One-half of each plot was dressed with oyster shell lime at the rate of 250 pounds per acre.

Each plot received in the drill 120 pounds of dissolved bone black (containing 20 pounds of phosphoric acid) and 90 pounds of dried blood (containing 12 pounds of nitrogen).

Plot A received no potash. Plot B received 63 pounds of potash as muriate. Plot C the same quantity of potash in form of double sulphate of potash and magnesia, and plot D the same quantity of potash as high grade sulphate.

The field was planted to potatoes and cultivated and harvested in the usual way.

The yields were as follows :

Potato Experiment on Land of J. H. Webb, Season of 1895.

Plot.	Potash salt used.	Yield per ¼ acre in pounds. Salable.	Small.	Equivalent bushels per acre.	Water.	Starch in fresh Potatoes.	Starch in dry matter of potatoes.
A	No potash salt,	2610	432	202	79.55	15.47	75.72
A_1	Same as A, with lime,	3276	576	256	79.65	15.48	76.07
B	Muriate of Potash,	2646	666	221	79.25	15.63	75.41
B_1	Same as B, with lime,	2574	792	224	79.24	15.68	75.59
C	Double sulphate of potash	2808	369	212	79.42	15.63	75.93
C_1	Same as C, with lime,	2592	342	196	78.86	16.07	76.03
D	High grade sulphate of Potash,	3456	432	259	78.72	15.90	74.74
D_1	Same as D, with lime,	2772	486	217	78.42	16.55	76.69

The results show that the soil was not strikingly deficient in potash. The muriate increased the yield some 10 per cent., the high grade sulphate 29 per cent., the double sulphate 5 per cent., assuming that the plots at the outset were alike in crop-producing capacity.

Lime in connection with the potash salts in two out of the three tests reduced the yield.

The difference in composition of the tubers from the several plots was small.

The largest difference in water-content was 1.2 per cent. and in starch 1.1 per cent., and the greatest difference in starch content of the dry matter was 1.95 per cent.

Contrary to general experience, the potatoes grown without potash fertilizers had nearly as much water and less starch than any others.

Averaging the results of the limed and unlimed plots, the potatoes grown on muriate of potash contained 15.65 per cent. of starch, those grown with sulphate of potash 16.22 per cent. and those grown with double sulphate 15.85 per cent.

The percentages of starch in the dry-matter of the potato were 75.50, 75.70, and 75.98 respectively.

The per cents. of small and unsalable potatoes in the crops from the several plots were as follows:

No potash salt in fertilizer	14.6	per cent.
Muriate of potash used	21.8	"
High grade sulphate used	13.0	"
Double sulphate of potash	11.6	"

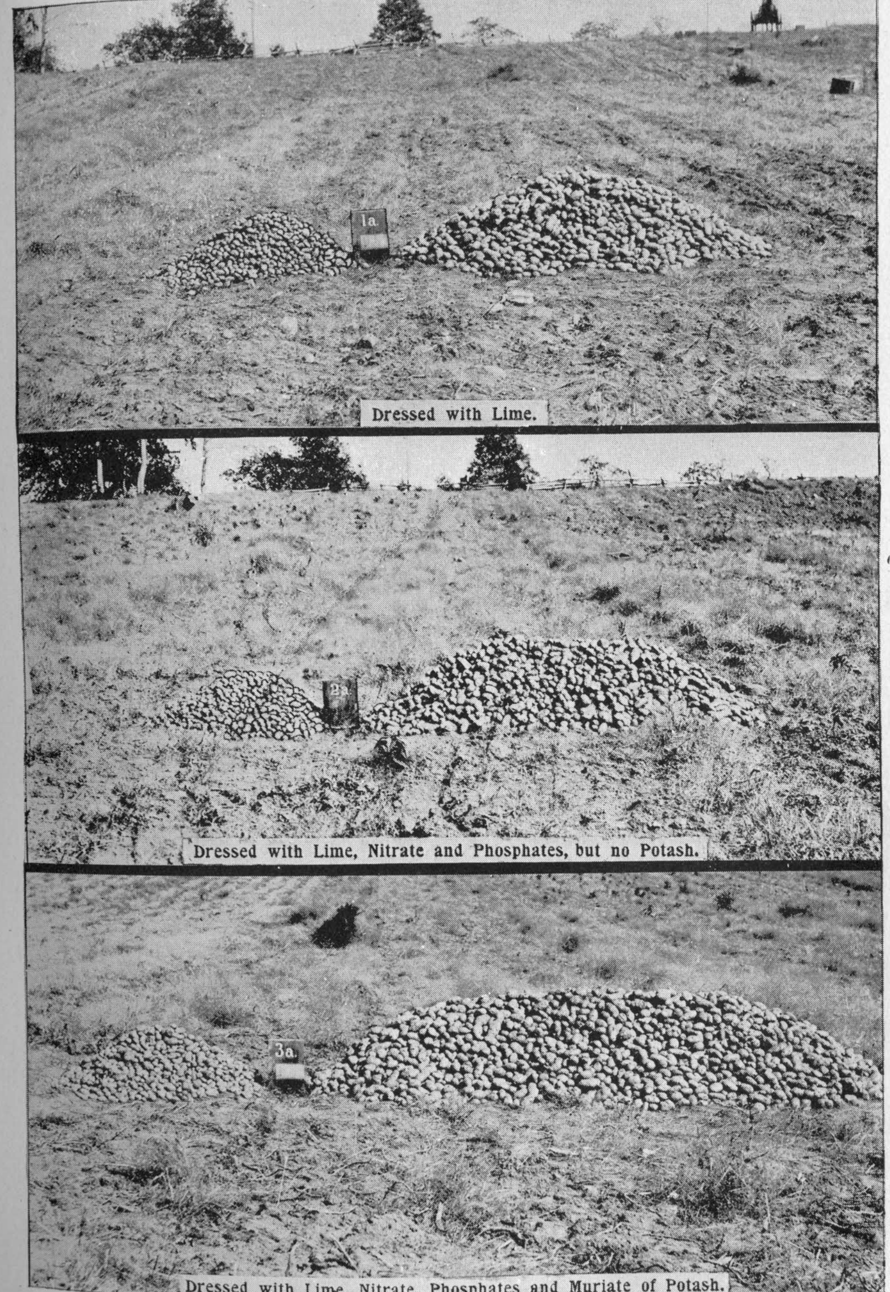
Photographs of the potatoes from some of the plots are reproduced in the accompanying plates.

The salable potatoes from each plot were sampled by the Station representative and water and starch were determined by Mr. Winton in each lot.

The results of the experiment appear in the following table:

POTATO EXPERIMENT, CONDUCTED BY MR. T. J. STROUD, SHAKER STATION, SEASON OF 1895.

No. of Plot.	Fertilizers Used.	Yield, (pounds) per Plot. Salable.	Small.	Total.	Equivalent Bushels per Acre.	Moisture, per cent.	Starch, per cent.	Per cent. of Starch in Water Free Substance.
1	No fertilizer	436	444	880	73	78.20	16.65	76.39
1a	400 lbs. lime	910	300	1210	101	78.27	16.58	76.32
2	80 lbs. nitrate of soda 123 " acid phosphate	1370	318	1688	140	78.25	16.79	77.13
2a	80 lbs. nitrate of soda 123 " acid phosphate 400 " lime	1207	278	1485	124	78.48	16.51	76.73
3	80 lbs. nitrate of soda 123 " acid phosphate 24 " muriate of potash	2284	222	2506	209	79.01	16.22	77.27
3a	Same as plot 3, with addition of 400 lbs. lime	2386	304	2690	224	78.56	16.48	76.85
4	80 lbs. nitrate of soda 123 " acid phosphate 48 " muriate of potash	2415	450	2865	239	78.98	16.16	76.87
4a	Same as plot 4, with addition of 400 lbs. lime	2434	377	2811	234	79.23	15.44	74.31
5	80 lbs. nitrate of soda 123 " acid phosphate 24 " sulphate of potash	1914	446	2360	197	78.03	16.69	76.04
5a	Same as plot 5, with addition of 400 lbs. lime	1896	335	2231	186	78.56	16.16	75.18
6	90 lbs. Florida soft phosphate	942	278	1220	102	78.74	16.28	76.52
6b	80 lbs. nitrate of soda 90 " Florida soft phosphate	1306	306	1612	134	78.95	15.57	73.99
7	24 lbs. muriate of potash 90 " Florida soft phosphate			2034	170			
7b	80 lbs. nitrate of soda 90 " Florida soft phosphate 24 " muriate of potash	----	----	2210	184	----	----	----
8	200 lbs. Home mixed fertilizer	2512	314	2826	235	78.63	16.47	77.10
9	80 lbs. nitrate of soda 550 " wood ashes	1996	252	2248	187	78.76	16.19	76.23

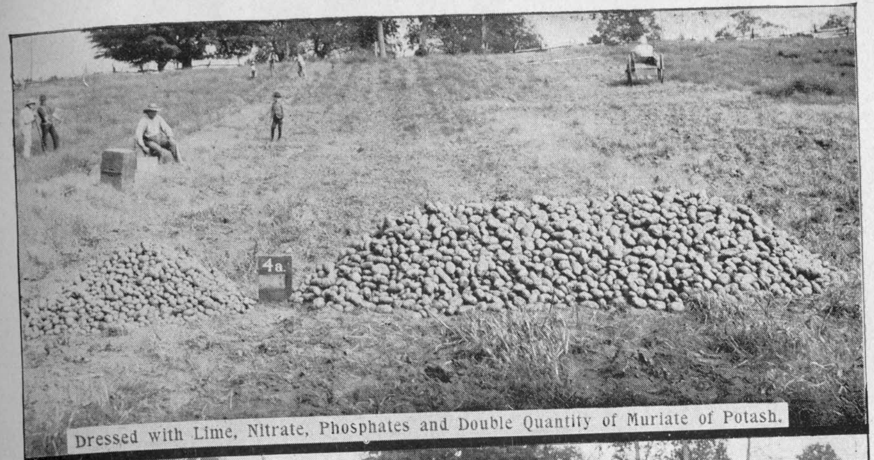


Dressed with Lime.

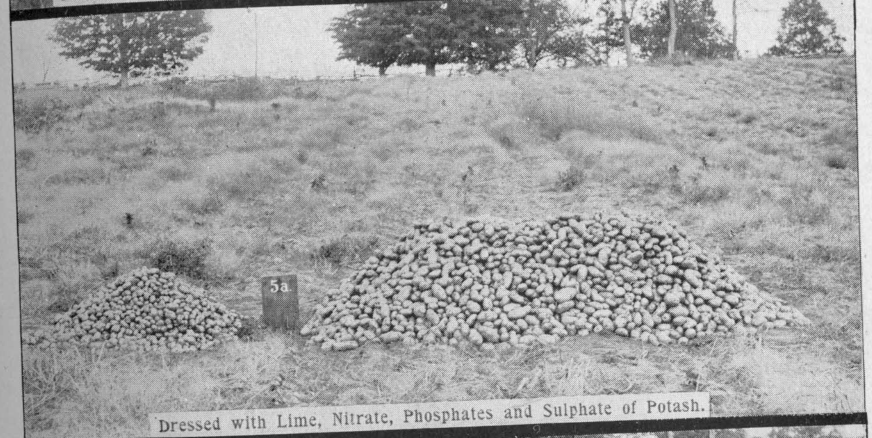
Dressed with Lime, Nitrate and Phosphates, but no Potash.

Dressed with Lime, Nitrate, Phosphates and Muriate of Potash.

FIELD EXPERIMENT WITH POTATOES. Conducted by T. J. Stroud.



Dressed with Lime, Nitrate, Phosphates and Double Quantity of Muriate of Potash.



Dressed with Lime, Nitrate, Phosphates and Sulphate of Potash.

Dressed with a "Home Mixture."

FIELD EXPERIMENT WITH POTATOES. Conducted by T. J. Stroud.

If the yield of the plot which received no fertilizer is called 100, the yields from the other plots will rank as follows:

No. of Plot.	Dressed with	Relative yield.
1.	Nothing,	100
1a.	Lime,	137
2.	Nitrate and acid phosphate,	192
2a.	Same as 2, with lime,	169
3.	Nitrate, acid phosphate and muriate of potash,	285
3a.	Same as 3, with lime,	306
4.	Nitrate, acid phosphate and double quantity of muriate,	325
4a.	Same as 4, with lime,	319
5.	Nitrate, acid phosphate and sulphate of potash,	268
5a.	Same as 5, with lime,	254
6.	Florida soft phosphate,	139
6b.	Nitrate and Florida phosphate,	183
7.	Muriate and Florida phosphate,	231
7b.	Nitrate, Florida phosphate and muriate of potash,	251
8.	Home mixture,	321
9.	Nitrate and wood ashes,	255

The results of this experiment may be summarized as follows:

1. The yields on plot 4, nitrate, acid phosphate and double quantity of muriate, on 4a, the same fertilizer as on 4 with lime added, and on plot 8, home-mixture, are essentially alike, three times as large as from plot 1, which had no fertilizer, and amounted to over 230 bushels of potatoes per acre.

2. The addition of lime to the fertilizers had but little effect, and in three out of four cases depressed the yield.

3. Muriate of potash gave a larger yield of potatoes per acre than an equivalent quantity of sulphate, by 25 bushels.

4. Florida phosphate alone, plot 6, increased the yield about as much as an application of lime; with nitrate, plot 6b, it still further increased the yield. With potash, plot 7, the yield was greater than with nitrate alone, but the combination of nitrate, Florida phosphate and muriate, plot 7b, yielded more than any two of the three, but 25 bushels per acre less than an equivalent quantity of dissolved bone black with nitrate and muriate, plot 3.

5. The potatoes from the four plots that received muriate contained in their fresh substance 16.22, 16.48, 16.16, 15.44 per cent. of starch respectively, the average being 16.07. The potatoes from the two plots which received sulphate of potash contained 16.69 and 16.16 respectively, the average of which is 16.42.

The potatoes on the plot which received most muriate had a smaller per cent. of starch than any others, with two exceptions (5a and 6b), and the potatoes on the plot with sulphate of potash had the highest per cent. of starch of any except those from plot 2. It is to be noticed, however, that the per cent. of starch in potatoes on plot 5a, which was dressed with high grade sulphate and lime, was as low as any in the experiment, excepting plot 6b.

6. The lower per cent. of starch in the potatoes raised with muriate is due to their higher per cent. of water. The per cent. of starch *in the dry substance* of the potatoes is highest where muriate was used, plot 3. The average per cent. of starch in the dry substance of the potatoes from the four plots on which muriate of potash was used is 76.32; the average on the two sulphate of potash plots is 75.60.

The soil of the experiment field was strikingly deficient in available potash, nitrogen and phosphoric acid. Thus nitrate and dissolved bone black increased the yield of the soil by 92 bushels per acre, and muriate added to the chemicals named made a further increase of 93 bushels.

In this experiment, muriate of potash gave a larger yield than the equivalent amount of sulphate of potash, by 25 bushels per acre.

The starch-content of the fresh potatoes was as high with sulphate of potash as where no fertilizer was used.

The starch-content in the fresh potatoes raised with muriate was about .5 per cent. less than in those raised with equivalent sulphate.

Doubling the quantity of muriate increased the yield and still further depressed the per cent. of starch.

The lower content of starch in potatoes raised with muriate was wholly due to the larger amount of water in them. The dry matter of potatoes raised with muriate contained more starch than those raised with sulphate of potash.

The results here reported naturally differ with the character of the land, quantity of nitrogen applied, weather conditions, etc.

In general the potatoes where muriate was applied contained less starch, by half a per cent. or less, than those raised with sulphate of potash. The yield of potatoes is most likely to be larger with muriate than with sulphate of potash.

The actual potash in sulphate of potash costs about 12 per cent. more than in muriate, so that if 80 pounds of actual potash were applied per acre, the added cost of using sulphate would be about 75 cents.

It is not always and every where advisable to use sulphate rather than muriate of potash on potato land.

When yield alone is sought and there is no possibility of getting an extra price on account of quality, the muriate may be used, partly because, pound for pound of actual potash, it is cheaper than the sulphate, but mainly because it is likely to produce a larger yield.

When used, its unfavorable effect on the quality of the tubers may probably be lessened by putting it on the land early, even the fall before.

When potatoes are to be raised for seed, or when an increased price may be secured because of extra quality of tubers, the sulphate should be used.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS.

FINAL REPORT ON THE FERMENTED CROPS OF 1894.

BY E. H. JENKINS.

The object of these experiments is to study the effects of certain fertilizers commonly used by our Connecticut growers on the quality of wrapper-leaf tobacco. Each plot under experiment receives the same fertilizers for a term of years in order to test these fertilizers under the varying climatic conditions which a succession of years affords, and final judgment on the quality of the crops is made after they have been fermented in the case and are ready for manufacture.

The work was begun in 1892 and has been carried on each year since then by this Station, in connection with the Connecticut Tobacco Experiment Company.

A full description of this experiment will be found in former reports of this Station, viz.: 1892, pp. 1–24; 1893, pp. 112–144; 1894, pp. 254–284.

An account of the growing, harvesting and curing of the crop of 1894 is printed on pages 270 to 279 of the 17th Annual Report of this Station for 1894.

Samples of the long and short wrappers from each plot, with top leaves and seconds sufficient to fill the case, were cased down at the warehouse of Mr. L. B. Haas in Hartford, on Dec. 13th, 1894. The case lay undisturbed till Dec. 10th, 1895, when it was opened and the samples examined.

SHRINKAGE DURING FERMENTATION.

The tobacco weighed 343 pounds when it was cased. After fermentation it weighed 307 pounds, baving lost during twelve months 36 pounds, or 11.1 per cent. The crops of 1892 and 1893 lost about 14 per cent. during fermentation. The crop of 1892 was "well sweated," that of 1893 "unsweated," and that of 1894, which lost nearly 3 per cent. less than the others, "well sweated." It is the *nature* of the change during fermentation—about which almost nothing is known at present—and not the total loss in the case, which determines the effect of the process on the quality of the leaf.

JUDGMENT OF THE EXPERT.

Each lot of tobacco was marked with a number, different from the one used in the previous year, and which gave no indication of the plot from which the tobacco came.

The lots were examined and graded by Mr. Benjamin L. Haas of Hartford, who has graded the two previous crops. Mr. Haas devoted two days to the work, and there has thus been secured a perfectly unbiased and intelligent judgment by an expert fully acquainted with the present requirements of the trade.

A strict judgment has been given, noting all defects in the leaf.

The crops on the experiment field were in general of quite as good quality as those grown elsewhere in the neighborhood.

Following is the grading given by Mr. Haas, in detail:

LOT A.

Fertilizers: 1360 lbs. cottonseed meal and 1560 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 150 lbs. phosphoric acid and 339 lbs. potash. Cost, $53.12 per acre.

Yield: 740 lbs. long wrappers per acre.
230 " short " " "
Total 970 "

Quality:—*Burn*, free, does not coal, holds fire fairly well. *Ash*, clear white. *Vein*, small, some white vein. *Texture*, well sweated, open grain, thin and good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative Rank*, 5th.

LOT B.

Fertilizers: 1826 lbs. linseed meal, 1572 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 143 lbs. phosphoric acid and 339 lbs. potash. Cost, $60.02 per acre.

Yield: 690 lbs. long wrappers per acre.
205 " short " " "
Total 895 "

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear gray. *Vein*, small, curly. *Texture*, well sweated, good grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, clear, bright, medium. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 6th.

LOT C.

Fertilizers: 2260 lbs. cottonseed meal, 1480 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 170 lbs. phosphoric acid and 339 lbs. potash. Cost, $63.24 per acre.

Yield: 880 lbs. long wrappers per acre.
260 " short " " "
Total 1140 "

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear white, hard. *Vein*, good. *Texture*, well sweated, good grain, good finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, dark, mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 11th.

LOT D.

Fertilizers: 2720 lbs. cottonseed meal, 1440 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 180 lbs. phosphoric acid and 340 lbs. potash. Cost, $68.44 per acre.

Yield: 1050 lbs. long wrappers per acre.
280 " short " " "
Total 1330 "

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear white. *Vein*, curly, with some white vein. *Texture*, well sweated, open grain, lacks finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 16th.

LOT E.

Fertilizers: 1900 lbs. castor pomace and 1640 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. potash. Cost, $59.70 per acre.

Yield: 710 lbs. long wrappers per acre.
240 " short " " "
Total 950 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, curly and white. *Texture*, medium, well sweated, close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark, mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium to small. *Relative rank*, 28th.

LOT F.

Fertilizers: 1820 lbs. linseed meal, 640 lbs. cotton hull ashes and 260 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 153 lbs. phosphoric acid and 152 lbs. potash. Cost, $42.48 per acre.

Yield: 820 lbs. long wrappers per acre.
260 " short " " "
Total 1080 "

Quality:—*Burn*, coals slightly, holds fire fairly. *Ash*, clear white, does not flake. *Vein*, good. *Texture*, well sweated, inclined to be close grain, good finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 4th.

LOT G.

Fertilizers: 3160 lbs. castor pomace and 1540 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 162 lbs. phosphoric acid and 338 lbs. potash. Cost, $72.52 per acre.

Yield: 860 lbs. long wrappers per acre.
280 " short " " "
Total 1140 "

Quality:—*Burn*, coals slightly, fairly free. *Ash*, clear gray. *Vein*, medium, white vein. *Texture*, thin, well sweated, good grain, fair finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, clear, dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 15th.

LOT H.

Fertilizers: 3780 lbs. castor pomace and 1540 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 171 lbs. phosphoric acid and 340 lbs. potash. Cost, $79.56 per acre.

Yield: 1050 lbs. long wrappers per acre.
280 " short " " "
Total 1330 "

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear white, hard. *Vein*, good. *Texture*, well sweated, good grain, lacks finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 14th.

LOT I.

Fertilizers: 1900 lbs. castor pomace, 1640 lbs. cotton hull ashes, 640 lbs. nitrate of soda (the latter in two applications after planting) per acre, containing 208 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. of potash. Cost, $75.70 per acre.

Yield: 920 lbs. long wrappers per acre.
250 " short " " "
Total 1170 "

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear gray. *Vein*, inclined to be curly and some white. *Texture*, well sweated, grain rather open, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark and somewhat mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, rather small. *Relative rank*, 20th.

LOT J.

Fertilizers: 1900 lbs. castor pomace, 1640 lbs. cotton hull ashes, and 640 lbs. nitrate of soda (the latter applied after planting) per acre, containing 208 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. potash. Cost, $75.70 per acre.

Yield: 980 lbs. long wrappers per acre.
260 " short " " "
Total 1240 "

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear gray. *Vein*, some white, medium. *Texture*, well sweated, rather close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark, somewhat mottled. *Yield*, fairly desirable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 19th.

LOT K.

Fertilizers: 1360 lbs. cottonseed meal, 1160 lbs. double sulphate of potash and magnesia, and 380 lbs. Cooper's bone per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 341 lbs. of potash. Cost, $40.55 per acre.

Yield: 930 lbs. long wrappers per acre.
225 " short " " "
Total 1155 "

Quality:—*Burn*, coal slightly, holds fire fairly. *Ash*, clear gray. *Vein*, inclined to be white. *Texture*, well sweated, good grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, not profitable. *Soundness*, fairly sound. *Stem*, rather small. *Relative rank*, 17th.

LOT L.

Fertilizers: 1360 lbs. cottonseed meal, 1160 lbs. double sulphate of potash and magnesia, 380 lbs. Cooper's bone, and 300 lbs. lime per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 341 lbs. of potash. Cost, $43.55 per acre.

Yield: 760 lbs. long wrappers per acre.
270 " short " " "
Total 1030 "

Quality:—*Burn*, does not coal, does not hold fire well. *Ash*, clear white. *Vein*, small, with some white. *Texture*, thin, well sweated, open grain, good finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 7th.

LOT M.

Fertilizers: 1360 lbs. cottonseed meal, 660 lbs. high grade sulphate of potash and 380 lbs. Cooper's bone per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 338 lbs. of potash. Cost, $41.30 per acre.

Yield: 680 lbs. long wrappers per acre.
210 " short " " "
Total 890 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, small, some white. *Texture*, well sweated, close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to light but mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 26th.

LOT N.

Fertilizers: 1360 lbs. cottonseed meal, 660 high grade sulphate of potash, 380 lbs. Cooper's bone and 300 lbs. lime per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 338 lbs. potash. Cost, $44.30 per acre.

Yield: 720 lbs. long wrappers per acre.
220 " short " " "
Total 940 "

Quality:—*Burn*, coals very slightly, holds fire fairly. *Ash*, mixed gray. *Vein*, inclined to be white. *Texture*, well sweated, fair grain but inclined to be close, lacks finish. *Size*, good. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 25th.

LOT O.

Fertilizers: 1360 lbs. cottonseed meal, 580 lbs. carbonate of potash and 380 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 339 lbs. potash. Cost, $72.45 per acre.

Yield: 780 lbs. long wrappers per acre.
240 " short " " "

Total 1020 "

Quality:—*Burn*, coals, holds fire fairly. *Ash*, mixed gray. *Vein*, small amount of white vein, otherwise good. *Texture*, well sweated, fairly open grain, good finish. *Size*, very desirable. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 13th.

LOT P.

Fertilizers: 1360 lbs. cottonseed meal, 1740 lbs. double carbonate of potash and magnesia, and 380 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 340 lbs. potash. Cost, $57.08 per acre.

Yield: 660 lbs. long wrappers per acre.
220 " short " " "

Total 880 "

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, hard and white. *Vein*, good. *Texture*, well sweated, very thin, open grain, good finish. *Size*, very desirable. *Ripeness*, ripe. *Colors*, fairly clear, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 2d.

LOT Q.

Fertilizers: 2000 lbs. Baker's A. A. Superphosphate, 4000 lbs. Baker's tobacco manure per acre, containing 241 lbs. nitrogen, 489 lbs. phosphoric acid and 495 lbs. potash.

Yield: 920 lbs. long wrappers per acre.
190 " short " " "

Total 1110 "

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, muddy gray. *Vein*, prominent, curly. *Texture*, well sweated, thin, papery, close grain. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, inclined to be large. *Relative rank*, 29th.

LOT R.

Fertilizers: 2000 lbs. Stockbridge Tobacco Manure and 500 lbs. of the same, used as a starter, per acre, containing 149 lbs. nitrogen, 281 lbs. phosphoric acid and 283 lbs. potash.

Yield: 730 lbs. long wrappers per acre.
230 " short " " "

Total 960 "

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small, but some white. *Texture*, well sweated, open grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark, mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 23d.

LOT S.

Fertilizers: 3000 lbs. Stockbridge Tobacco Manure, 500 lbs. of the same, used as a starter per acre, containing 209 lbs. nitrogen, 393 lbs. phosphoric acid and 396 lbs. potash.

Yield: 910 lbs. long wrappers per acre.
250 " short " "

Total 1160 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, inclined to be white. *Texture*, well sweated, fair grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, not profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 22d.

LOT T.

Fertilizers: 880 lbs. dry ground fish, 440 lbs. nitrate of soda, and 300 lbs. lime per acre, containing 142 lbs. nitrogen, and 60 lbs. phosphoric acid. Cost, $31.60 per ton.

Yield: 740 lbs. long wrappers per acre.
160 " short "

Total 900 "

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, white. *Vein*, white and curly. *Texture*, well sweated, open grain, without finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark and mottled. *Yield*, very unprofitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 27th.

LOT U.

Fertilizers: 2200 lbs. Mapes' Tobacco Manure, wrapper brand, and 600 lbs. Mapes' Starter per acre, containing 158 lbs. of nitrogen, 211 lbs. phosphoric acid, and 278 lbs. potash.

Yield: 1110 lbs. long wrappers per acre.
180 " short " "
Total 1290 "

Quality :—*Burn*, coals slightly, holds fire fairly. *Ash*, medium, clear gray. *Vein*, prominent, curly, inclined to be white. *Texture*, well sweated, good grain. *Size*, too large. *Ripeness*, ripe. *Colors*, medium. *Yield*, unprofitable. *Soundness*, sound. *Stem*, large. *Relative rank*, 18th.

LOT V.

Fertilizers: 2400 lbs. Mapes' Tobacco Manure, wrapper brand, and 400 lbs. Mapes' Starter per acre, containing 163 lbs. nitrogen, 196 lbs. phosphoric acid, and 294 lbs. potash.

Yield: 870 lbs. long wrappers per acre.
225 " short " "
Total 1095 "

Quality :—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small, no white vein. *Texture*, thin, well sweated, open grain, no finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium to dark, dry. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 24th.

LOT W.

Fertilizers: 2400 lbs. Mapes' Tobacco Manure per acre, containing 151 lbs. of nitrogen, 143 lbs. phosphoric acid, and 280 lbs. potash.

Yield: 990 lbs. long wrappers per acre.
270 " short " "
Total 1260 "

Quality :—*Burn*, inclined to coal, does not hold fire very well. *Ash*, mixed gray, does not flake. *Vein*, small, inclined to be white. *Texture*, well sweated, thin, good grain, good style. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to light. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 8th.

LOT X.

Fertilizers: 2000 lbs. Sanderson's Tobacco Formula per acre, containing 103 lbs. nitrogen, 281 lbs. phosphoric acid, and 105 lbs. potash.

Yield: 680 lbs. long wrappers per acre.
240 " short " "
Total 920 "

Quality :—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small. *Texture*, well sweated, open grain, good finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, fair. *Soundness*, sound. *Stem*, small. *Relative rank*, 9th.

LOT Y.

Fertilizers: 1360 lbs. cotton seed meal, 8540 lbs. wood ashes, and 80 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 147 lbs. phosphoric acid, 340 lbs. potash. Cost, $70.34 per acre.

Yield: 840 lbs. long wrappers per acre.
200 " short " "
Total 1040 "

Quality :—*Burn*, coals slightly, holds fire fairly well. *Ash*, clear gray. *Vein*, some white. *Texture*, well sweated, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, clear, medium to dark. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 12th.

LOT Z.

Fertilizers: 1300 lbs. dry ground fish, 1260 lbs. double sulphate of potash and magnesia, and 200 lbs. Cooper's bone per acre, containing 104 lbs. nitrogen, 146 lbs. phosphoric acid, and 342 lbs. potash. Cost, $47.60 per acre.

Yield: 670 lbs. long wrappers per acre.
250 " short " "
Total 920 "

Quality :—*Burn*, does not coal, holds fire fairly well. *Ash*, clear gray. *Vein*, small, some white. *Texture*, too hard sweated, thin, open grain, good finish. *Size*, very desirable. *Ripeness*, ripe. *Colors*, dark and mottled. *Yield*, very profitable. *Soundness*, sound. *Stem*, very small. *Relative rank*, 3d.

Lot AA.

Fertilizers: 10 to 12 cords stable manure, on half the plot 500 lbs. Swift-Sure Superphosphate per acre, containing (estimated) 125 lbs. nitrogen, 143 lbs. phosphoric acid, and 171 lbs. potash.

Yield:	380 lbs.	long wrappers per acre.	
	180 "	short	" "
Total	560 "		

Quality:—*Burn*, coals slightly, holds fire well. *Ash*, mixed gray. *Vein*, small, very little white vein. *Texture*, well sweated, thin, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 1st.

Lot BB.

Fertilizers: 6000 lbs. tobacco stems, 2640 lbs. castor pomace, on half the plot 500 lbs. Swift-sure Superphosphate per acre, containing (estimated) 253 lbs. nitrogen, 146 lbs. phosphoric acid and 539 lbs. potash. Cost, $83.18.

Yield:	600 lbs.	long wrappers per acre.	
	180 "	short	" "
Total	780 "		

Quality:—*Burn*, coals very slightly, holds fire fairly well, free burn. *Ash*, clear gray. *Vein*, small, some white. *Texture*, well sweated, rather thin, open grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium to small. *Relative rank*, 21st.

Lot CC.

Fertilizers: 3000 lbs. Pinney's Formula per acre, containing 131 lbs. nitrogen, 196 lbs. phosphoric acid and 305 lbs. potash.

Yield:	620 lbs.	long wrappers per acre.	
	230 "	short	" "
Total	850 "		

Quality:—*Burn*, coals, holds fire fairly well. *Ash*, mixed gray. *Vein*, small, not white. *Texture*, well sweated, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, clear, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 10th.

The lots in order of their value as wrappers, taking all points into consideration, are graded as follows:

AA (best), 1st.	P, 2d.	Z, 3d.	F, 4th.	A, 5th.	B, 6th.	L, 7th.	W, 8th.	X, 9th.	CC, 10th.
C, 11th.	Y, 12th.	O, 13th.	H, 14th.	G, 15th.	D, 16th.	K, 17th.	U, 18th.	J, 19th.	I, 20th.
BB, 21st.	S, 22d.	R, 23d.	V, 24th.	N, 25th,	M, 26th.	T, 27th.	E, 28th.	Q, 29th.	

General Remarks.—The short wrappers from all the plots contain a larger per cent. of fine wrappers than the short wrappers of the experiment crops of 1892 or 1893 contained.

The first ten in the above list differ *very* little in quality. The tobaccos all show a great improvement over the 1893 crops, and the first fifteen in the above list are all very desirable tobaccos.

The presence of white vein has impaired the salability of the crops somewhat, but this is considered a defect of curing rather than of growing.

Discussion of the Results.

The crop of 1894 was a dry-weather crop. During the tobacco-growing season of 1892 nearly 16 inches of rain fell, and the quality of the crop was exceptionally good. In 1893 only 6.2 inches of rain fell while the crop was standing, and the crop was exceptionally poor: its one good feature being the "burn," which was even better than that of 1892 crop.

In 1894 the rain-fall, while the tobacco was in the field, amounted to 7.16 inches, an inch more than in 1893. On fifteen days out of the 83 days the conditions were reported as "too dry" by the superintendent of the field work.

The total rain-fall, however, gives a very inadequate idea of the supply of water to the crop. A succession of showers at tolerably uniform intervals is most favorable to the crop. Two or three heavy down-pours of rain with long periods of dryness between, even if more rain falls than in the former case, are much less favorable.

In 1894 there was a time in June when no rain fell for 16 days, and no rain fell for the last 10 days of June, but for the rest of the season some rain fell in every week.

The crop received no great amount of rain, but the rain-fall was well distributed and the quality of the crop was very fair.

Comparative Fire-Holding Capacity.

In the following table is given the relative fire-holding capacity of the long and short wrappers from each plot determined by Messrs. Winton and Ogden, by the method described in the Report of this Station for 1893, p. 124.

The lot which held fire the shortest time is marked 100, and the other lots are so marked as to express numerically their capacity for holding fire: for example, lot T held fire for a shorter time than any other (100), lot A held fire more than four times as long (436).

Comparative Fire-Holding Capacity. Fermented Crop of 1894.

	Long Wrappers.	Short Wrappers.	Calculated from mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	485	409	436	11.9	45.8
B	331	315	318	11.0	33.4
C	292	241	260	12.0	27.3
D	251	197	218	11.8	22.9
E	257	209	227	9.1	23.9
F	150	100	120	7.8	12.6
G	255	340	298	9.7	31.2
H	400	190	277	11.9	29.0
I	223	198	206	10.6	21.6
J	194	215	204	14 0	21.5
K	228	237	230	7.6	24.1
L	162	178	168	6.8	17.6
M	172	127	145	7.9	15.2
N	162	217	190	9.6	19.9
O	182	248	216	11.5	22.7
P	430	337	374	13.7	39.3
Q	107	111	107	5.5	11.3
R	153	192	172	10.2	18.1
S	190	243	216	8.1	22.7
T	100	103	100	6.9	10.5
U	137	204	172	7.8	18.0
V	160	180	170	8.0	17.6
W	181	230	205	8.9	21.6
X	101	103	101	6.4	10.6
Y	305	309	303	15.2	31.8
Z	253	250	248	10.6	26.0
AA	216	326	273	7.8	28.7
BB	170	239	205	9.8	21.5
CC	298	192	236	9.9	24.8

The fire-holding capacity of the leaf was in every case increased by the fermentation, though not by any means equally in all cases.

The *average* fire-holding capacity of the three year's crops already fermented are:

	Before Fermentation.	After Fermentation.
Crop of 1892	9.6	24.4
Crop of 1893	9.0	18.0
Crop of 1894	9.7	23.2

There is substantial agreement in most cases between the judgment as to fire-holding capacity by the expert and the results of laboratory tests.

Thus the seven lots L, Q, R, T, V, W, X, which did not hold fire well in the expert's judgment, were all far below the average fire-holding capacity as determined in the laboratory. The five lots judged to hold fire "very well," B, C, H, P, AA, had a relatively high fire-holding capacity as determined by the chemist.

Exceptional are lots F, M, N, U, BB, which "hold fire fairly" in the opinion of the expert, but as determined by laboratory tests are quite below the average, and A and Y, which are judged to "hold fire fairly," yet have a very high fire-holding capacity as determined in the laboratory.

Tendency to coal is not always associated with small fire-holding capacity. Lots O and CC, which "coaled" most, had a fire-holding capacity above the average.

The relative average fire-holding capacity of all the lots which did not coal was 265, while that of the lots which coaled slightly was 190.

Number of Fermented Leaves to the Pound.

On page 281, Report of 1894, are given the number of leaves per pound of each lot of *pole-cured* tobacco of this crop.

The number of leaves per pound of this same crop after fermentation in the case, appear in the following table.

From 25 to 35 leaves were weighed on a balance sensitive to $\frac{1}{30}$ of an ounce, and from these weights the results in the table are computed.

NUMBER OF FERMENTED LEAVES TO THE POUND. CROP OF 1894.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	68	101	P	76	111
B	66	93	Q	72	94
C	67	97	R	68	109
D	73	93	S	61	96
E	80	101	T	77	96
F	72	89	U	63	95
G	70	97	V	72	89
H	74	89	W	76	95
I	65	111	X	71	97
J	73	105	Y	72	93
K	70	95	Z	70	108
L	66	88	AA	64	92
M	78	112	BB	70	85
N	72	101	CC	64	90
O	79	106			

The average of these figures is as follows:

NUMBER OF LEAVES TO THE POUND.

	Pole-cured.	Fermented.
Short wrappers	88	97
Long wrappers	64	71

EFFECTS OF DIFFERENT FORMS OF NITROGEN.

Cotton Seed Meal and Castor Pomace.

Cotton Seed Meal and Castor Pomace were each applied to three plots in quantities supplying 105, 175 and 210 lbs. per acre of nitrogen respectively, with 150 lbs. of phosphoric acid and 340 lbs. of potash in form of cotton hull ashes.

In 1894 the yield of wrappers was practically the same from the Cotton Seed plots as from the Castor Pomace plots.

In both cases the yield regularly increased with the increase in nitrogen.

The number of wrapper leaves per pound was practically the same where cotton seed was used as where castor pomace was used.

In both cases the number of leaves per pound was slightly greater with the smaller amount of nitrogen than with the larger.

The per cent. of wrappers in the crops was nearly the same with both fertilizers and increased in each case with the increase of nitrogen in the fertilizers.

The quality of the leaf raised on Cotton Seed Meal was somewhat better than that raised with Castor Pomace.

Thus lots A, C, D (Cotton Seed Meal) were graded 5th, 11th and 16th. Lots E, G, H (Castor Pomace) were graded 28th, 15th, 14th. Excepting lot E, there is, however, little difference in quality between the two.

Linseed Meal.

Plot B, which received 105 pounds of nitrogen per acre in this form, yielded 65 pounds less per acre of wrappers than the corresponding plots A and E, dressed with Cotton Seed and Pomace; the per cent. of wrappers in the crop was about the same, the weight per leaf was somewhat greater, and the quality was of the best, ranking 6th.

Plot F, with the same amount of linseed meal and phosphoric acid, but half the quantity of potash that was put on B, yielded 115 pounds more of wrappers per acre than A or E, but in other ways the crop differed little from that on F, and was graded 4th.

Practically the same results were obtained with the previous crop.

Fish.

Plot Z was dressed with 1300 pounds of dry ground fish, which supplied 105 pounds of nitrogen and 1260 pounds of double sulphate of potash and magnesia. It is not strictly comparable with plots A (Cotton Seed Meal), E (Castor Pomace), and B (Linseed Meal), in that the form of potash was different,—though the quantity of actual potash supplied was the same.

The yield of wrappers was somewhat less than from plots A and E, and somewhat more than from B. The quality of leaf was, however, nearly as good as any, ranking 3d.

Nitrate of Soda, at First and Second Cultivation.

(Plots I and J compared with H.)

The point of this experiment is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds), as a top dressing in the form of nitrate of soda in one application at the time of the first cultivation (plot I), or in two applications at the time of the first and second cultivation (plot J). The effect in both cases was decidedly injurious to the quality of the wrappers, though plot J yielded 180 pounds more of wrappers than H. In 1893 J yielded 165 pounds more wrappers than H, and the quality of the wrappers was even better. Plot I, which received all the nitrate in one application, produced less tobacco and of inferior quality.

In 1894 the effect in each case was somewhat injurious. J produced 70 pounds more wrapper leaf than I, but 90 pounds less than H. The wrapper leaves on I and J were somewhat lighter in weight than on H, but the quality was not quite as good.

Stable Manure.

Plot AA was dressed with 10 to 12 cords of stable manure and some Swift Sure Superphosphate as a starter.

The yield of wrappers was very small, 560 pounds per acre, scarcely more than half the average yield of all the plots taken together.

The per cent. of wrappers in the crop was also the smallest of any. But the *quality* of the leaf was the very best of all and was ranked first. The calculated quantity of nitrogen on this plot was 125 pounds per acre. It is quite likely that this was not all readily available, and that the small crop may be explained by a deficiency of nitrogen.

Tobacco Stems.

Plot BB, dressed with three tons of tobacco stems per acre and 2640 pounds of Castor Pomace, with 500 pounds of Swift Sure Superphosphate, yielded 780 pounds of wrapper leaf, which was of less than average quality.

EFFECT OF DIFFERENT FORMS OF POTASH.

Plots A, K, L, M, N, O, P, Y, were dressed with like quantities of nitrogen (in form of Cotton Seed Meal), phosphoric acid and potash; but the potash was supplied in different forms.

The plot which received double sulphate of potash and magnesia yielded the most wrappers per acre, 1155 pounds.

The yield from the double sulphate of potash and magnesia with lime, carbonate of potash, and wood ashes were about alike, 1020 to 1040 pounds. Cotton hull ashes and high grade sulphate with lime yielded 970 to 980 pounds, while the high grade sulphate without lime, and the double carbonate of potash and magnesia yielded least (880 to 890 pounds of wrappers per acre).

The expert graded the lots raised with cotton hull ashes, double sulphate of potash and magnesia *with lime*, double carbonate of potash and magnesia and wood ashes, 5th, 7th, 2d and 12th, respectively, among the very best in the whole experiment.

The lots raised with carbonate of potash, and double sulphate of potash and magnesia *without lime*, ranked next, 13th and 17th, while those raised with high grade sulphate, with and without lime, were among the poorest, 25th and 26th.

Notice is also called to the facts that lot Z raised with fish and double sulphate of potash and magnesia ranked 3d, and that lot F, which received only half the quantity of potash applied to plot B, ranked 4th, i. e., among the very best.

It should be remembered in considering the results of 1894, that it is not designed to draw any definite conclusions from these experiments till five successive crops have been grown, cured, sweated, and finally examined and graded by the expert. The fourth crop is now cased down for fermentation, and the fifth is to be grown in the summer of 1896.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1895.

By E. H. Jenkins.

These experiments are in continuation of those begun in 1892 in coöperation with the Connecticut Tobacco Experiment Co. of Poquonock in the town of Windsor.

Full particulars regarding the land, the conduct of the experiments and their results are given in the Reports of this Station for 1892, pages 1 to 24; for 1893, pages 112 to 144; for 1894, pages 254 to 284.

Fertilizers.

The fertilizers used in 1895 were sampled and analyzed by Messrs. Winton and Ogden, with the following results:

Composition and Cost of Fertilizers Used.

	Cost Per Ton.	Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$50.00	15.03	----	----
Cotton Seed Meal	22.00	6.65	2.35	1.73
Castor Pomace	15.00	5.04	4.18	1.81
Linseed Meal	27.00	6.29	1.66	1.24
Tobacco Stems	14.00	1.90*	.60*	8.10*
Cooper's Bone	28.00	2.24	26.65	----
Cotton Hull Ashes	45.00	----	7.04	2.41
Wood Ashes	10.40	----	2.43	4.28
High Grade Sulphate of Potash	50.00	----	----	50.39
Carbonate of Potash	170.00†	----	----	54.10
Double Carbonate Potash and Magnesia	39.00‡	----	----	18.10
Double Sulphate Potash and Magnesia	30.00	----	----	28.39
Fish	35.00	9.26	7.36	----

The chemicals used for each plot were accurately weighed and labeled by the Station representative, mixed thoroughly and bagged by Mr. DuBon and himself.

The bags were carried to the several plots by Mr. DuBon, and their contents were sowed under his constant supervision.

The following table shows the plan of the experiment, the fertilizers applied, with the cost of each as far as known, and the quantities of nitrogen, phosphoric acid and potash contained in them.

* Estimated. † By single pound; ton rates would be much lower.
‡ Total cost of importing a one ton lot from Stassfurt.

Fertilizers Applied, Season of 1895.

Name of Plot.	Fertilizers Applied. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds. Nitrogen.	Phosphoric Acid.	Potash.
A	1579 Cotton Seed Meal 1297 Cotton Hull Ashes	$46.55	105	159	340
B	1669 Linseed Meal 1324 Cotton Hull Ashes	52.32	105	152	340
C	2631 Cotton Seed Meal 1221 Cotton Hull Ashes	56.41	175	177	340
D	3158 Cotton Seed Meal 1184 Cotton Hull Ashes	61.38	210	186	340
E	2083 Castor Pomace 1254 Cotton Hull Ashes	43.83	105	205	340
F	1669 Linseed Meal 536 Cotton Hull Ashes 277 Cooper's Bone	38.47	105	152	150
G	3472 Castor Pomace 1149 Cotton Hull Ashes	51.87	175	253	340
H	4166 Castor Pomace 1097 Cotton Hull Ashes	55.93	210	277	340
I	2083 Castor Pomace 1254 Cotton Hull Ashes 320 Nitrate of Soda* 320 Nitrate of Soda†	59.84	210	205	340
J	2083 Castor Pomace 1254 Cotton Hull Ashes 640 Nitrate of Soda*	59.84	210	205	340
K	1579 Cotton Seed Meal 1102 Double Sulphate of Potash and Magnesia 457 Cooper's Bone	40.29	105	159	340
L	1579 Cotton Seed Meal 1102 Double Sulphate of Potash and Magnesia 457 Cooper's Bone 300 Lime	42.27	105	159	340
M	1579 Cotton Seed Meal 621 High Grade Sulphate of Potash 457 Cooper's Bone	39.28	105	159	340
N	1579 Cotton Seed Meal 621 High Grade Sulphate of Potash 457 Cooper's Bone 300 Lime	41.26	105	159	340

* Applied between the rows at the time of first cultivation.
† Applied between the rows at the time of second cultivation.

Fertilizers Applied, Season of 1894.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
O	1579 Cotton Seed Meal 578 Carbonate of Potash 457 Cooper's Bone	$72.90	105	159	340
P	1579 Cotton Seed Meal 1728 Double Carbonate Potash and Magnesia 457 Cooper's Bone	57.46	105	159	340
Q	2000 Baker's A. A. Superphosphate 4000 Baker's Tobacco Manure	----	240	453	434
R	2000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	----	154	307	278
S	3000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	----	215	430	389
T	945 Dry Ground Fish 547 Nitrate of Soda 300 Lime	32.19	175	70	----
U	2200 Mapes' Tobacco Manure, Wrapper Brand 600 Mapes' Starter	----	138	232	291
V	2400 Mapes' Tobacco Manure, Wrapper Brand 400 Mapes' Starter	----	143	219	309
W	2400 Mapes' Tobacco Manure, Wrapper Brand	----	130	165	296
X	2000 Sanderson's Formula for Tobacco	----	99	156	122
Y	1579 Cotton Seed Meal 7290 Wood Ashes	55.27	105	214	340
Z	1134 Dry Ground Fish 1197 Double Sulphate of Potash and Magnesia 283 Cooper's Bone	41.74	105	159	340
AA	Stable Manure 10–12 cords†	----	111	71	149
BB	6000 Tobacco Stems 2894 Castor Pomace	63.71	239	74	517
CC	3000 Pinney's Formula Fertilizer	----	131	196	305

* Applied as a starter.

† Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

Planting and Care During Growth.

The experience of previous years having showed that the plants were injured by contact with the fertilizers, if the latter were merely harrowed in, near setting time, in 1895 the fertilizers were plowed under, two weeks before the plants were set. The results were perfectly satisfactory. The plants started quickly, grew well and showed no signs of "burning" by contact with the fertilizers.

The plants were set with the Bemis planter on May 25th. Paris green was applied on the 27th, to check the ravages of the cut worm.

On June 3d, 2,000 plants were re-set.

On July 13th, about two thirds of the whole field was topped. On the 20th, all had been topped except plots T, Z and Y, which were backward in development. At this time the tobacco on plot AA was as large as any, but looked as if needing plant food. On the 25th, this plot of tobacco had begun to turn yellow. The crop was harvested on Aug. 14th and 15th.

Notes on the Rainfall, Soil Moisture and Temperature.

As in the season of 1893, through the coöperation of Prof. Milton Whitney, Chief of the Division of Agricultural Soils of the U. S. Department of Agriculture, who supplied the necessary instruments, daily observations were made by Mr. Adelbert DuBon during the growing season, of maximum and minimum air temperature (radiation thermometers), maximum and minimum soil temperatures (average to depth of nine inches), and rainfall.

The instruments were placed near the crop on a plot which was kept free from all vegetation.

Samples of soil to the depth of nine inches were also daily drawn by Mr. DuBon from several plots and sent to the Station for determination of moisture.

The sampling apparatus and method of packing the samples were designed by Prof. Whitney.

These observations taken together give a record of meteorological conditions which, however incomplete, is of great assistance in comparing the conditions under which the crops of successive years are raised.

Rain-fall in 1895.

The tobacco was set on May 25th, and harvested on August 14th and 15th, and was in the field therefore 81 days. The rainfall during that time was as follows :

May 26	.22	July 1	.09	July 25	.10
" 27	.66	" 4	.50	" 27	.51
June 3	.30	" 5	.25	" 30	.30
" 6	.21	" 6	1.10	Aug. 7	1.20
" 25	.19	" 9	1.37	" 10	.06
" 27	.25	" 13	.74	" 12	.25
" 28	.48	" 16	.35	" 13	.09
" 29	.10	" 20	.06		

Total 9.38 inches.

The corresponding rain-fall in 1894 was 7.16 inches, in 1893 6.13, in 1892, 16.01.

On only nine days was the soil "too dry" in the opinion of the grower. In 1894, there were 15 such days. June was a dry month and no rain fell from the 6th to the 25th, but after this time more or less rain fell every week.

On the whole the season was more favorable for the crop as far as concerns rainfall than either 1893 or 1894.

The Percentage of Water in the Soil.

Daily determinations of moisture in the soil, taken to the depth of 8 inches, were made on three different plots of the field, as follows:—

Plot 1, after lying unfertilized and untilled for ten years, was plowed in 1894 and 1895, kept free from vegetation and the soil surface was occasionally stirred by raking.

Plots F and Y were planted with tobacco, the former dressed with 1670 lbs. to the acre of Linseed Meal, 536 of Cotton Hull Ashes and 277 lbs. of Cooper's Bone. Plot W was dressed with 2,400 pounds of Mapes' Tobacco Manure.

In the following table are given the average per cents of water found in the soils for each week, calculated from daily determinations.

Average Moisture in Tobacco Soil.

	Plot bare of vegetation. A	Plots planted to Tobacco. F	Y
June 17 to 23	7.4	8.6	6.3
" 24 " 30	8.5	9.8	7.8
July 1 " 7	8.5	9.9	9.1
" 8 " 14	10.6	11.7	11.3
" 15 " 21	8.6	9.7	8.8
" 22 " 28	8.5	7.6	5.6
" 29 " Aug. 4	7.9	6.4	7.2
Aug. 5 " " 11	8.2	8.3	6.8
" 12 " " 18	8.5	9.5	8.2
Average,	8.5	9.1	7.9

In 1895, the plot which was bare of vegetation contained on the average one per cent. more of moisture than in 1894. Plot F, for some unknown reason, in both seasons has held more moisture than most of the plots.

In 1894 the plots planted to tobacco contained considerably less water after the crop had reached its full development than earlier in the growing season. In 1895, on the contrary, the rain-fall was such as to keep the water-content of the soil practically the same throughout the growing season.

Temperature of Air and Soil.

Daily observations of temperature were made, as already described, by Mr. Adelbert DuBon.

In the following table are given the average weekly maxima, minima and ranges of temperature.

Air and Soil Temperature at the Tobacco Field.

Weekly Averages.

	Radiation thermometers. Max.	Min.	Range.	Soil temperature. Max.	Min.	Range.
June 18 to June 22	97	50	47	85	69	16
" 23 " " 29	87	60	28	84	65	19
" 30 " July 6	84	53	31	84	61	23
July 7 " " 13	83	52	31	87	60	27
" 14 " " 20	85	53	32	80	57	23
" 21 " " 27	92	53	39	93	70	23
" 28 " Aug. 3	84	49	35	86	60	26
Aug. 4 " " 10	93	56	37	94	69	25
" 11 " " 17	94	56	38	97	64	33
" 18 " " 22	84	49	35	92	59	33

The highest temperature recorded by the radiation thermometer was 102°, the lowest 41°.

The highest record of the soil thermometer was 101°, and the lowest 50°.

Harvesting, Curing, Stripping and Sorting.

The crop was harvested on Aug. 14 and 15. The weather was generally favorable for rapid and dry curing. There was no trace of pole-sweat in the tobacco, but some white vein. The crop cured too rapidly to get the best quality of wrapper leaf.

On Oct. 13th, the cured tobacco was taken from the poles and was stripped on the 14th and 15th.

Sorting was begun on the 7th of November and required about a week for its completion.

At each handling of the crop a representative of the Station was always present; all weights were made and recorded and samples drawn by him.

As the crops were sorted, samples were carefully drawn from each lot of long and short wrappers and labeled as described in the Report for 1893, p. 138.

These samples were for laboratory examinations and for fermentation.

The following table gives the results of the sorting. The weights are in pounds. For those unfamiliar with the details of sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk, smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and often cutting to greater advantage than "long wrappers." The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

WEIGHTS OF THE BARN-CURED LEAVES FROM $\frac{1}{20}$ ACRE.

CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Seconds.	Top Leaves.	Net weight of Sorted Tobacco.
A	41½	11	13½	17	83
B	39	12	10	20½	81½
C	47½	16½	11½	15½	91
D	58½	15	10	17	100½
E	50½	15	10½	17½	93½
F	32	11	14	21	78
G	42½	14½	15	17½	89½
H	59½	13	8½	17½	98½
I	65½	13	8	15	101½
J	63½	16	7½	19½	106½
K	41½	13½	12½	19	86½
L	32	12½	19½	23½	87½
M	32	12½	17	26½	88
N	42	15½	13½	17½	88½
O	42	15½	10½	17	85
P	37	16½	10½	16½	80½
Q	45	10	14½	22½	92
R	40½	12	10½	19	82
S	55½	11½	8	15½	90½
T	29	7	15½	39	90½

WEIGHTS OF THE BARN-CURED LEAVES FROM $\frac{1}{20}$ ACRE.

CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Seconds.	Top Leaves.	Net weight of Sorted Tobacco.
U	48½	10½	14½	20	93½
V	39½	10½	13	14	77
W	42½	10½	9	13	74
X	50	10½	12	14	86½
Y	34½	13½	13	17½	78½
Z	35½	13	16	19½	84
AA	29	12½	19	18	78½
BB	62½	13½	8½	13	97½
CC	37	11½	13	19	80½

PER CENT. OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Total per cent. of Wrappers.	Seconds.	Tops
A	51	13	64	16	20
B	48	15	63	12	25
C	52	18	70	12	18
D	57	15	72	10	18
E	54	16	70	11	19
F	41	14	55	18	27
G	47	16	63	17	20
H	60	13	73	8	19
I	64	13	77	8	15
J	60	15	75	7	18
K	47	16	63	14	23
L	36	14	50	22	28
M	36	14	50	20	30
N	48	17	65	15	20
O	50	18	68	12	20
P	46	20	66	13	21
Q	49	11	60	16	24
R	49	14	63	13	24
S	61	13	74	9	17
T	32	8	40	17	43
U	52	11	63	16	21
V	51	14	65	17	18
W	57	14	71	12	17
X	58	12	70	14	16
Y	44	17	61	16	23
Z	42	15	57	19	24
AA	37	16	53	24	23
BB	64	14	78	9	13
CC	46	14	60	16	24

Comparative Fire-Holding Capacity.

Pole-cured Crop, 1895.

The method of determining the fire-holding capacity is described in the Station Report for 1892, page 17, and the meaning of the figures in the following table is described on page 140 of the present Report.

Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.	Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.
A	491	267	347	P	348	189	246
B	254	393	319	Q	189	129	150
C	337	282	292	R	250	228	227
D	291	390	332	S	159	280	218
E	352	465	399	T	152	100	117
F	283	275	266	U	174	195	178
G	237	349	288	V	162	221	188
H	291	179	217	W	241	316	271
I	256	254	244	X	100	108	100
J	226	272	241	Y	582	343	426
K	156	287	220	Z	293	233	248
L	287	244	251	AA	365	308	318
M	183	243	208	BB	321	236	260
N	185	267	221	CC	191	233	205
O	324	403	353				

Number of Pole-cured Leaves to the Pound.

Crop of 1895.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	57	78	P	65	83
B	53	78	Q	48	77
C	51	83	R	52	80
D	46	81	S	54	73
E	49	76	T	53	87
F	61	86	U	59	72
G	52	72	V	50	78
H	50	75	W	48	90
I	49	75	X	54	84
J	55	70	Y	59	87
K	54	85	Z	52	81
L	61	77	AA	63	70
M	57	69	BB	79	85
N	53	71	CC	58	81
O	62	82			

Discussion of the Results.

The following paragraphs note the chief features of the crops of 1895. No strict comparison of them will be attempted till the crop has been fermented in the case.

Net Weight of the Sorted Crops, 1895.—The weights of sorted tobacco per acre, per cent. of wrapper leaves and weights of wrappers in the crops of 1892 and following years are:

Years.	Weight of Sorted Tobacco.	Per cent. of Wrappers.	Weight of Wrappers.
1892	1845	66.7	1231
1893	1559	48.5	756
1894	1713	62.1	1064
1895	1754	64.1	1124

Plots J, I, D, H and BB gave the largest yield of tobacco, from 2130 to 1950 pounds per acre, and also the largest yield of wrapper leaves, 1590 to 1450 pounds.

Plots W, V, F, Y and AA, yielded less than any others, from 1480 to 1570 pounds of leaf. The smallest yield of wrappers, however, was on plots T, AA, F, L and M, from 720 to 890 pounds.

Cotton Seed Meal and Castor Pomace.—(Plots A, C, D, compared with E, G, H.)

Between the gross yield of cured leaf from the plots dressed with cotton seed meal, and from those dressed with castor pomace was a difference of 140 pounds in favor of castor pomace; the difference in yield of wrapper leaf was but 100 pounds.

The weight of 100 leaves from the plots dressed with cotton seed was a little less than the weight of the same number of leaves from the castor pomace. As far as can be judged at present, there was no significant difference in the crops raised with these two fertilizers.

Increasing the quantity of cotton seed meal or of castor pomace applied to the land, from 1580 to 3160 pounds in case of cotton seed meal, and from 2080 to 4170 in case of castor pomace, increased the total yield and the yield of wrapper leaves.

Linseed Meal.—Plots B and F compared with A. The yield on Plot B, which was dressed with linseed meal instead of the corresponding quantity of cotton seed meal, was smaller than on plot A by only 30 pounds of leaves. No other differences between the two are noted.

On plot F, where the potash supplied was but 150 pounds instead of 340 pounds per acre as on plot B, the yield of leaves was 100 pounds less, and of wrappers 210 pounds less than on plot A.

Nitrate of Soda with Castor Pomace.—Plots I and J compared with plot H. Where, for an application of 210 pounds of nitrogen in form of castor pomace as on plot H, was substituted one-half that quantity of nitrogen in form of castor pomace, and the other half in form of nitrate of soda, plots I and J, the total yield of leaf and the yield of wrapper leaf were increased by about 150 pounds.

Fish, Stable Manure and Tobacco Stems.—Plot T, which was dressed with fish and nitrate of soda without potash, gave a very small yield of wrappers, 720 pounds per acre, with a very small capacity for holding fire. Plot Z, dressed with fish and double sulphate of potash yielded 250 pounds more of wrappers per acre.

The yield of wrappers on plot AA, dressed with 10–12 loads of stable manure per acre, was small, 830 pounds, while plot BB, dressed with tobacco stems and castor pomace, yielded 1520 pounds of wrappers.

Plot AA during the growing season showed signs of lack of plant food.

Potash Salts.—Plots A, K, L, M, N, O, P, Y. The nitrogen and phosphoric acid supplied to these plots in fertilizers has been the same in kind and quantity for four years.

The largest gross yields in 1895 from this series of plots were on M, high grade sulphate of potash, and N, high grade sulphate with lime, and were respectively 1760 and 1770 pounds of leaves.

The yield of wrappers, however, on M was as low as any, 890 pounds per acre, and on N 1050.

The yields of leaves on plots P, carbonate of potash and magnesia, and on Y wood ashes, were smaller than on A, cotton hull ashes; the others in the series were larger.

Plot O, carbonate of potash, gave the highest yield of wrappers, 1150 pounds, and plot K, double sulphate of potash and magnesia, came next, 1100 pounds.

The fire-holding capacity of the tobacco raised with high-grade sulphate was least in the series, that raised with the low grade sulphate was next.

The number of pole-cured leaves required to make a pound was also least in the leaves raised with the last two named forms of potash.

THE NITROGEN AND MINERAL MATTERS IN A PEACH CROP.

By E. H. Jenkins.

Analyses by Messrs. Winton and Ogden.

A basket of peaches, raised at the Summit Orchard of Messrs. Platt and Barnes, West Cheshire, and bought in the New Haven market, has been examined at the Station laboratory.

The basket contained 151 peaches, which weighed 23.92 pounds,* or a little more than 2½ ounces† apiece.

2,000 grams of the fresh peaches were "stoned," sliced, air-dried and partially analyzed. The composition of the fruit was as follows, per cent. :—

Pulp or flesh, air-dry	11.85	containing nitrogen	1.35
		" ash	2.77
Stones or seeds, "	5.75	" nitrogen	.88
		" ash	.62
Water lost in air-drying	82.40		
	100.00		

Total nitrogen in air-dry fruit .... 2.23 per cent.
" ash " " " .... 3.39 " "

The ash of pulp and stones had the following composition :—

	Pulp.	Stones.
Sand and silica	6.38	5.26
Oxide of iron and alumina	.94	6.53
Lime	2.76	16.43
Magnesia	3.27	10.06
Potash	67.72	33.11
Soda	3.17	5.50
Phosphoric acid	11.60	18.92
Sulphuric acid	2.83	4.00
Chlorine	1.70	.21
	100.37	100.02
Oxygen equivalent of chlorine	.37	.02
	100.00	100.00

* Equal to 10,850 grams.
† Equal to 72 grams.

When peach trees are set 18 feet apart each way, as is the common practice in this State, there are 130 trees to an acre.

Experienced growers reckon 3 baskets per tree, an average yield for orchards 5 years planted. Four baskets per tree is a maximum crop.

From the above data are calculated the quantities of nitrogen and mineral matters removed from an acre of 130 trees by the average crop of three baskets of peaches per tree, viz:

NITROGEN AND ASH-INGREDIENTS IN A PEACH CROP OF 390 BASKETS PER ACRE.

Nitrogen	19.7	pounds.
Potash	21.9	"
Soda	1.2	"
Lime	1.0	"
Magnesia	1.0	"
Oxide of iron	.4	"
Phosphoric acid	4.2	"
Sulphuric acid	1.0	"
Chlorine	.4	"

Contrary to the commonly received idea, the pulp of the fruit contains the greater part of both the nitrogen and mineral matters. Only about one-fourth of the nitrogen and one-tenth of the ash-elements are contained in the stones.

While these quantities of nitrogen and mineral matters are smaller than those removed by many other garden or field crops, it does not follow that peach trees need less care for their proper manuring.

The quantities of plant food required for the yearly growth of wood and leaves must be considerable. Young twigs contain a larger proportion of nitrogen, phosphoric acid and potash than old wood. But we have no exact data at hand from which to compute the yearly demand of the growing peach tree on the plant food in the soil.

Field experiments demonstrate that liberal fertilization is necessary to secure the most profitable returns from peach orchards.

ON FERTILIZING ORCHARDS.

BY S. W. JOHNSON.

The figures given in the foregoing paper, p. 158, simply show what is carried off from the acre of land by the crop of peaches and indicate that an annual return of 20 pounds of nitrogen, 22 of potash and 5 of phosphoric acid will restore to the land what the average peach crop requires, and that 27 lbs. of nitrogen, 30 of potash, and 7 of phosphoric acid will make good the deficit caused by a maximum crop, provided there are no other sources of loss besides the export of fruit. But it is one thing to return to the soil what the crop has removed and, to some extent, another thing to maintain the fertility of the soil so far as relates to the suitable supply of plant-food.

The active feeders of the tree in the soil are the young rootlets and root-hairs that are put forth the current year. The roots of five and two years ago are probably themselves totally incapable of feeding the plant. Even last year's roots are of little use except as they are a necessary basis of the new rootlets that develop this year. The young roots of each successive year of growth thus occupy different positions in the soil, and since most of the plant-food in the soil is incapable of movement, much of it, at any time, is out of the reach of the rootlets, and to be fertile the acre of soil must contain many pounds of plant-food in order to ensure to the crop the few pounds which the crop requires.

If the soil is very rich to begin with, the trees may produce well for years without fertilizers, but the New England hills which furnish our best orchard sites are now, as a rule, not fertile, and must be well enriched to make them profitable.

It is now, no doubt, well known to orchardists, that soils have the power of changing the solubility and availability of the plant-food which may be put upon them, in fertilizers. It is well-proved that phosphoric acid, applied in water-soluble form, shortly, in many soils within a few days or weeks, becomes quite insoluble in water, and for a considerable time gradually diminishes in availability. Certain soils contain enough phosphoric acid to serve many large crops if it were freely accessible to their roots, but that this phosphoric acid is not immediately available is demonstrated by the fact that moderate dressings of plain superphosphate strikingly increase the yield. What has just been stated of phosphoric acid is equally true of potash.

As to nitrogen, we know much but not nearly enough of its incomings and outgoings. We know that the soils of forests, meadows and moist pastures gain in nitrogen, while dry, naked or tilled ground loses nitrogen from year to year. We know that clovers and legumes generally, rapidly enrich or may enrich the soil they grow upon, as respects nitrogen, while the culture of cereals, root and fiber crops, and garden "truck," diminishes and exhausts the soil-nitrogen.

As a rule, in case of soils that have a fair proportion of fine, clayey matters, all the phosphoric acid and potash that may be needed to aid any crop, if once applied, cannot escape from the soil and will be retained near the surface, will not in any event descend much below or spread from where it has been placed. With nitrogen it is very different and loss of this element may occur in three ways: 1st, by leaching out, in the drainage-water, as nitrates; 2d, by escaping into the air, as nitrogen gas, and 3d, by conversion into comparatively inert forms, such as exist in leaf-mold, swamp-muck and peat (humus), or in the cell tissues of fungi and the shells or cases of insects (chitin).

For these reasons, soluble and active, and therefore costly fertilizers, are best applied in small doses, at or near the surface of the ground and at short intervals, while cheap, insoluble and slowly-acting manures may be used in large applications and deeply mixed in order to establish a more permanent state of fertility.

The amount of any needed fertilizer-element to be supplied annually, must be learned by experience or experiment, since soils vary greatly in their composition and qualities, and the supply must commonly be several or many times larger than the amount annually taken off in the crop.

One fertilizer-element that is scarcely noticeable in the export of the peach crop, is nevertheless important to its production. The chief ingredient of the ash of the wood, bark and leaves of all trees is generally lime. The wood of healthy peach twigs, of one year's growth, from the orchard of the late P. M. Augur, analyzed at this station (Annual Report, 1884, p. 93), contained 1.87 per cent. of ash, of which 54.2 per cent. was lime, 9.5 per cent. magnesia, 16.3 per cent. potash, 4.3 per cent. phosphoric acid and 6.9 per cent. sulphuric acid. The mature leaves of oak and

chestnut trees contain, with about 30 per cent. of water, 3 to 4 per cent. of ash and of the latter 30–40 per cent. is lime. Where the water of wells or springs, coming from the soil, is soft or but slightly hard, the orchard needs lime to be supplied. This substance dissolves rather freely in the drainage water and is therefore subject to constant waste. In case of most Connecticut soils the natural supply of lime comes from rocks (boulders, gravel, sand and rock-dust) which contain but little and yield it up very slowly. For these reasons wood ashes or cheap lime should be broadcast at the rate of some 500 lbs. per acre, yearly.

If, as is becoming common, scarlet clover or other legume is sown to gather nitrogen, this dressing of lime and a liberal use of potash salts will probably be essential to the highest success.

THE BEST ECONOMY OF CONCENTRATED FERTILIZERS.

By S. W. Johnson.

All plants commonly cultivated in the field or garden require to their full and profitable development the coöperation of a number of *agencies* or forms of energy, of *substances* or kinds of matter and of *conditions* or circumstances of situation. These agencies, substances and conditions *must work together* in due quantities and proportions, and the absence or deficiency of any single one, as well as too much of any one, will injure, destroy or prevent a crop.

The *agencies required* are on the one hand the radiant energy that comes to us primarily from the sun, which we call light and heat, and on the other, the forces that reside in the matter of air, water, soil and fertilizers—forces which are named chemical affinity, cohesion, adhesion, etc.

To what extent electrical energy is involved in crop-production is as yet but little understood. Latterly the agencies of microscopic life in the soil have been found to have an importance that but a few years ago was not dreamed of.

The *needed substances* are those which essentially compose fertile soil, perfect plants and animals and useful manures, viz: oxygen gas and carbonic acid gas of the air, water of air and soil, sand, clay and humus (or decaying vegetable matter) of the soil, and the several forms of plant-food which the productive soil is the source of—sulphates, phosphates, nitrates, carbonates and muriates of potash, ammonia, lime, magnesia and iron.

Among the *requisite conditions* are certain alternations of heat and cold, of light and darkness, of dryness and wetness, due porosity and compactness of soil.

Many farmers who live on a fertile soil and under a genial sky, even in these latter days, gather in their abundant harvests with little thought or knowledge of these energies and substances. The sun, the rain, the soil, prepared for them in the beginning, have been the sufficient sources of everything needed for their crops.

But most of those who will read these lines do so because, what in the beginning answered well enough for them or for their forerunners has become insufficient and they are compelled to make inquiry: What is the reason that crops are poor, and what can be done to the land to restore and increase its productiveness?

The commercial fertilizer commonly supplies to the crop several substances which are indispensable to its make-up and which, therefore, are adapted to assist its growth, principally nitrogen, phosphoric acid and potash. With these, lime, magnesia, chlorine and sulphuric acid are frequently associated. The three substances first-named are also those which, in general, are most rare in the soil; which, therefore, are most quickly exhausted and most difficult and costly to restore.

When land is infertile, because it is deficient in one or more of the ingredients of commercial fertilizers, then the use of the latter is the certain and proper remedy, as experience on the part of thousands of farmers in Europe and America has thoroughly demonstrated.

But the commercial fertilizer does not, in most cases, fully restore what the crop removes, and as the land, by a long series of harvests, has once been reduced to a comparative infertility which the superphosphate or potash salt or nitrate has relieved, so it will in time, if cropped by their help alone, fail again because some substance or condition which they have not supplied has been exhausted or destroyed.

The solar energies that develop our crops are furnished, in the course of nature, in such plenitude as, we well understand, belongs to our climate and to the exposure and situation of our fields. We cannot increase the sunshine either in its duration or intensity. We can, however, more or less neutralize and nullify its good offices or fail to get the full measure of its benefits by leaving our originally wet fields water-soaked, or by permitting them to pass into a springy and stagnant condition. The heat of the sun, without which the soil is incapable of affording a genial rooting-place to our crops, cannot find its way downward to give due warmth to the earth unless there is free circulation of water in the soil, nor can the abundant oxygen of the air, without which no part of any plant can grow or live, be supplied to the roots of our crops unless the soil has a proper porosity and openness of texture established and maintained in it by judicious tillage and, it may be, by drainage or other amendment.

It is true enough, that in many instances a few hundred pounds of superphosphate or bone-dust, or sulphate of ammonia or a combination of them, has enabled a field to yield better harvests than could be got by a more costly application of stable or yard manure. This is plainly because the manure alone could not supply enough of nitrogen or of phosphoric acid or of potash for the crop. It is also true, that in many cases the commercial fertilizer which, for a few years, far outdid the stable manure, finally fails to perform the duty expected of it and the stable manure must be had recourse to and gives satisfaction, save in respect to the trouble and cost of getting it. This, again, is because the stable manure supplied something which the commercial fertilizer could not.

That "something" in some cases is a substance or kind of matter—it may be lime, which in the course of cropping is removed from the soil in larger quantity than commercial fertilizers supply, or potash, which is often wanting in superphosphates; but in most cases it is a "condition," a "texture" of the soil which is not easy to describe, but which in the dunged land is recognized as a mellowness and moistness that is lacking in the land not dunged.

The garden of the Connecticut Agricultural Experiment Station is a coarse, sandy loam, which with moderate dressings of decaying vegetable matter in shape of stable manure has the texture, feel and look of good land and gives good crops, but without a supply of humus soon becomes harsh and "worn out."

A little of the spongy matter of dead and rotting manure, a little of the gelatinous "Geine" of the author of the "Muck Manual," gives to soil a quality which enables the earth to serve as an efficient regulator of the heat and moisture that have or should have access to it.

Reference has been made to the fact that lime is supplied to the land in small quantity by superphosphates. It may be added that they furnish lime mostly as phosphate or sulphate. The well authenticated result of experience, in British agriculture, some forty years ago, that "lime had reclaimed more poor land than all other fertilizers put together," is a practically acquired fact, demonstrating that application of carbonate of lime (or quicklime which rapidly becomes carbonate) in many cases makes land fertile by supplying one or several "conditions" favorable to crops. We have of late years learned in what some of these conditions consist. We know that when muriate of potash and sulphate of ammonia are given to growing crops the potash and ammonia are appropriated by the plant while the muriatic acid and sulphuric acid are left in the soil. Now that they shall not accumulate in such quantity as to injure vegetation it is essential

that the soil contain some substance, itself harmless, which shall take up and neutralize the liberated acids. Carbonate of lime is one of the best materials for this purpose and on the soil of regions where lime is naturally deficient (which is the case where well- and spring-waters are "soft") the farmer should lose no good opportunity to add moderate quantities of carbonate of lime to those of his fields upon which he has made or intends making extensive use of potash or ammonia salts, or of fertilizers containing them.

Again, we understand that the conversion of refuse vegetable and animal matters—such as stable-manure, leaf-mold, the stubble of crops, dried blood, tankage, hair and wool waste and the organic matter of bone—into plant-food, requires the intervention of chemical agencies which shall transform their inert nitrogen into ammonia-salts or nitrates. The natural forces that do this work, and do it most cheaply and beneficially, are those of the microbes (small life) which the most powerful microscopes just enable us to see, organisms that feed upon these refuse matters in the soil. The nitrifying microbe, which changes agriculturally inert nitrogen into nitrates, cannot perform its work in a soil where any considerable amount of free acid other than carbonic acid exists, but works well and multiplies in presence of a little carbonate of lime.

Space is wanting here to go further into this subject and my purpose is simply to illustrate the fact that the interests of those who buy as well as of those who sell commercial fertilizers can be best promoted by a knowledge, well applied, of all the factors of crop-production; that the plant, like the man, to flourish, not only requires an abundant and varied bill of fare, but also a suitable lodging and the comforts of a well-appointed home; that the best economy of commercial fertilizers is to be attained by intelligently investigating what special wants of the soil or crop their various grades are adapted to meet, and what further wants of soil or crop must be attended to in order to prevent that impoverishment of land and landholder which otherwise, sooner or later, is likely to ensue—the experience of which has led many agriculturalists to the erroneous conclusion that concentrated fertilizers are "stimulants and not nourishment," and that they "exhaust the soil," whereas they merely aid the farmer to exhaust the soil by rapidly removing, in the crops, substances which the soil unaided can supply but slowly or insufficiently and by impairing or destroying one or several of those conditions which are indispensable to plant-production.

FURTHER EXPERIMENTS ON THE PREVENTION OF POTATO-SCAB.

BY WM. C. STURGIS.

The results of the experiments conducted at South Manchester during the summer of 1894 clearly demonstrated the value of treating "seed"-potatoes with corrosive sublimate. Incidentally the results indicated the value of certain minor precautions. The use of clean seed, that is, seed free from scab, is to be strongly recommended, inasmuch as the amount of scab on the crop was found to be directly proportional to the amount of scab on the seed. There was strong evidence that the use of barnyard manure tends to increase the amount of scab on the crop, other things being equal, an effect which cannot be entirely counteracted by the corrosive sublimate treatment. These results harmonized with those obtained by other observers, and seemed conclusive as far as they went. One very important factor however, was disregarded in the experiments. The land itself was free from the germs of the scab-fungus, having been in grass for a number of years, and having never probably borne a root crop; the freedom from scab which resulted from the planting of clean seed, treated before planting with corrosive sublimate, might very probably therefore have been due in a measure to the fact that there was no source of infection in the soil. It is usually either impossible or impracticable to secure such a soil-condition on the farm, and it was therefore necessary to repeat the experiment under the conditions obtaining in general farm practice. The previous experiment had brought about the required condition. The smallest percentage of scabby potatoes obtained from any one plot in 1894 was 16 per cent. on plot H. The other plots yielded from 23 to 84 per cent. of scabby potatoes. At the close of the experiment therefore, the whole piece was infested with the scab-fungus in various degrees, and the percentage of scabby potatoes obtained respectively from each plot served as a basis for determining in a general way the comparative quantity of the scab-fungus in the soil of that particular plot. Thus it was not only known that the land contained the germs of the disease, but it was also possible to estimate roughly to what extent this condition might be expected to affect the coming crop on any partic-

ular portion of the field. In order to have a basis of comparison between potatoes grown on land infested with scab and on land free from scab, a new piece immediately adjoining the old was ploughed under in the autumn and prepared for planting; this land was practically free from scab except where it joined the old piece. Here it was doubtless contaminated, as the whole piece, including the new land, was ploughed and harrowed in the spring in a direction at right angles to the former rows.

In 1893 and 1894, the Rhode Island Station undertook a series of experiments with the view of ascertaining the effect of lime in increasing or diminishing scab upon potatoes.* These experiments are interpreted as showing that air-slaked lime tends to increase the scab of potatoes if applied to land which is naturally acid, this action being attributed to the production by the lime of a neutral in place of an acid condition of the soil, and the fact that the scab-fungus thrives best in a medium which is neither strongly acid nor strongly alkaline. Inasmuch as it had been generally supposed that lime, wood-ashes, or other alkaline substances always tended to increase scab, no matter what the soil-conditions, the results obtained in Rhode Island are valuable, and it seemed advisable to include in our experiment at South Manchester some inquiry into the matter. It should be borne in mind however, that the Rhode Island soils are said to be very acid, while that of our experimental field is not considered "sour."

Finally, information was desired upon the effect of barn-yard manure as regards the prevalence of scab. To obtain this, another piece of new land immediately adjoining the old was prepared and heavily manured.

The subjoined plan (Table I, p. 168) shows the divisions of the field at the beginning of the experiments. The portion enclosed by solid lines represents the land used in the experiments of 1894, the broken lines indicate the new land used for the first time in 1895. The limits of plots A–H were the same in both experiments; the numbers of rows in each plot are given on the plan, the rows being numbered consecutively from A; and the estimated percentage of scab in each plot is also shown.

For the experiment of 1895, the whole field, including the new land, received an ordinary dressing of commercial fertilizer.† To

* R. I. Agr. Exp. Sta., Bull. 26, Nov. 1893; and Bull. 30, Nov. 1894.

†Applied at a rate to the acre of 1200 lbs. cotton-seed meal, 300 lbs. muriate of potash, and 500 lbs. dissolved South Carolina rock.

TABLE I.—PLAN OF EXPERIMENTAL FIELD OF POTATOES AT SOUTH MANCHESTER, CONN.

Plot	Rows	Scab
A.	1–14.	23%
K.	10–21	Clean
B.	17–30.	75%
C.	31–36.	76%
D.	37–41.	84%
E.	42–47.	40%
F.	48–51.	63%
G.	52–66.	29%
H.	67–72	15%
M.	73–106.	Clean

test the effect of lime, plot A was divided into two portions, one of which received a top-dressing of air-slaked lime with the fertilizer at the rate of one-half ton to the acre, while the other received no lime. A portion of each of these two half-plots was planted with treated seed, and the other with untreated. The seed-potatoes used throughout the whole experiment were clean.

Between A and B were planted two rows of seed which had been sprouted in order to test the effect of corrosive sublimate on the vitality of the sprouts. The latter were from one to three inches long at the time of planting. Plots B, D, F, G and H were planted with treated seed, i. e., with seed which had been soaked one and one-half hours in a solution of two and a quarter ounces of corrosive sublimate (bi-chloride of mercury) in fifteen gallons of water, then cut and planted as usual. Plots C and E were planted with seed not so treated, but in every other regard the same. The greater part of plot M was planted with treated seed, but a few rows received untreated seed for purposes of comparison.

Finally, plot K was divided into two parts of six rows each. One of these received fresh barn-yard manure, the other well-rotted compost from the same source. Each of these materials was applied in two different ways—in direct contact with the seed, and separated from the seed by a layer of soil. Plot K therefore, comprised four sub-plots illustrating the effect of (1) raw manure in direct contact with the seed, (2) raw manure not in contact with the seed, (3) composted manure in contact with the seed, and (4) composted manure not in contact with the seed. In order that any results which were obtained might be reasonably attributed to the presence of the manure or to the method of its application, the seed used on plot K was selected for its freedom from scab, the land was clean, and the seed received no preventive treatment.

From the plots so arranged and treated, information was expected on the following points :

1. The effect of lime on the prevalence of scab in a fairly neutral soil infested with scab and planted with clean seed, both treated with corrosive sublimate and untreated. (Plot A.)

2. The effect of corrosive sublimate on the vitality of sprouted seed-potatoes. (Two rows between plots A and B.)

3. The effect of treating seed-potatoes with corrosive sublimate in preventing scab upon land infected by a previous crop of scabby potatoes. (Plots B–G.)

4. The effect of the same upon clean land. (Plot M.)

5. The effect of barn-yard manure, both fresh and composted, in inducing scab upon potatoes grown from clean seed on clean land.

A few words may be of interest regarding the conditions of growth. The potatoes were all planted May 17th and 18th, and by June 15th were making fine growth. The plants from the sprouted seed were about a week in advance of the others, and maintained their advantage throughout, although those fertilized with fresh manure were not far behind them. From June 6th to June 20th the weather was exceptionally dry, but abundant rains had fallen previously and the vines received no serious check from drought during the season. They were all thoroughly sprayed with Bordeaux mixture on July 19th, but blight appeared notwithstanding, and by the beginning of August its effects had become very serious. A second application of Bordeaux mixture on August 12th failed to check the blight. As far as the experiment was concerned however, there was no serious injury, as all the experimental rows with one exception were planted with the variety New Queen, which proved remarkably resistant to the blight. The other varieties, Polaris, Woodbury White, and Early Rose proved very susceptible, and by the middle of August were half dead. All of the potatoes were dug Oct. 9th.

As in the experiment of last year, one or more sample rows were taken from each plot, the tubers were cleaned and separated with the greatest care into three grades according to the amount of scab visible upon them, grade I including tubers free from scab, grade II tubers fairly scabby but marketable, and grade III tubers rendered unmarketable by scab. After sorting, the product in each grade was weighed, measured, and photographed. The same process was applied to the sample yield from each plot.

Referring now to Table II, p. 171, we see that, leaving out of consideration for the present the treatment of the seed, the use of lime has increased the percentage of scab. The two rows which received lime show an average of over 34 per cent. of scabby potatoes, while those which received no lime show somewhat less than 21 per cent.

The results following the treatment of the seed on plot A are not without interest. The difference between the percentage of

TABLE II.—RESULTS OF EXPERIMENTS ON POTATOES AT SOUTH MANCHESTER, CONN.

Plot.	Sample row.	Fertilizer.	Scab in land.*	Treatment of seed.	Weight of Crop.	Quality of Crop.	Total Per Cent. of Scab.
A¹	No. 3	Commercial with Lime	23%	Corrosive Sublimate	111 lbs.	1. 77 lbs. = 69% 2. 29 " = 26% 3. 5 " = 4.5%	30.5%
A²	No. 5	Commercial with Lime	23%	0	106 lbs.	1. 66 lbs. = 62% 2. 36 " = 34% 3. 4 " = 4%	38%
A³	No. 11	Commercial without Lime	23%	Corrosive Sublimate	102.5 lbs	1. 78 lbs. = 76% 2. 22.5 " = 22% 3. 2 " = 2%	24%
A⁴	No. 13	Commercial without Lime	23%	0	92 lbs.	1. 75.5 lbs. = 82% 2. 14.5 " = 16% 3. 2 " = 2%	18%
Sprouted seed	No. 15	Commercial	49%	Corrosive Sublimate	124 lbs.	1. 90 lbs. = 76% 2. 32.5 " = 26% 3. 2 " = 2%	28%
D & G	Nos. 39 & 60	Commercial	56%	Corrosive Sublimate	191 lbs.	1. 122.5 lbs. = 64% 2. 65.5 " = 34% 3. 3 " = 2%	36%
C & E	Nos. 32 & 45	Commercial	58%	0	233.5 lbs.	1. 133 lbs. = 57% 2. 92.5 " = 39.6% 3. 8 " = 3.4%	43%
M¹	No. 76	Commercial	0	Corrosive Sublimate	88 lbs.	1. 72 lbs. = 82% 2. 16 " = 18% 3. 0 = 0	18%
M²	No. 78	Commercial	0	0	107.5 lbs.	1. 81.5 lbs. = 75.8% 2. 25 " = 23.2% 3. 1 " = .9%	24.1%
K¹	Nos. 10–15	Barnyard manure (Composted)	0	0	297.5 lbs.	1. 173 lbs. = 58.2% 2. 91.5 " = 30.7% 3. 33 " = 11.1%	41.8%
K²	Nos. 16–21	Barnyard manure (Fresh)	0	0	226.5 lbs.	1. 189.5 lbs. = 83.7% 2. 31 " = 13.7% 3. 6 " = 2.6%	16.3%

* Comparative estimate of scab-infection based on per cent. of scabby potatoes in crop of 1894, see page 166.

scab in rows 3 and 11, the seed for which was treated, and rows 5 and 13, which were not treated, is hardly appreciable. In fact all the plots occupying the infested land show similar results. In no case is the showing so markedly favorable to the treatment as in the experiments of 1894, where all the land was clean and the scabby seed served as the only means of infection. The conclusion seems inevitable that the prevalence of potato-scab is largely due to the prevalence of the germs in the soil, and under these conditions the treatment of the seed with corrosive sublimate loses much of its efficacy. Such a conclusion was to be expected. When the germs of the fungus are largely confined to the seed-potato itself, any treatment which will kill all or most of the germs will tend to produce a clean crop if the growing tubers are not infected from the soil or the manure. If, on the other hand, the germs exist throughout the soil, it is inconceivable to suppose that tubers formed even a few inches from the seed would be materially affected by any substance applied to the seed. The uniform results of these experiments tend to confirm the impression that potatoes, even if previously subjected to a disinfecting treatment, should not be planted on land infested with the scab-fungus. For the purpose of testing the effect of corrosive sublimate on the vitality of sprouted seed-potatoes, two rows between plots A and B were selected. The seed-potatoes were spread out in a warm, light attic, where they readily sprouted, producing slender shoots from one to three inches in length. For practical purposes it would have been better to have sprouted the seed under conditions of warmth and sunlight, which would have produced a short and stocky growth. The comparatively long shoots are very delicate and are liable to become broken off in the necessary handling. The sprouted potatoes enclosed in a sack were immersed for one and one-half hours in the corrosive sublimate solution, then dried, cut, and planted, and by exercising care in handling, very few of the sprouts were lost. That the sprouts were uninjured by the treatment was indicated by their fresh and sound appearance an hour or more after the potatoes were removed from the solution, and by the fact already mentioned that throughout their period of growth they were a week in advance of potatoes planted in the ordinary way. A comparison of the yields is also interesting. The yield from one row of sprouted seed 105 feet long, amounted to 124½ lbs.; that from an average row of the same length, of unsprouted seed, amounted to 102½ lbs. The difference is over one-third of a bushel. Upon an acre, the increased yield would amount to about fifty-one bushels, an item certainly worth considering. As regards the effect of the treatment upon the scab, the only row with which the sprouted potatoes can be fairly compared is row 13. The comparison shows an advantage of ten per cent. in favor of the treatment, notwithstanding the fact that the land occupied by the sprouted potatoes presumably contained more than double the percentage of the scab-fungus. These figures however, regarding the scabbiness of the soil on the various plots are not to be considered as more than a rough appraisal, since even if we allow that the percentage of scab upon matured potatoes is a fair estimate of the percentage of germs remaining in the soil, many factors such as drainage, cross-cultivation, etc., tend to produce uniformity of soil conditions in adjacent plots. The figures are of value merely as an indication of the more or the less scabby condition of the soil in the respective plots.

For obtaining results on the third point—the effect of the treatment in preventing scab upon infested land—it was necessary to take two rows of treated seed and the same of untreated seed in order that the soil conditions might be as nearly as possible identical so far at least as the prevalence of scab was concerned. Plots D and G combined showed an average of 56 per cent.; the product of one row from each of these plots might therefore be justly compared with that of one row from each of the plots C and E, which together averaged 58 per cent. Although the percentage of scab upon the crop in both of these cases is very high (36 and 43 per cent.), the difference between them of 7 per cent. is in favor of the treatment, and the percentage of very scabby potatoes, though small in both cases, is almost twice as large in the untreated as in the treated rows. Furthermore, if we compare the quality of the crop from rows 39 and 60 on the one hand, and from row 76 on the other, the result of planting potatoes upon scabby land is rendered still more apparent. Although the seed in both instances was clean, was subjected to the same preventive treatment, and received the same application of commercial fertilizer, the gain in favor of the clean land amounts to more than 17 per cent. It will also be noted that the seed on the clean land of plot M, when treated, produced no very scabby potatoes, and it is doubtful if 5 per cent. of the tubers classed as grade II would have exhibited any trace of scab except to the eye of an expert.

We may feel assured that, so far as it goes, there is abundant evidence that land infested with scab will produce a scabby crop even when every other condition favors a clean crop, and the seed has been treated thoroughly with corrosive sublimate. The treatment however, does tend in a definite though small degree, to diminish the percentage of scab upon tubers grown on slightly infested land.

The effect of the treatment upon potatoes planted on clean land is illustrated by rows 76 and 78, both being included in the new plot M. This matter was dwelt upon at length in our Report for 1894, and owing to the undoubted infection of plot M from the adjacent plot, the results are not sufficiently reliable or striking to merit further notice.

Finally, we may consider the effect of the barnyard manure. The question is important since the evidence of the experiments of 1894 in this direction has by some been considered inconclusive, and because many inquiries have been addressed to the Station regarding the effect, in this connection, of barnyard manure in different stages of decomposition. To test this matter, a piece of clean land on the west border of the original field was prepared.* Clean seed, which had received no treatment, was planted in twelve rows, each 33 feet long, continuous respectively with rows 10–21 of the old piece. The plot is represented by the division marked K on the field-plan. The use of clean seed and clean land secured conditions of practical immunity to the crop, except from germs conveyed to the land with the fertilizer. In six of the furrows, barnyard manure, freshly dropped and mixed with a small amount of litter, was used as a fertilizer; in the remaining six rows, manure from the same source, but composted for a year, was used. Each of these lots of six rows was divided into two smaller lots of three rows each, in one of which the seed was placed in immediate contact with the manure, both above and below, and in the other was separated from the manure by a layer of soil. This difference in the method of applying the manure exerted no appreciable influence upon the growth of the plants or the prevalence of scab, and in tabulating the results the condition of the manure itself was alone considered.

As has been said before, the plants on plot K were in advance of those on the remainder of the field, with the exception of those

*This new piece received an application of commercial fertilizer in common with the old piece, at the same time, and in the same proportions.

from sprouted seed, and they maintained this advantage throughout the season. The tops made a very remarkable growth, and remained green for some time after those of the same variety (New Queen) on the rest of the field were practically dead. The yield exceeded that from the old piece by an amount equivalent to about sixty bushels to the acre. It must be remembered however, that plot K received a heavy application of manure in addition to the commercial fertilizer applied to the whole field, including plot K; this may be sufficient to account for the increased vigor of the plants and the proportional increase of the yield.

But a matter of more importance at present is the effect of the composted manure as compared with the fresh, in inducing a scabby condition of the crop. The results show that the use of composted manure as compared with fresh manure has increased the amount of scabby potatoes by 25.5 per cent., and if we consider the very scabby tubers only, the difference is still more marked. It is impossible at present to account satisfactorily for this result, and with only the results of this experiment at hand it would be unwise to conclude hastily that fresh manure is always less liable to induce scab than manure which has been composted for a year or more. Many factors enter into the consideration of such a question. Manure from the same barnyard may show differences within a twelve-month as regards its scab-inducing quality; the feeding of scabby potatoes to live-stock might produce a manure which would insure the prevalence of scab on any land to which it was applied, while a change of feed a few months later might render manure from the same source entirely harmless. It is unwise to speculate upon the results of a single experiment. Should future experiments prove what in this instance has been indicated, i. e. that composted manure has a greater inherent tendency to favor the development of potato-scab than manure freshly dropped, the fact will be one of importance in cases where it would be more practicable to draw the manure directly from the barnyard to the field than to compost it and hold it over for one season.

SUMMARY.

The experiments of 1895 upon the prevention of potato-scab indicate the following points:

1. That the addition of lime in small quantities to the soil of our experimental field, increased the amount of scab upon the potatoes. We are not prepared at present to offer any explanation of this fact.

2. That the presence in the soil of the germs of the scab-fungus tends so markedly to infect the coming crop that it is highly inadvisable to plant such land with potatoes, beets, or turnips.

3. That in case the soil is infested with the germs of the scab-fungus, the treatment of the seed with corrosive sublimate is of but little avail in preventing scab upon the crop.

4. That fresh barnyard manure exhibits less tendency to induce scab than composted manure. It cannot be too strongly emphasized however, that great stress must not be laid upon the result of our single experiment, since practically nothing was known regarding the infectious character of the particular manure used.

We hope to continue these experiments another year.

TRANSPLANTING, AS A PREVENTIVE OF SMUT UPON ONIONS.

BY WM. C. STURGIS.

There is no doubt that of the various fungous troubles of onions, the one known as "smut" and caused by the fungus *Urocystis Cepulæ* is by far the most serious. The rapid spread and disastrous nature of its attacks, the remarkable vitality of the germs or *spores*, and the persistence of the fungus in soil once infested with it, have combined to render worthless for onion culture many tracts of land in this State which formerly produced large crops. The fungus, its life-history, and its effects upon onions, have been ably discussed by Thaxter*, and for details the reader is referred to his work. Two methods of raising onions have long been practiced by Connecticut growers; one directly from seed, the other from small onions of the previous year's growth called "sets." As long as onion-smut has been recognized as a serious disease, it has been observed that onions raised from sets remain free from the disease even upon

* Annual Report of this Station for 1889, pp. 127–153.

fields where onions raised from seed always suffer more or less seriously. Thaxter first suggested a sufficient reason for this fact, and proved his point by an ingenious experiment. He demonstrated that the smut fungus enters the onion seedling only while the latter is beneath the surface of the ground, so that if growth starts above ground, as in the case of sets, the plants are not affected with smut. The fact of the immunity, for the same reason, of transplanted seedlings was mentioned by Thaxter in this connection, but so far as I know the matter has received no practical demonstration. The method of growing onions by starting the seed in hot-beds, and transplanting the seedlings to the field, was suggested in 1891 by Mr. T. Greiner of La Salle, N. Y., and has since been practiced by him and by others with marked success. Several of the Experiment Stations also have tried this method. But all of these experiments have had for their object increase in the size and value of the onion crop. As far as that was concerned they were successful in proving that larger yields are obtained at no greater expense, and that the onions are larger and mature earlier than onions grown from seed sown in the open. But it seemed more than likely that this method would have another important advantage in producing a sound crop of onions even upon smutty land. Through the generous coöperation of Messrs. C. Buckingham and N. H. Sherwood of Southport, there was placed at the disposal of the Station a piece of land known to be infested with smut. The variety selected for the test was Wethersfield Red, and on March 6th the seed was sown in flats in Mr. Sherwood's greenhouse. Early in May the land was carefully prepared, and on the 8th of the month seed of the same variety and from the same package as that sown in flats, was sown in drills one foot apart, in the field. This could have been done earlier with profit, and the crop would doubtless have made a better showing. Between every two rows of seed, a space 3 ft. wide was left for the reception of two rows of seedlings. The latter were lifted from the flats on May 13th, and at once transplanted to the vacant rows. At this time the seedlings were half as thick as a lead-pencil and about 5 in. high. The soil was extremely dry, and a hot sun caused the plants to wilt badly, but they were watered that same evening and in a few days had recovered and were making a good growth. The plants were set in holes three inches apart, made by means of a narrow board set with wooden pins and pressed down with the foot. As fast as the holes were made, a man followed with the seedlings, dropping one in each hole and pressing the earth about it. The pins were of such a length that when the plants were set, the bulbs were about half an inch below the surface of the ground. From this time on the whole piece received the same treatment, being cultivated and weeded as usual. The transplanted rows however, required one less weeding than the rows from seed, and of course did not require thinning.

All of the onions were harvested on September 4th. There were 20 rows grown by each method, each row being 26 ft. long. The onions were carefully examined as they were pulled, and all smutty plants and scallions were put on one side. It was then found that about 10 per cent. of the onions from seed were smutty, and fully 15 per cent. were scallions. Had the onions been thinned, the percentage of scallions would doubtless have been smaller; but on the other hand, there was abundant evidence throughout the rows, that many of the plants had been affected with smut so early that they failed to grow, the places where they had been being marked by scanty, smutted remains of leaves and bulb-scales. The 10 per cent. of smutted onions mentioned above includes only those which reached a fair degree of maturity. The contrast on the transplanted rows was very striking. Not a single plant showed any trace of smut; less than 1 per cent. of the seedlings had failed to reach maturity, notwithstanding the fact that they were very small when transplanted and were subjected to a period of very dry weather immediately after being set; and only a trifle over 1 per cent. of the plants were scallions. (See Table III, p. 179).

It seems fair to conclude therefore, that by raising seedlings in flats, and transplanting to the open ground, a clean crop of onions can be grown even upon land thoroughly infested with smut. I am not yet prepared to recommend this method for adoption on a very large scale, though by many it is contended that the increased yield, larger bulbs, and less labor incident to weeding and thinning, more than compensate for the added labor and expense involved in raising the seedlings under glass and transplanting. I am convinced however, that under certain circumstances this method would be highly profitable. As will be shown presently the yield is greater, the bulbs are larger and more perfect, and the crop matures earlier, by the transplanting method than by sowing

TABLE III.—RESULTS OF EXPERIMENTS ON ONIONS AT SOUTHPORT AND AT THE EXPERIMENT STATION.

	Weight.	Quantity.	Av. Circumference.	Per cent. Smutted.	Per cent. Scallions and Missing.	Remarks.
EXPERIMENT AT SOUTHPORT. Plot 39 ft. x 26 ft.						
20 rows Transplanted.	387 lbs.	6 bu. 1 pk.	8.24 in.	0	2%	
20 rows Seed.	212 lbs.	3 bu. $2\frac{1}{5}$ pks.	4.98 in.	10%	15%	The actual percentage of smutted onions on these rows was much larger than appears, since many of the plants were completely destroyed. See p. 178.
EXPERIMENT AT STATION. Plot 29 ft. x 10 ft.						
14 rows Transplanted	81 lbs. 8 oz.	$7\frac{1}{2}$ pks.	6.8 in.		5%	The soil on this plot was poor and ill-adapted to onions; all of the bulbs were consequently small.
7 rows. Seed Thinned.	4 lbs. 15 oz.	$\frac{1}{2}$ pk.	3.4 in.		40%	Most of the loss on the 14 seeded rows was caused by cut-worms. The transplanted rows were practically untouched by worms.
7 rows. Seed Not Thinned.	11 lbs. 2 oz.	1 pk.	2.8 in.		40%	

in the open; the former method therefore, will be of advantage where an acre or less is to be planted with onions for home consumption or for small sales. This method presents the advantage over sets that, whereas the labor and expense is practically the same in both cases, the transplanting method produces mature bulbs in the course of one season with only the initial expense of sash for the hot-bed. Transplanting might therefore, with increasing profit, supersede the use of sets. Finally, if for any reason it becomes necessary for a grower to use smutty land for onions, or if smut has recently made its appearance in a piece of onion land, the land so infested can be set with seedlings which will produce a clean crop, thus not only making smutty land once more available for onions, but lessening the danger of spreading the disease.

Although considerations regarding the comparative value of different methods of cultivation are rather horticultural than mycological, it seems advisable to note certain facts which this and other similar experiments have made apparent.

The general opinion seems to be that the large foreign varieties of onions show a greater gain from transplanting than the native varieties which are mainly used in Connecticut. It is not unusual for such varieties as White Tripoli, Rocca, Pompeii and White Victoria to show a gain of from 100 per cent. to 300 per cent. by this method of growing; Mr. Greiner's striking results were secured with the variety known as Prizetaker, grown from American seed. In the experiment at Southport, as well as one undertaken simultaneously at this Station, Wethersfield Red was used, the object being to make the test with a variety very largely grown in this State. When the onions were harvested the total weight and bulk of the crop from seed and of that from transplanted seedlings was ascertained; fifty bulbs selected at random from each were then measured to find the average circumference, and finally ten of the largest bulbs in each lot were selected for photographing. Plate I, Fig. 1, shows the comparative size of the bulbs. One-half of the seeded rows at the Station were thinned out when the plants were about eight inches high, so that the remaining plants were about three inches apart, thus corresponding to the transplanted seedlings. The smaller size of the bulbs grown at the Station was due to the fact that the soil was not well suited to onions.

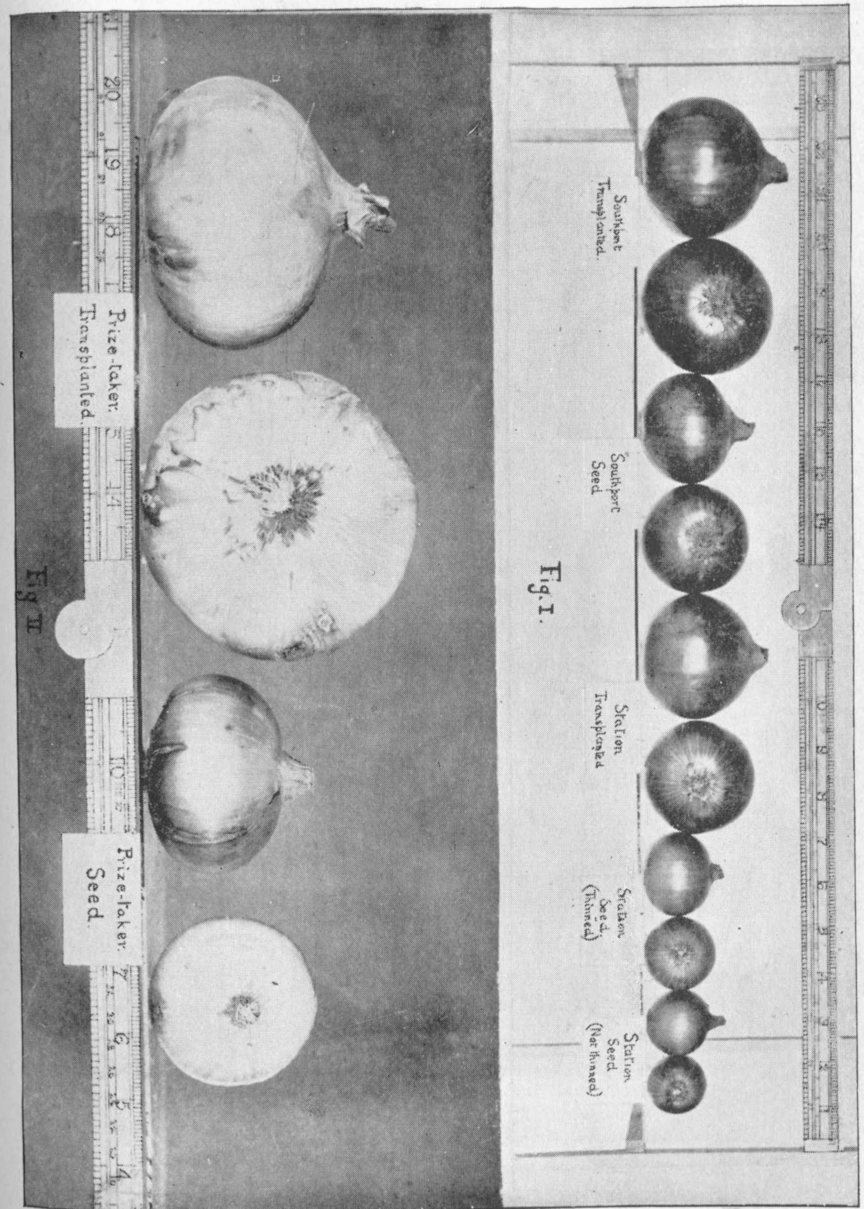


PLATE I. COMPARATIVE TESTS WITH ONIONS.

Table III, p. 179, gives the results as regards the yield and the quality of the crop. It will be seen that in the Southport experiment there was a gain in favor of the transplanted onions of 81 per cent. in weight, and of 65 per cent. in the average size of the bulbs. The advantage of transplanting to avoid smut has already been commented on.

The results obtained at the Station exhibit still greater contrasts; in fact the crop obtained from seed was fit for nothing but pickling, whereas the transplanted seedlings gave a full yield of fair-sized bulbs. When the plants from seed were about three inches high they were attacked by cut-worms. It was impossible to determine accurately the damage from this cause, but a moderate estimate would place the loss at 25 per cent.; these were counted as "missing." On the transplanted rows the onions were almost a month in advance of the others and practically escaped injury. The advantage gained by thinning out the seed-rows was only what might have been expected.

After the completion of these experiments it was learned that Mr. L. C. Beecher, of Woodbridge, had tried the same method, and through Mr. Beecher's kindness I am enabled to publish his results. These are of the greater interest in that the seed used was of the variety Prizetaker, so highly recommended for transplanting.

The seed was sown in flats about March 20th and transplanted on May 14th. Two drills were made, each 25 feet long; the fertilizer was sown in them, and as the soil and weather were very dry the soil in the drills was thoroughly watered. The seedlings were then dropped three inches apart in the drills and the earth from both sides was drawn up firmly to them. Meanwhile seed from the same package had been sown in ten rows, each 10 feet long, immediately adjoining but at right angles to the transplanted rows. At the time of transplanting, the plants from seed were two inches high. Both lots received the same care and treatment throughout the season except for the less weeding required by the transplanted rows. The fifty feet of transplanted onions yielded two bushels and one peck of bulbs, while the 100 feet of onions from seed yielded only two bushels, a gain in favor of the former of over 100 per cent. The individual bulbs also showed a marked difference in size, the smallest of the transplanted bulbs being larger than the largest bulb from seed. Two of the largest of each kind were brought to the

Station by Mr. Beecher and photographed (Plate I, Fig. 2). These measured respectively 13 inches and 8.7 inches in circumference. Mr. Beecher further states that the transplanted bulbs matured from two to three weeks earlier than those from seed, and that there were much fewer scallions among the former than among the latter. These very large onions would seem to be rather too large for the ordinary onion trade, but, as noted by several growers, they could doubtless be brought to compare favorably in size and appearance with the imported Spanish onions which bring fancy prices.

Summary.

The experiments above described show the following advantages of starting onion-seed in flats with heat, and transplanting the seedlings to the field.

1. This method insures a clean crop even upon smutty land.
2. Transplanted onions are less liable to the attacks of cut-worms than onions sown in the field.
3. The crop matures earlier by three or four weeks.
4. The crop is larger by an average of 50 per cent. or more with native varieties, and the average increase with large foreign varieties may exceed 100 per cent.
5. The individual bulbs are larger and mature more evenly.
6. The increase in the size and quality of the crop, the earlier ripening, and the lessened expense incident to the care of the plants after transplanting, offset in a measure the cost and labor of raising and transplanting the seedlings.
7. This method may be applied with certain profit wherever it has been the custom to grow onions from sets upon smutty land, or in small quantities for home use or small sales.
8. Several observers state that this method is applicable on a large commercial scale. Carefully estimated figures relative to the number of seedlings required per acre, the quantity and cost of sash for forcing-frames, the labor and time required for transplanting, the comparative cost of caring for the crop, and the comparative value of the yield, will be found in "The New Onion Culture," by T. Greiner, LaSalle, N. Y., 2d edition, revised, Jan., 1892; Bull. Ohio Agr. Exp. Station, 2d Series, Vol. III, No. 9; Bull. Tenn. Agr. Exp. Station, Vol. V, No. 4; and Bull. N. Dak. Agr. Exp. Station, No. 12.

A LEAF CURL OF PLUM.

By Wm. C. Sturgis.

On June 6th of the past summer I received from Mr. J. L. Raub, of New London, some leaves of a cultivated variety of Japan Plum which were evidently suffering from the attacks of a fungus related to that which causes the "leaf-curl" of peach. In this case the appearance was very peculiar. The fungus had attacked the terminal shoots and young leaves, causing them to become swollen and distorted. The young green shoots were in some cases swollen to three or four times their natural size, and transformed into a semi-hollow mass of spongy tissue, externally mealy in appearance, and white or pinkish in color. Sometimes the whole cluster of young leaves at the tip of a diseased shoot was involved, so that the individual leaves were hardly distinguishable; in other cases the stalks and bases only of the leaves were attacked and the narrow green leaf-blade presented the peculiar appearance of growing from the white spongy mass below. At this time the few fruits which had set were about a quarter of an inch long. The fruit itself, that is the ovary of the flower, was not invaded by the fungus to any extent; the structure was normal and the young stone could easily be seen when the fruit was cut open; it was certainly not, therefore, a case of "plum-pockets." The stems of the fruit were, however, diseased in almost every case; they were very much swollen, whitish and mealy in appearance, and bore at their extremities the dried petals and stamens together with the young fruit. Specimens of the diseased tips are figured in Pl. II. Investigation of Mr. Raub's orchard showed that fully 80 per cent. of the plum trees were suffering from the disease, almost every terminal shoot of the season's growth being affected. The perennial character of the disease was indicated by the fact that although when it appeared the previous season, the diseased leaves and twigs had been removed and burned as fast as they formed, this proceeding proved of no avail in checking the trouble, and it reappeared the following spring with such virulence that much more radical measures became necessary. Under the circumstances, the only course to be recommended consisted in removing and burning the infested twigs as far as practicable and in pruning severely in the early winter, cutting out and destroying most of the present season's growth. If this were followed by treatment of the trees in early spring with a strong solution of copper sulphate, and later with Bordeaux mixture, it seemed probable that the disease might be eradicated, and Mr. Raub was so advised.

The accurate determination of the fungus causing the trouble proved to be a matter of some difficulty. Several species of the genus to which this fungus belongs, are known to attack the leaves and young shoots of our wild and cultivated plums; these species are enumerated as follows by Atkinson:*

On *Prunus Americana*, Marsh. (Wild Red Plum) *Exoascus decipiens*, Atk.

On *Prunus nigra*, Ait. (Wild Red Plum) *Exoascus decipiens*, Atk.

On *Prunus angustifolia*, Marsh. (Chickasaw Plum) *Exoascus mirabilis*, Atk.

On *Prunus hortulana*, Bailey. (Wild Goose Plum) *Exoascus mirabilis*, Atk.

On *Prunus triflora*, Roxb. (Japan Plum) *Exoascus rhizipes*, Atk.

E. F. Smith† records the occurrence of a leaf-curl on cultivated varieties of *Prunus Chicasa* (*Prunus angustifolia*) in Maryland and Georgia, which Atkinson (l. c., p. 336) refers to *Exoascus mirabilis*. Finally, Crozier reports a plum leaf-curl "on a vigorous grower and light bearer known as Maquaketa," at Ames, Iowa. This fungus Atkinson again (l. c., p. 340) identifies with some doubt as *Exoascus mirabilis*. It will thus be seen that all the varieties of our cultivated plums of the *Americana*, *Chicasa*, and *hortulana* types, as well as the Japanese varieties, are subject to leaf-curl caused by one of three species of a fungus belonging to the genus *Exoascus*. Microscopic examination of the species in question leaves little room for doubt that it is identical with Atkinson's *Exoascus mirabilis*. This species would seem to be wide-spread, and very destructive in its effects. Atkinson reports it from Columbia, S. C., and Auburn, Ala., on the wild Chickasaw plum and its cultivated varieties; on the same host in Iowa; and on the cultivated varieties of the Wild Goose plum (*P. hortulana*) from four localities in Iowa. Smith and Atkinson record its occurrence in Maryland and Georgia. Galloway and

* Cornell Univ. Ag. Exp. Station, Bull. 73, Sept., 1894.

† Journal of Mycology, Vol. VI., p. 108, 1891.

PLATE II. LEAF-CURL OF JAPAN PLUM.

Atkinson report it on the variety Maquaketa at Ames, Iowa, this variety, according to Atkinson, being "inadvertently referred to the Chickasaw plum." Finally, its occurrence in Connecticut marks an extreme easterly limit.

The serious injury which it causes has been already referred to, as well as the means which may be taken to eradicate it. It must be borne in mind that this fungus belongs to a genus in which the vegetative portion or *mycelium* lives from year to year within the tissues of the diseased shoots; the pruning-knife must therefore be depended upon to remove the existing trouble, and fungicides to prevent subsequent infection. One of the striking characteristics of the Japanese plums heretofore, has been their comparative freedom from the diseases to which our native varieties are subject. The appearance of so serious a trouble as this leaf-curl is therefore of great scientific and economic importance, and growers are warned to watch for the first appearance of the disease, and to take immediate action to prevent its spread.

MISCELLANEOUS NOTES ON VARIOUS FUNGUS DISEASES.

By Wm. C. Sturgis.

The Powdery Mildew of Grapes (*Uncinula spiralis, B. & C.*).—Early in August a package of grapes was received from Mr. A. B. Plant of Branford, who reported that a large percentage of his grapes had been ruined by a disease quite unfamiliar to him, but well illustrated by the specimens sent for examination. The appearance of the grapes was peculiar, and inasmuch as this particular effect of fungous attack is somewhat exceptional, a brief note on the subject may be of interest.

The surface of the grapes showed a somewhat blotchy appearance, and the skin was abnormally thick and leathery; the principal damage however, was due to a cracking of the berries lengthwise, in some cases so severe as to expose the seeds. Microscopic examination of the berries showed no trace of any fungus, but the peculiar thickening of the skin in places, led to the conclusion that the cracking was due primarily to an early attack on the part of the fungus mentioned above. The powdery mildew is much less common in Connecticut, and does less damage as a rule than the downy mildew [*Plas-*

mopara viticola (B. & C.)]. When the former does occur it is usually confined to the upper surface of the leaves, and seldom attacks the fruit. In this case however, the leaves were very slightly affected. The powdery mildew is superficial in its manner of growth, sending its vegetative and fruiting threads in the form of a white, frost-like covering over the surface of the host and drawing nourishment from the latter by means of small suckers which penetrate the tissue. If, as in this case, the grapes are attacked while very small, those portions of the surface upon which the fungus grows, cease enlarging because of the exhausting effect of the fungus; the tissues beneath, being uninjured, continue growing, and eventually the difference in increase between the internal portions and the external cells causes the skin to split open. As the grapes increase in size, the same conditions being operative, the crack becomes deeper, and the smaller the grapes when first attacked, the deeper will the crack eventually extend. Meanwhile spraying begun after the fungus has injured portions of the surface of the fruit beyond recovery, checks its further spread upon the fruit or to the leaves, rains wash off the now dead and loosely adhering fungus threads, the suckers dry up or are concealed in the tissues of the thickened skin, and no evidences of the attack remain except the cracks, which are deepened continually by the natural growth of the berry. Such seems to have been the cause of the trouble in the present instance. The remedy consists in early and thorough spraying, once just before the blossoms open, and again as soon as the blossoms have fallen.

A DISEASE OF MELONS (*Alternaria sp.*).—Late in August specimens of Musk-melon leaves were received at the Station from Mr. S. B. Wakeman of Saugatuck. The leaves were evidently diseased, and Mr. Wakeman wrote that the trouble was spreading very rapidly over his melon ground notwithstanding applications of Bordeaux mixture. A visit to Saugatuck confirmed Mr. Wakeman's report. Of three large fields of melons, one was completely ruined, and the other two showed abundant evidences of disease. The trouble seemed to start at the center of the hills and extend rapidly outwards. It was characterized by a wilting of the leaves, followed by the appearance of small yellowish spots and blotches; these increased rapidly in size, the surface of the diseased areas became marked with dark, concentric rings, the tissues became dry and brittle, and upon all the older spots there was a copious growth of black mould distinctly visible with a

lens. Microscopic examination showed that the leaf-tissue in every diseased spot was traversed by delicate, colorless threads, which, coming to the surface either singly or in little erect tufts, gave rise to short chains of large, brown, club-shaped spores, provided with a long erect appendage, and serving to place the fungus in the genus *Alternaria*. No other fungus was found in connection with the trouble, and this, together with the fact that the *Alternaria* was found abundantly in every one of the diseased leaves examined, produced a strong impression that the disease was due to the fungus in question. There was no opportunity however, to prove this supposition by the inoculation of sound leaves with a pure culture of the *Alternaria*. When the field was first examined, late in August, the plants had received two applications of Bordeaux mixture, but it had not been applied very evenly. The only thing to be done under the circumstances was to recommend another immediate and thorough application of Bordeaux mixture, especially upon those portions of the vines at a distance from the centre, which as yet showed no symptoms of the disease. There was but little hope however, of saving the crop to any great extent, and as the result proved, the disease continued to spread even after thorough treatment of the vines with Bordeaux mixture.

There are a number of fungi which are known to affect the leaves of melons, but the one in question is probably identical with the species of *Alternaria* recently described by Smith and by Peglion as affecting melon-leaves in this country and in Italy. Whether in this case the fungus was a true parasite, or whether it merely followed an injury due to other causes, must remain an open question for the present.*

*Since the above was written, pure cultures of this fungus have been obtained by inoculating sterilized tubes of prune-agar with spores from the diseased leaves. These cultures furnished spores which were used in the inoculation of leaves of growing melon and tomato plants. In the case of the melon the inoculation has been successful even upon normal, uninjured leaf-tissue, proving beyond question the connection between the fungus and the disease. With the tomato, the inoculation of leaf-tissues which were injured has resulted in a diseased condition identical with that seen in the melon, and at the present time similar results seem liable to follow from the inoculation of sound tissues. Should these experiments prove that the tomato as well as the melon is susceptible to this disease, some doubt may arise as to the propriety of the name which has been given to the fungus. In other words the fungus causing a diseased condition of melon-leaves may prove to be identical with a species previously described from some other plant. It is hoped that the series of cultures and inoculations now in progress at this Station may serve to settle this question.

THE LEAF-SPOT OF PLUMS (*Cylindrosporium Padi*, Karst.).—This fungus, which attacks both the plum and cherry, is not usually abundant in Connecticut, but this year there was at least one serious case. The trouble is manifested by the premature yellowing and falling of the leaves. The affected leaves are marked upon the upper surface with numerous small greenish or brownish spots with paler centres and sharply defined borders. Later the tissue of these diseased spots dies and separates from the surrounding tissue, leaving the leaf pierced with a number of roundish holes whence the name "*shot-hole fungus*," sometimes applied to the disease. The owner of the orchard in which the trouble appeared wrote under date of Aug. 17th, "Three-fourths of the leaves are off now or soon will be; the trees have not been sprayed. My trees at home, of the same variety, which have been sprayed twice, are the picture of health." Comment is unnecessary.

HOLLYHOCK RUST (*Puccinia Malvacearum*, Mont.).—This fungus is interesting as having sprung into notoriety within comparatively few years. It was first described from Chili, and spread thence to Europe, where it increased so rapidly that by the year 1875 it had become a well-known disease of great severity. It first appeared in this country in 1886, and has spread with remarkable rapidity, particularly in the Eastern States, so much so that it now ranks as a fairly common disease of hollyhocks, and it is by no means rare to find all the plants in a single locality completely ruined by it. Fortunately it is quite unmistakable and easily recognized. It is characterized by the appearance, on the lower surface of the leaves, of small warts about twice the size of a pin-head; these are at first yellow, but soon change to a purplish-gray or brown color. On breaking open one of these little warts, the interior is found to be composed entirely of a dark brown dust—the two-celled spores of the fungus. The fungus appears to pass the winter in the remains of old hollyhock plants, or upon the first-year leaves, whence it spreads in the spring to the new growth, appearing visibly upon the leaves and stems in June. In severe cases the leaves are so permeated by the fungus that they wither and fall early, and the flowers fail to mature.

The "rusts" are all extremely difficult to combat with fungicides. Their appearance upon the surface only after a long period spent within the tissues of the host, protects them from injury until most of the damage has been done; while their large, thick-walled spores seem to be peculiarly resistant to the effects of fungicides. The most practical method of preventing the spread of the disease would seem to be the destruction by fire of all refuse of infested plants, and the avoidance of land upon which rusted hollyhocks have previously grown. Picking off and burning the leaves as fast as the disease appears upon them would doubtless assist in checking its spread; and in England a wash consisting of two tablespoonfulls *of a saturated solution* of permanganate of potash, added to one quart of water, and applied with a sponge, has proved efficacious in checking the disease.

NOTES ON INJURIES DUE TO PHYSIOLOGICAL CAUSES.

BY WM. C. STURGIS.

WINTER KILLING OF PEACH TREES.

A peculiar and rather obscure trouble manifested itself last spring in a number of peach orchards throughout the State, and specimens were sent to the Station for examination. In every case the symptoms were as follows: With the opening of the season the trees were apparently thrifty, and produced leaves and blossoms normally. About the middle of May evidences of a diseased condition suddenly appeared. One portion of an otherwise thrifty tree seemed on the point of dying; upon cutting through the bark, the wood appeared blackened and dead, or in less severe cases showed brownish streaks, especially in the delicate tissue just beneath the bark. The leaves upon these affected portions ceased growing and became stunted and wilted, while a red discoloration appeared in spots upon the leaves, especially at the tips. No external cause of the trouble could be found; borers were in no case present, nor could any parasitic fungus be traced in or upon the affected portions. No serious frost had occurred since the trees began their growth. Eventually the trees which seemed to be but slightly affected recovered; while others in which the injury was more severe, suffered a gradual loss of vitality, and finally died. I was for some time at a loss to determine the cause of the injury, but conversation with a number of experienced growers led to the conclusion that it was due to severe and sudden changes of temperature during the winter. It will be remembered that the winter of '94–'95 was characterized by two or three short periods of extremely cold weather accompanied by high winds, preceded and followed by longer periods of mild weather. It seems highly probable that these sudden changes of temperature affected unfavorably a few trees here or there which were constitutionally weak, and whose thin bark caused the delicate underlying tissues to be peculiarly susceptible to such changes. Under such circumstances the tissues which remained uninjured might perform their functions for a time, and enable the tree to leaf out, while in some cases the trees might be injured past recovery. There seems to be no practical method of guarding against injury of this kind, and the conditions which induce it are probably too exceptional to warrant serious apprehension.

Frost Injury to Pears.

A peculiar injury to pears was very prevalent during the spring of 1895 in many sections of the State. It appeared very early upon the fruit, when the latter was from one-half to three-quarters of an inch long, as a russet band or blotch upon the surface. Generally this russet appearance was limited to the calyx end of the fruit; occasionally it partly or entirely encircled the fruit midway between the stem and the calyx. The same appearance was seen rarely upon apples. The opening of the season was characterized by one or two sharp frosts after fruit had set, and it was natural to regard the late frosts and the injury as cause and effect. This view is substantiated by Mr. G. Harold Powell of Cornell University, who says*: "This belt is due to an injury to the epidermis of the fruit in its young stage, and is caused by the freezing of dew collected on these spaces. The fruit at this time is upright, and the place where the dew collects is probably determined by the formation and position of the fruit." The russet appearance is a result of the natural process by which plants commonly repair their surface injuries, viz., the development of cork. The portions of the epidermis thus injured and healed, cease expanding, and as the remainder of the fruit continues its growth, the uninjured epidermal cells immediately adjoining the injured portion become gradually ruptured, and in their turn give rise to a growth of cork, so that the russet area increases in extent with the growth of the fruit.

* Garden and Forest, Vol. VIII., p. 417, Oct. 16th, 1895.

NOTES ON INJURIOUS INSECTS.

By Wm. C. Sturgis.

The Wheat Midge (*Cecidomyia Tritici.*).—A number of heads of rye were received early in June from Coventry which were undoubtedly suffering from the depredations of this insect. The heads were partially eaten out, the lower kernels being entirely destroyed, leaving only the chaff. Our correspondent stated that at the time of writing, June 5th, the trouble was spreading rapidly. The injury is caused by the grubs or maggots of a small insect nearly related to the "Hessian Fly" (*Cecidomyia destructor*). The eggs are deposited among the chaff of the heads of a variety of grains, and the small grubs, which soon hatch out, eat into and destroy the maturing kernels. The only remedies which have been recommended for this pest consist in gathering and burning the infested heads; deep plowing of infested fields, whereby many of the insects are killed; planting a small quantity of grain very early, in order that after it has become infested by the midge it may be ploughed under or destroyed before the land is sown for the final crop; and planting varieties which mature early, such varieties being less liable to attack than those ripening later.

The Bark-beetle (*Scolytus rugulosus*, Ratz.).—This insect, to which attention was called in our Report for 1894, seems to be increasing in the peach orchards of the State, and bids fair to become a serious pest. Specimens of the bark and wood of peach trees received in May from the eastern part of the State were completely riddled with the small "shot-hole" punctures of the insect, each puncture exuding a drop of gum. The only remedy which can be suggested is of a purely preventive nature, and consists in applying to trees liable to attack, a lime-wash to which a small quantity of Paris green has been added. In case a tree is very badly infested with this borer, it had better be destroyed at once; trees only slightly attacked have been known to recover.

SCALE-INSECTS.*

THE SAN JOSÉ SCALE (*Aspidiotus perniciosus*, Comst.).—This pest was found last summer for the first time in Connecticut, infesting an orchard of peach, plum, and apple trees, in the vicinity of New London. The discovery was deemed of sufficient importance to be made the subject of a bulletin (Bull. 121, July 1895, republished in this Report, p. 194), which was distributed widely, and the reader is referred to that publication for detailed information regarding the occurrence, characteristics, and life-history of the insect, and the methods which have elsewhere proved successful in eradicating it. Since the publication of our Bulletin 121, information has been received of the appearance of the scale in other orchards near New London, and specimens have also been received from Hartford. There can be little doubt that the scale was introduced into Connecticut upon stock purchased from a New Jersey nursery prior to 1894, at which time the proprietors of the nursery discovered that their stock was infested, and by prompt and energetic measures succeeded in stamping out the trouble. Meanwhile however, between the years 1890 and 1894, during which time the infested stock had escaped notice, the firm had supplied no less than ninety-two individuals in this State with young fruit-trees. It seemed probable, therefore, that the San José Scale might be much more widely distributed in Connecticut than the information at hand would lead one to suppose.

Great credit is due to the New Jersey firm of nurserymen for the prompt and thorough manner in which they met and overcame the trouble in their own nurseries, as soon as the matter was called to their attention; and also for their courtesy in responding to our request for a list of the fruit-growers in Connecticut whom they had supplied with stock between the years 1890 and 1895. A circular letter was recently sent to each person on this list requesting him to examine such stock as he had purchased in New Jersey between the years above mentioned, and to report to us whether or not the San José scale was to be found upon it. A postal card was enclosed with each circular, together with a copy of our Bulletin 121. The replies thus far received show cause for some apprehension; the only locality where a serious outbreak is definitely known to have occurred is in the neighborhood of New London, and there vigorous treatment of the infected trees is proving effectual. In Hartford the scale was found upon one pear tree purchased in New Jersey, but it had not spread to other trees, and the infested tree was, upon our recommendation, destroyed. The latest information received is from the neighborhood of Bridgeport, where, judging from samples lately received, the scale is present in numbers sufficient to cause very great damage to apple, pear, and peach stock. The owner of the trees in question has expressed his determination either to destroy the infested trees or to rid them of the pest by treatment with whale-oil soap.

* For the identification of most of the species herein noted I am indebted to the kindness of Profs. Comstock and Slingerland of Cornell University.

SCALE ON TULIP-TREES (*Lecanium Tiliæ*, Fitch). — Specimens of this large, convex, brown scale were received in August from Hartford, where they were reported as covering the bark of tulip-trees (*Liriodendron tulipifera*), and injuring the trees to a very serious extent. It has also occurred upon tulip-trees in New Haven. According to Prof. Slingerland this insect is identical with that described by Prof. Cook* as *Lecanium tulipiferæ*. The owner of the infested trees was advised to scrape off as many of the scales as could be conveniently reached, to apply strong kerosene emulsion in the late autumn as recommended for the San José scale in our Bull. 121, and to follow this up with an application of a weaker form of the emulsion as soon as the young insects were seen to be emerging from beneath the scales, which would probably take place during the following June. We have yet to hear the result of this treatment, but there is every reason to suppose that it will prove satisfactory.

SCALE ON OAK (*Asterodiaspis quercicola*, Bouché).†—Specimens of this insect were received early last March from the proprietors of the Elm City Nursery of New Haven; they occurred in large numbers on the limbs and terminal twigs of the British or Black Oak, *Quercus Robur*, and were undoubtedly the cause of considerable injury. The insect however, is not a common one, and its appearance in numbers sufficient to cause serious apprehension is hardly to be expected.

The scales received early in March covered living eggs, which, in the warmth of the laboratory hatched out during the last week in April, probably at least two weeks earlier than they

* Canadian Entomologist, Vol. X, p. 192.

† U. S. Dept. of Agric., Report for 1880, p. 330.

would have hatched in the open air. Two or three applications of kerosene emulsion or whale-oil soap, beginning about the middle or latter part of May, would doubtless be an effective remedy. In very severe cases a treatment with strong kerosene emulsion in winter, or as soon as the trees become thoroughly dormant, might be advisable. This treatment is recommended only for nursery stock; if large trees are infested they had better be destroyed.

SCALE ON HONEYSUCKLE (*Lecanium sp.*).—Our cultivated shrubs are not as a rule subject to injury from scale insects; it is therefore of interest to note the occurrence of a species of *Lecanium* on a shrubby honeysuckle, probably one of the Japanese species of the genus *Diervilla*, commonly cultivated under the name *Weigela*. Specimens of this shrub were received from Waterbury in June, but they were too scanty to allow of accurate determination. The scales were numerous upon all of the twigs received, and are evidently capable of doing serious injury to this most useful and showy shrub. In this case again, applications in early summer of kerosene emulsion or whale-oil soap are to be recommended.

THE SAN JOSÉ SCALE.*

BY WM. C. STURGIS AND W. E. BRITTON.

Occurrence in Connecticut.—The appearance of the San José scale (*Aspidiotus perniciosus*) is an event of very great importance to all our fruit growers.

During a visit to the orchard of Mr. Joseph L. Raub of New London, on June 12th, we were struck by the appearance of certain young peach trees which were then apparently dead, though earlier in the season they had put out a few leaves near the tips, and last year had been exceptionally vigorous. Close inspection showed that in every case the trunk and larger limbs were fairly incrusted with a grayish coating composed of vast numbers of scale insects. These so resembled the published drawings of the San José scale, Fig. 1, page 196, that they were suspected to be that pest. Specimens were at once submitted to the experienced entomologists, Messrs. L. O. Howard of the U. S. Department of Agriculture and M. V. Slingerland of Cornell University, who kindly examined them and confirmed our conclusion. The specimens secured on June 12th were small and undeveloped, having apparently died while still in the hibernating condition. On June 20th, careful notes were taken of the condition and surroundings of the orchard, which occupies an isolated position on the outskirts of the city, with no other orchard in its vicinity, and which contains a variety of fruit trees from one to four years of age. It was evident that the scale had not come from the neighborhood, but it was still more evident that the orchard in its present condition might be a fertile source of infection, for living scales were found upon fully one-half of the trees. All the trees came originally from a firm in New Jersey, and were set out in or since 1891. The plantings of 1891 and 1892 were very badly affected, many of the trees being completely dead and covered with the scale, others being killed to the ground but sending up new shoots from the roots. Living scales were found principally upon the trees set out in 1893, but the insect had not yet completely infested these trees, which remained comparatively vigorous. The trees set out in 1894 were practically free from scale. From these facts it is evident that the insect was introduced upon the stock of 1891 and 1892 and had developed until the trees died; and that the stock of 1893, while originally infested equally with the previous plantings, had remained sufficiently vigorous to show but little evidence of the attack. Doubtless, however, these trees offered suitable conditions for the breeding of the pest and its spread to the still unaffected trees of the planting of 1894. The freedom from scale of the latter was undoubtedly due to the energetic and successful measures adopted in 1894 by the New Jersey firm to eradicate the scale from their nurseries by the destruction of all infested trees, and the fumigation of all suspected stock before placing it upon the market.

Since our first visit, Mr. Raub has undertaken to destroy the trees in his orchard which are most seriously infested, and to apply to the others a strong solution of whale-oil soap. This will undoubtedly check the spread of the scale until next winter, when more drastic remedies can be applied to the dormant trees.

* This paper, first printed in Bulletin 121 of this Station, is here reproduced in slightly amended form. See also "Notes on Injurious Insects," page 192.

General appearance of the Scale.—When the scales occur singly they are not easy to detect with the naked eye; but when, as is usually the case, they occur in groups, they are easily seen as a grayish and roughened or pimply coating upon the bark, as shown in Fig. 1. This coating, when scraped off with the

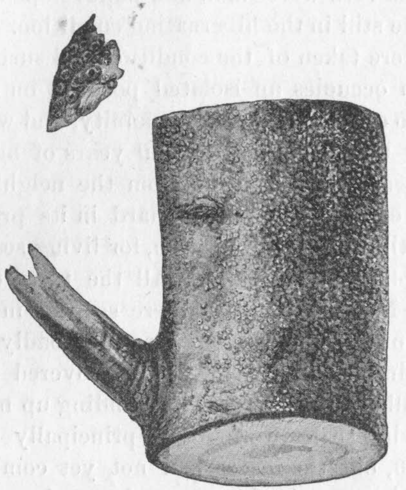


FIG. 1.—San José Scale: Apple Branch, with scales—natural size.—(From *Insect Life.*)

thumb-nail or with the blade of a knife, appears mingled with a yellowish liquid if the insects composing it are alive. In severe cases the bark is completely covered with this scaly coating, and upon removing the bark the delicate tissues beneath are seen to present a pinkish or purplish color. When a tree is but slightly affected, the scales are usually found singly or in small groups upon the twigs, often at the base of the leaves. When the scales occur upon the fruit, it is usually in the form of scattered individuals closely attached to the surface, each one being surrounded with a purplish ring, Fig. 2. The separate scales measure, when fully grown, about one-eighth of an inch in diameter, are almost circular, slightly convex with a minute blackish projection in the center, and are of a dirty brown or gray color. The scale may be easily lifted upon the point of a pen-knife, and the insect beneath it, if alive, is seen as a small bit of yellowish jelly. This scale differs in appearance from other scales commonly found upon fruit trees; it is rounder than the "oyster-shell bark louse," and is smaller and darker in

color than the "scurfy bark louse." In fact it is the only scale among those commonly found on fruit trees in Connecticut, which is distinctly circular in outline.

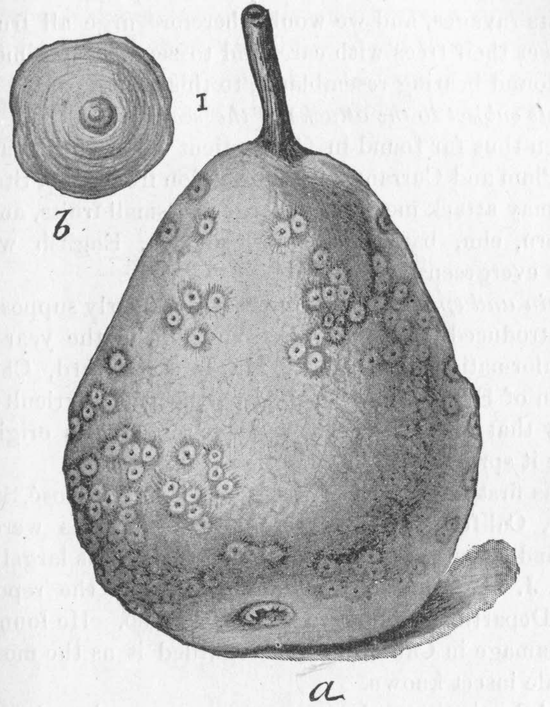


FIG. 2.—San José Scale: *a*, Pear, moderately infested—natural size: *b*, female scale—enlarged.—(From *Insect Life.*)

Effect of the scale on the trees.—The pernicious effects of the San José scale are in a great measure due to its inconspicuous character, and to the fact that its effect upon the vitality of the tree is not at once apparent. During the first season of its attack, the tree may be apparently healthy, with full leafage and abundant fruit. As the scale spreads, however, the effect becomes more plainly visible, though it is such as might readily be attributed to the attacks of borers or to drought. Only the most careful observation will discover the true cause of disturbance. Generally by the second or third season only does the scale become so abundant as to be conspicuous, and by that time the whole tree is infested with the grayish coating of scales; in its weakened condition it succumbs easily to an exceptionally severe winter, and though it may put forth leaves, they shortly wither, and before the cause of the trouble is actually known, the tree is practically dead. If taken in time, however, it is not difficult to check its ravages, and we would therefore urge all fruit-growers to inspect their trees with care, and to send us specimens of any insect found bearing resemblance to this scale.

Plants subject to the attacks of the scale.—The San José scale has been thus far found in Connecticut upon the Peach, Apple, Pear, Plum and Currant, but information from other States shows that it may attack most of our large and small fruits, and the rose, hawthorn, elm, basswood, alder, sumach, English walnut and various evergreens.

Origin and spread.—This insect was formerly supposed to have been introduced into California from Chili, in the year 1870, but later information obtained by Mr. L. O. Howard, Chief of the Division of Entomology, U. S. Department of Agriculture, seems to show that our Pacific coast was probably its original home, whence it spread to Chili and other countries.

It was first noticed by fruit shippers near San José, Santa Clara County, California. No exterminative measures were at once taken and a few years later the Pacific slope was largely infested.

Prof. J. H. Comstock first described it in the report of the U. S. Department of Agriculture for 1880. He found it doing much damage in California and regarded it as the most destructive scale insect known.

The Atlantic States, however, were supposed to be uninfested until the summer of 1893, when it appeared upon orchard trees in Charlottesville, Va. The attention of Dr. C. V. Riley, then U. S. Entomologist, was called to the fact of its presence, and measures for its suppression were immediately employed.

It was soon discovered that this was not the only center of infection, but that the scale existed at De Funiak Spring, Florida; Bartle, Indiana; Neavitt and Chestertown, Maryland; Lewisburg and Atglen, Pennsylvania, and in several localities in New York and New Jersey. It has recently been found in Delaware and on Long Island.

The introduction of the San José scale into the Eastern States has been traced to the importation of Japanese plum trees into New Jersey from California.

Like other scale insects, the San José scale can spread only a short distance each year, unless its distribution is aided by the agency of wind, water or animals.

Probably its distribution in this country has been largely effected through shipments of fruit and nursery stock; but the insect has been found upon other insects, and these, especially the flying ones, have doubtless assisted in its dissemination.

Life History.—This insect is viviparous; i. e., brings forth living young, Fig. 3.

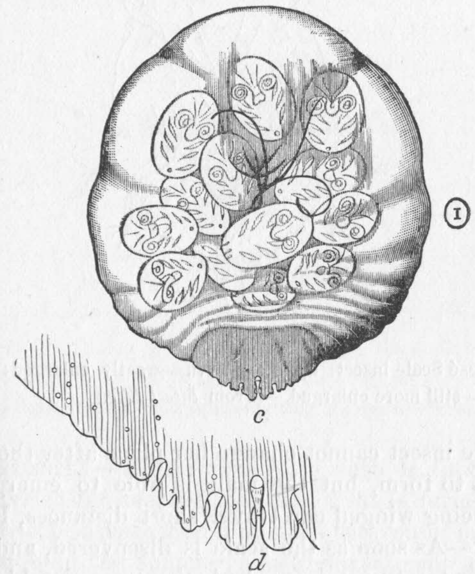


FIG. 3.—San José Scale insect: *c*, adult female containing young—greatly enlarged: *d*, anal fringe of same—still more enlarged.—(From *Insect Life*.)

In California three annual broods appear, but for our climate the number of yearly broods has not been definitely determined.

The San José scale survives the winter either in the egg or in a half grown state. It becomes fully developed and reproduces about the last of May or first of June, and successive broods appear until winter begins.

The newly born or hatched individuals, Fig. 4, unlike their female parent, have no scaly covering but crawl about like ordinary plant lice. They are very small at first. The period of activity lasts but a day or two, sometimes only a few hours, when the young insects settle upon the bark and become fixed.

The scaly covering then begins to form. The insect soon molts and the cast-off skin uniting with a waxy secretion forms the visible external scale.

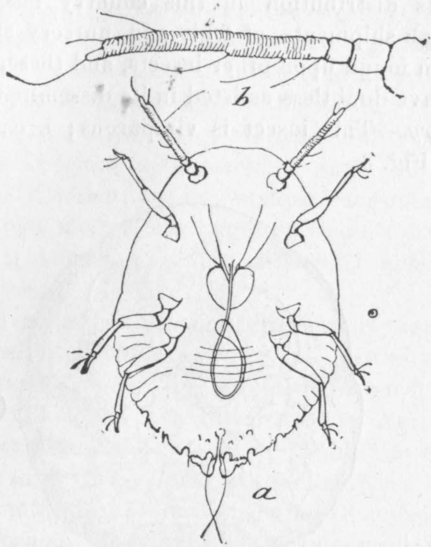


FIG. 4.—San José Scale insect: *a*, young larva—greatly enlarged: *b*, antenna of same—still more enlarged.—(From *Insect Life.*)

The female insect cannot change her place after the scaly covering begins to form, but the male is able to emerge from his cover, and being winged can travel short distances, Fig. 5.

Remedies.—As soon as the scale is discovered, and before any wash or other treatment is applied, the trees should be cut back as severely as seems advisable, and all the cuttings burned, as, in the case of newly infected stock, most of the scales occur on the terminal shoots.

Gas Treatment.—This requires an oiled canvas or some other gas-tight tent in which the tree is enveloped. Hydrocyanic acid gas is then generated by pouring, say three fluid ounces of water into an earthen-ware vessel, adding one fluid ounce of commercial sulphuric acid (oil of vitriol), and lastly one ounce (by weight) of fused potassium cyanide, these materials making enough gas to fill a space of one hundred and fifty cubic feet.

If this treatment is employed, the greatest caution must be taken not to breathe the gas, for hydrocyanic (or prussic) acid is a most dangerous poison.

According to Lintner (Bull. N. Y. State Mus., Vol. 3, No. 13, p. 302) Mr. Howard lately reports the gas treatment as not wholly efficacious in Virginia, possibly owing to the more complete dormancy of the insects in the East than in California, where it was first successfully employed.

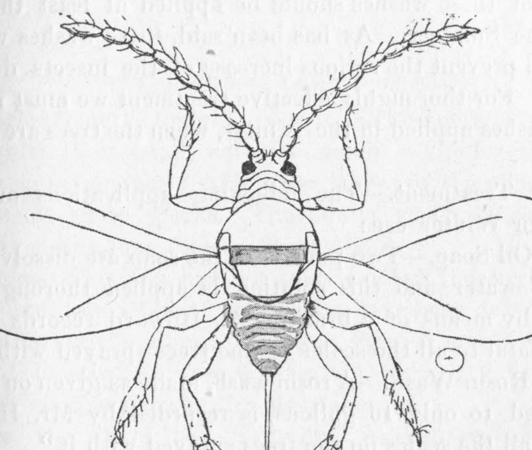


FIG. 5.—San José Scale insect: male adult—greatly enlarged.—(From *Insect Life.*)

Summer Treatment.—Either weak rosin wash or dilute kerosene emulsion is advised for keeping the scale in check during the Summer. Neither will do more than this, since the young hatch out at intervals throughout the Summer, and this treatment will not kill the mature scales.

The following formulas are recommended :—

WEAK ROSIN WASH.

Rosin	20 pounds
Caustic soda	5 pounds
Fish-oil	2½ pints
Water to make	100 gallons

Pulverize the rosin and soda, add the oil, and place the mixture in a large kettle with water sufficient to cover it. Boil for one or two hours with occasional additions of water, until the compound will mix perfectly with water instead of breaking up into yellowish flakes. Dilute for use to 100 gallons.

STANDARD KEROSENE EMULSION.

Kerosene	2 gallons
Common soap or whale-oil soap	½ pound
Water	1 gallon

Heat the solution of soap and add it boiling hot to the kerosene; churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling, and should adhere without oiliness to the surface of glass. If the water is hard, add a little lye or soda, enough to make it feel very slightly slippery. For use, dilute with nine times its bulk of cold water.

Either of these washes should be applied at least three times during the Summer. As has been said, these washes will do no more than prevent the serious increase of the insects during the Summer. For thoroughly effective treatment we must rely upon strong washes applied in the Winter, when the trees are not liable to injury.

Winter Treatment.—The following applications are recommended for Winter use:

Whale-Oil Soap.—Two pounds of the soap are dissolved in one gallon of water and this solution is applied thoroughly, as a spray, or by means of a brush. Mr. Howard records this solution as "fatal to all the scales on the trees sprayed with it."

Strong Rosin Wash.—A rosin wash, made as given on page 201, but diluted to only 16 gallons, is recorded by Mr. Howard as "fatal to all the scales on the trees sprayed with it."

Potash Wash.—Dr. Smith recommends, as a result of his experiences in New Jersey, a wash consisting of a saturated solution of crude or commercial potash, i. e., potash in a quantity of water just sufficient to dissolve it. This is applied with a cloth or a brush, or as a spray. The potash serves to corrode and loosen the scales, killing many of the insects beneath them; and a spray of kerosene emulsion a month later completes the work of destruction.

On the whole, the Winter treatment with whale-oil soap, or strong rosin wash, seems to leave nothing to be desired, while in order to keep the insect in check during the Summer, or until this treatment can be safely applied, either of the two Summer washes described above will prove valuable.

Winter Treatment should be applied soon after the leaves fall, as the scales are thought to be more susceptible at that time than later in the winter.

Summer Treatment should be applied at least three times at intervals during the summer. Frequent rains necessitate repeated applications.

FURTHER NOTES ON INJURIOUS INSECTS,

By W. E. Britton.

THE PLANT-HOUSE ALEYRODES.

(*Aleyrodes vaporariorum?* Westwood.)

Order, Hemiptera: Family, Aleyrodidæ.

For several months tomato plants in the forcing house have been infested with these small, scale-like insects. The larvæ are found upon the under surface of the lower leaves of the plants, appearing as small white specks. The adults, which much resemble tiny white moths, may be seen flying about.

The genus *Aleyrodes* has not been studied thoroughly in this country, and only a few of our species have been described. One species infesting the orange tree was figured and described by Riley and Howard, in Insect Life, vol. v, p. 219, having been named *A. citri*, previously, by Mr. Ashmead.

In the Report of the Kentucky Agricultural Experiment Station for 1890, p. 37, Prof. H. Garman records a species of *Aleyrodes* which occurs upon the strawberry in Kentucky. This insect answers very closely the description of *A. vaporariorum*, of Westwood.* It has been observed upon the leaves of *Abutilon avicennæ*.

Specimens from our forcing house were submitted to Prof. Garman, who reports that it is the same species which he found upon strawberry plants. I have also noticed this insect upon lettuce, cucumbers, *Ageratum Mexicanum*, *Maurandya Barclayana* and a species of *Abutilon*.

Prof. L. H. Bailey refers to this insect in N. Y. Cornell Station Bull. 28, p. 58, as being a pest of the tomato house. Dr. A. S. Packard mentions *A. vaporarium*† in his Guide to the Study of Insects, 9th ed., pp. 526 and 712, as occurring upon both strawberry and tomato plants.

The larvæ are covered along the edges and upon the dorsal surface with bristles, which can be seen with the naked eye. Many cast pupa skins are found fastened to the tomato leaves. The pupa skin cracks open along the back and allows the adult to escape. These pupa skins occur most abundantly on the older and lower leaves of the plant, while the young larvæ may

* Gardener's Chronicle, 1856, p. 852. † *A. vaporariorum* was probably intended.

be found adhering closely to the younger and more tender leaves. (See plate III.)

Flitting about the tops of the plants are the small, white, moth-like adults which are mating and depositing eggs. The egg is oval, slightly conical, with the large end attached to the leaf. Two females were observed depositing eggs upon lettuce. The beak was inserted in the tissues of the leaf and an egg deposited. The female then turned, using her proboscis as a pivot, and continued to deposit eggs in a circle of about 1 m. diameter. In one instance this circle contained six, and in the other nine eggs. These eggs hatched in eleven days.

Eggs are not always deposited in circles: I have frequently found them single. When first deposited, the eggs have nearly the color of a lettuce leaf, but shortly become dark and brown.

In the adult stage both sexes have four wings, each with a single median vein. The color of the body is yellow, that of the wings, white. Antennæ are six-jointed.

Plate III shows the insect in the egg, larval and adult stages, from original drawings.

Tobacco fumes kill the adults, and in the greenhouse probably are the most satisfactory treatment. On plants out of doors, which cannot be fumigated easily, the insect may be held in check by frequent applications of whale-oil soap (1 lb. soap to 5 gallons water). Kerosene emulsion, which has proved most efficient against *A. citri*,* would doubtless destroy *A. vaporariorum* as well.

A LEAF MINER OF THE CAULIFLOWER.

(*Drosophila flaveola*, Meigen.)

Order Diptera; Family, Muscidæ.

A leaf miner was observed, in June, upon the cauliflower. A dozen plants growing in the shade were seriously injured; all the larger leaves were tunnelled and soon dropped off. Some of the plants finally died. Leaves were gathered and adult insects were reared from the mines.

Specimens were sent to Mr. D. W. Coquillett, who identified the insect as *D. flaveola*, the larvæ of which are found in the leaves of radish and turnip. Mr. Coquillett has given a brief account of this leaf miner in Insect Life, vol. vii, p. 381.

* Insect Life, vol. v, p. 224.

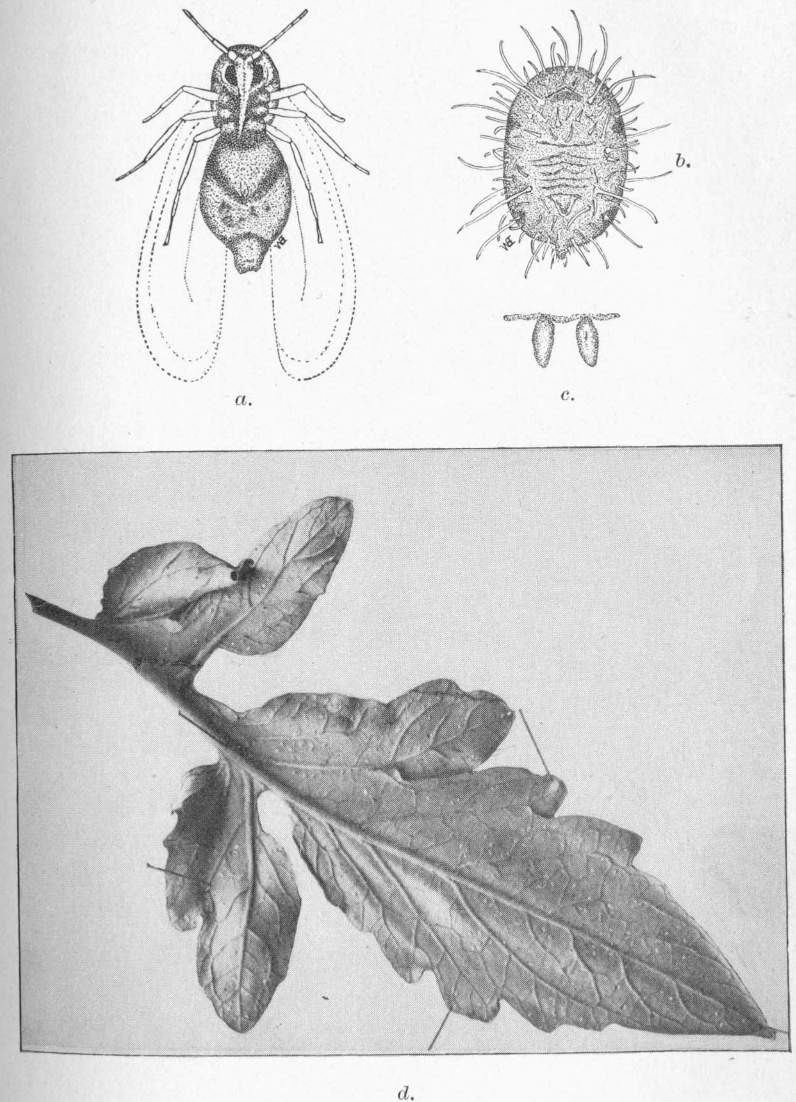


PLATE III. ALEYRODES VAPORARIORUM.

a. Adult magnified 51 diameters. *b.* Full grown larva. *c.* Eggs. Larva and eggs magnified 34 diameters, (original). *d.* Tomato leaf showing larvæ, (from photograph).

The adult is a two-winged fly, which deposits eggs in the tissues of the leaf. No experiments have as yet been made relative to a treatment for this leaf miner, but it is always wise to destroy all infested leaves. Mr. Coquillett writes me that so far as he is aware, this insect has not previously been reported as attacking the cauliflower.

CABBAGE PLUSIA ON TOMATOES IN THE GREENHOUSE.

(*Plusia brassicæ*, Riley.)

Order, Lepidoptera; Family, Noctuidæ.

On the morning of October 16th, green caterpillars were noticed in the forcing-house devouring the foliage of tomato plants, which were then about two feet in height. Fourteen of these caterpillars were found that day. Search was kept up for some time, but none were discovered after October 23d, twenty-five in all having been taken in the tomato-house during one week.

The larvæ were placed in a glass jar and fed with tomato-leaves, which they consumed voraciously. They were nearly all about full-grown and shortly began to pupate—one, in fact, changed on October 17th, the next day after imprisonment. They did not remain long in the pupal state. The warm air of the laboratory was favorable to development, and probably hastened the appearance of the adults, which came forth on October 31st and November 1st.

The insect proved to be the "Cabbage Plusia," the larvæ of which are quite common upon cabbages in the Southern, Central, and Middle-Atlantic States. Sometimes, in the absence of the cabbage, this insect attacks other vegetables, including celery, cauliflower, turnip, lettuce, dandelion and tomato.

The full grown larva is from 25 to 33 mm. (1 to $1\frac{3}{8}$ inches) in length, and 4 mm. in thickness at the thickest part, which occurs at the eighth segment. The color, above, is light green, indistinctly striped with white. The under surface is of a brighter green. There are two pairs of abdominal pro-legs. Though *Plusia* is a genus of *Noctuidæ,* the larvæ "loop" in traveling, much like Geometer larvæ; this is said to be due to the absence of front pro-legs. The full grown larva spins a white silken cocoon, usually on the under surface of the leaf, and becomes a brownish pupa. In about two weeks the adult emerges. The adult is a dark gray moth, each front wing having a silvery U-shaped spot near the middle.

Very likely the larvæ were feeding upon cabbages that grew in the garden near the forcing-house. They probably sought shelter from the cold, found their way indoors, where they at once began feeding, and where, if they had been allowed to remain, for a few hours even, they would have seriously injured several tomato plants by consuming the leaves.

THE RASPBERRY ROOT GALL-FLY.

(*Rhodites radicum*, Sacken.)

Order, Hymenoptera: Family, Cynipidæ.

The latter part of August, raspberry roots were received from Mr. C. C. Jones of Marlborough, Hartford County, Conn., which were covered with galls. Mr. Jones wrote: "I set some raspberry plants a year ago last spring and they are all dying. I send you a sample as they appear at the present time, and you will notice that there are worms at the roots. I set out some this spring and they are going the same way."

The injury is probably caused by the Raspberry Root Gall-Fly, which in its larval state produces rounded, warty galls, sometimes two inches in diameter, upon the roots of the raspberry, blackberry and rose. See plate IV.

These galls contain numerous cavities with a pithy substance intervening. Larvæ were found in these cavities. Plants attacked soon appear sickly and finally die.

There seems to be no remedy for the injury caused by this insect except to destroy the galls, and if plants are very badly infested they should be carefully dug up and burned.

The adult of this insect is a small four-winged fly about one-seventh of an inch in length. The head, thorax and abdomen are usually black, sometimes brown, with silky luster, and the feet are dark red.

According to Webster* these galls were first described by Harris† as being made by *Cynips semipicea*, Harr., but Sacken states that *C. semipicea* is not the cause of the gall and is probably a parasite of *R. radicum*.

* Ohio Exp. Station Bull. 45, p. 156.

† Insects Injurious to Vegetation, p. 549.

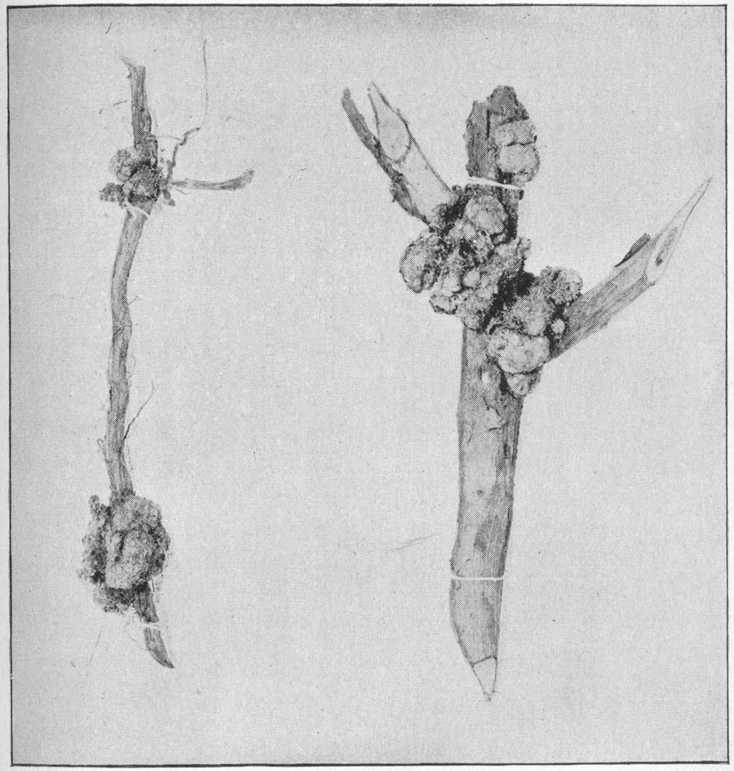


PLATE IV. RASPBERRY ROOT-GALLS.

THE CABBAGE ROOT MAGGOT.

(*Phorbia brassicæ*, Bouché.)

Order, Diptera: Family, Muscidæ.

The cabbage root maggot was reported as being injurious to cabbages in the town of Orange, Conn., during the latter part of May, 1895. The writer visited the fields of Mr. J. J. Merwin on May 25th and found fully two-thirds of the plants upon three acres of ground infested, while a large number of plants were seriously injured and a few had been killed. Other fields in the vicinity were also infested.

An application of lime and liquid manure (5 pecks of fresh lime slacked in 100 gallons of liquid manure) was advised for a part of the plants, in hope that the lime might kill the maggots, while the manure would stimulate the plants to outgrow the injury.

The owner began this treatment, but soon discontinued it, thinking the cost more than his plants were worth.

A "McGowen Injector"* was then procured and carbon bisulphide applied to 106 plants on June 4th. At this time the injury had gone so far that little or no benefit to the present crop could be derived from this treatment, which might, however, somewhat lessen the next year's brood of maggots.

Mr. Merwin finally lost about two-thirds of the plants on one field and one-third of those on another. On a third field, however, the cabbages suffered little, except that they did not head as early as where unattacked.

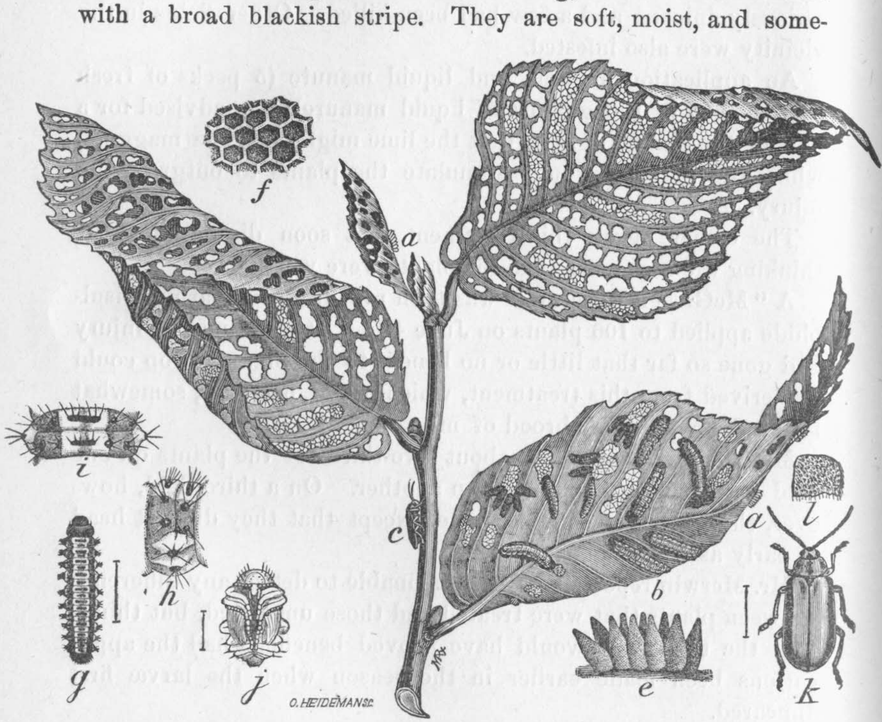
Mr. Merwin reports that he was unable to detect any difference between plants that were treated and those untreated, but thinks that the treatment would have proved beneficial had the applications been made earlier in the season when the larvæ first appeared.

An excellent account of this insect is given in the Cornell Station Bulletin 78, already referred to.

* Figured and described by M. V. Slingerland in N. Y. Cornell Station Bulletin 78, p. 533.

THE ELM LEAF-BEETLE (*Galeruca xanthomelæna*).*

Numerous inquiries have reached us lately regarding this insect, which is proving destructive to elm trees in many parts of the State. The beetle (see *c*, *k*, in the accompanying cut) deposits its eggs, *a*, *e*, in small clusters on the lower side of the young leaves early in June, the larvæ hatch out in about a week and at once begin feeding upon the leaves. These larvæ, *b*, *g*, are small worms about five-eighths of an inch long, marked on each side with a broad blackish stripe. They are soft, moist, and some-



Elm Leaf-Beetle.—*a*, eggs; *b*, larvæ; *c*, adult; *e*, eggs, enlarged; *f*, sculpture of eggs; *g*, larva, enlarged; *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa, enlarged; *k*, beetle, enlarged; *l*, portion of elytron of beetle, greatly enlarged. (*After Riley.*)

*This article was published in July, 1895, in Station Bulletin 121. It is here reprinted in slightly amended form. As to authorship, while Messrs. Britton, Sturgis, Jenkins and Johnson have each contributed some paragraphs, the natural history and treatment have been mostly compiled from the writings of Messrs. Howard and Smith.

what hairy to the touch. It is at this stage that the insect is most destructive, eating off the delicate surface tissue of the leaves, and causing the latter to become shrivelled and brown, and eventually to fall from the tree. By the end of June or early in July the worms become full grown. They then crawl down or fall from the trees and, in crevices of the bark or soil or under grass and leaves, change to soft, yellowish pupæ, *j*. Ten days later the pupæ give rise to the adult insects, small yellowish beetles, *c*, *k*, about one-quarter of an inch in length, marked on the back with two black stripes. The beetles ascend the tree and for a month feed upon the remaining leaves, though the injury done by them is much less than that due to the worms. During August and the early part of September the beetles enter cracks or crevices, where they hibernate, remaining until late in May, when they gather upon the young leaves to deposit their eggs. In New England there appears to be but one brood during the season.

Methods of Extermination.—This insect can best be destroyed in the larval and pupal conditions. The larvæ (worms) are found in June and July upon the leaves, the pupæ in July upon the trunks of the trees and on, or in, the ground beneath the trees.

The best method of combatting the Elm Leaf-Beetle is to spray the foliage with an arsenical poison.

Lead arsenate is better for this purpose than Paris green* because it stays longer in suspension and is less injurious to foliage. It is easily prepared from eleven ounces of sugar of lead (lead acetate), four ounces of sodium arsenate,† and one hundred gallons of water.

Throw the sugar of lead by itself into an empty hogshead and add 99 gallons of water, stirring with a paddle so as to mix the whole thoroughly. In another vessel dissolve the sodium arsenate in one gallon of water. Finally mix the two liquids together by effectual stirring, when the lead arsenate will appear as a fine white powder. In using this mixture the lead arsenate must be kept uniformly in suspension by suitable agitation.

* Both these dangerous substances contain arsenic and require caution in handling, but may be used without serious injury if not swallowed or introduced into wounds.

† To be had of Billings, Clapp & Co., Boston, for eight cents a pound in 25 pound quantities.

A serviceable spraying mixture may also be made by mixing one pound of Paris green and three pounds of lime with one hundred and fifty gallons of water. The lime should be newly slaked and strained free from grit or lumps.

If the Paris green is not kept uniformly mixed with the other materials, by thorough agitation of the entire contents of the tank, while spraying, it will partly settle to the bottom, and the last portions of spray will be likely to "burn" the foliage. The addition of two quarts of molasses or a little flour paste to these drenches will make the poison adhere to the foliage for a long time, thus rendering sufficient a smaller number of sprayings.

To reach the tops of high trees a powerful force pump and a long hose are necessary. The Douglas Palmetto spraying pump, manufactured by W. & B. Douglas, Middletown, Conn., is well adapted to this purpose when hand-power is employed. It should be mounted upon a cask and raised as high as possible above the ground. The discharge pipe should be a half-inch rubber hose, supported on a light pole, so that the spray can be directed well up into the trees.

While a few trees may be cared for by the use of a hand-pump, the many full-grown elms in our large villages and cities require much more powerful appliances.

In 1894, Mr. Stephen Hoyt, of New Canaan, Conn., had a steam spraying outfit* constructed, by the use of which the trees upon the estate of Stephen Hoyt's Sons have been treated for two seasons with success.

From their experience, kindly communicated and illustrated to us in all details, we are enabled to present the following plan of treatment by power, adapted for use on a large scale.

A portable steam engine of eight, ten, or more horse-power with a double-acting force pump and a tank of 300 or more gallons capacity, are mounted on a stout wagon with a platform large enough to accommodate the engineer.

The force-pump should be supplied with an indicator to show the water-pressure, and a number of outlets, two, four, or more, to connect with as many lines of hose as may be practicable. Suitable hose, guaranteed to stand 200 lbs. pressure to the inch and costing 12 cents per foot, may be got of the Mineralized Rubber Co., 18 Cliff st., N. Y. The Lightning Hose Coupling is recommended.

* See Mr. Hoyt's letter, appended.

To each hose is attached a nozzle adapted for producing a fine spray. A good nozzle for use with power is the McGowen, made by J. J. McGowen, Ithaca, N. Y., costing $1.50. This with 180 lbs. steam pressure throws a shower of fine spray vertically through thirty feet or more of still air.

The tank, to be charged with the poison drench, should be provided with an agitator to keep the materials in the tank uniformly mixed. Through the kindness of Mr. Hoyt we are able to show pictures of his outfit in the accompanying plate.

Besides the horses needful to bring the apparatus into position, a driver who can operate the agitator, an engineer, four, six or possibly eight men to manage as many lines of hose, and an assistant to charge the tank, are the needful force.

A man with "creepers" ascends a tree, carrying a stout cord, and choosing a good position in a crotch, hauls up a line of hose and fastens it to a limb, so that, holding the hose near the end, he can direct the nozzle on all sides. The power being applied, the water, with the poison in suspension, is forced out of the hose in a shower of fine spray, which, by skillful handling of the nozzle, is quickly applied to all parts of the foliage. To avoid waste of liquid the spray is thrown for a moment only on any one point, one, two or three minutes, at the most, sufficing to finish work on large trees.

While two or more men are directing the spray into as many trees, the same number are climbing the adjacent trees, so that the engine and its attendants are fully occupied.

Two treatments are advisable, the first in May as soon as the leaves are half grown, in order to destroy the beetles before they deposit their eggs; the second in June or as soon as it is seen that the eggs which have been laid are hatching out. This is undoubtedly the most effective means of destroying the insect, and should be kept up for several years.

If, for any reason, the spraying of the trees is impracticable, efforts must be made to destroy the insects in the pupal condition on or beneath the trees. This is best done by the use of kerosene emulsion, which is made as follows: Dissolve one-half pound of common hard soap in one gallon of boiling water; to this soap solution, while still hot, add two gallons of kerosene, and churn violently for five minutes until a creamy emulsion results, p. 202. Mix this with nine times its bulk of cold water by stirring, and sprinkle the thus diluted emulsion over the ground through a watering-pot. The application, which is not injurious to grass, should be made in such a quantity as to saturate the soil where the pupæ exist. By carefully examining the ground, grass, fallen leaves, etc., beneath the trees, the pupæ can be found, and the proper time for applying the emulsion as well as the extent of ground demanding treatment can be ascertained. In this climate the soft, yellow pupæ will be found on the ground from the middle of June to the middle of July or later, according to the season. The emulsion should be applied as soon as they are observed and the application repeated if needful to destroy them. To be thoroughly effective, this method of destroying the pupæ must be practiced each year.*

It is well to scrape away the rough outer bark of the trees for some distance above the ground, as many pupæ are likely to be concealed in the crevices. The scrapings should be burned or drenched with kerosene.

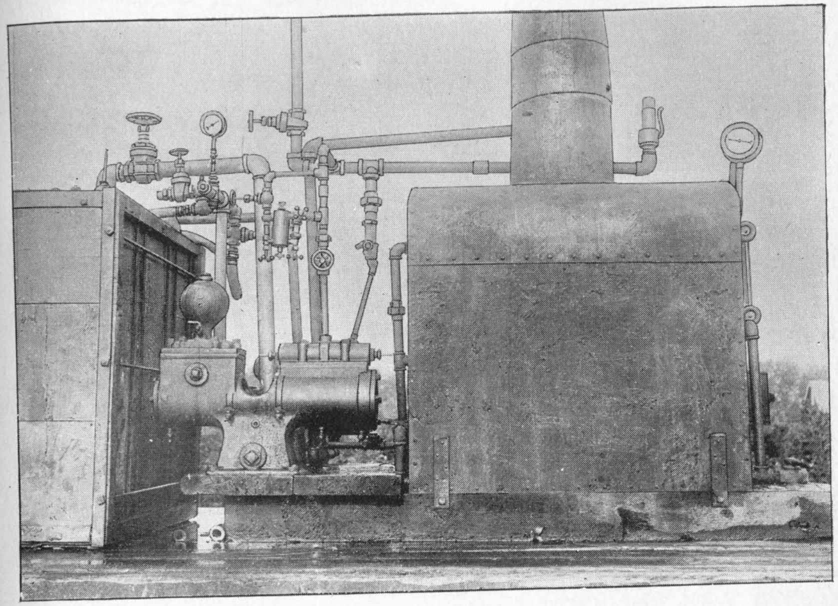
The worms which descend the trunk of the tree to pupate may be easily and almost completely intercepted by a band of hay an inch thick and 8 inches wide, secured to the scraped trunk at convenient height from the ground, by aid of a 6 in. girth of cheap cotton cloth, which is first tacked by one end to the bark and after packing the hay under it around the tree, is fastened at the other end by pins.

As often as the hay gets stocked with worms and pupæ it should be removed and burned, adding kerosene, if necessary, and a new hay band put in its place. If in the process of removal, pupæ have dropped to the ground they may be killed with kerosene emulsion.

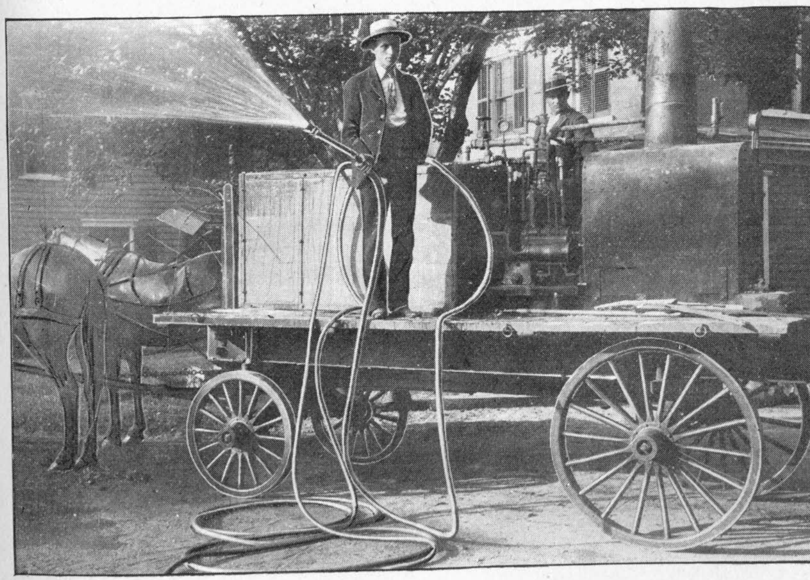
The following letter from Mr. Hoyt, addressed to the Director, in answer to a request for some particulars concerning his spraying outfit, will prove useful.

DEAR SIR:—In reply to yours would say, the boiler was made by Chas. W. Foster, in New Haven, and will generate steam sufficient to produce five or six h. p., at a pressure of 100 lbs. The cost was $200. The pumps were made by the Marsh Steam Pump Co., Battle Creek, Mich. We got two pumps, size BB, and intended to run them both for spraying. I had one arranged to feed the boiler and to spray also, but found this did not work satisfactorily, so bought

* While the touch of very little kerosene to the bodies of larvæ and young pupæ is fatal, the emulsion may fail to destroy hairy worms or older pupæ, because the hairs of the former or the chitinous coverings of the latter, shield the soft and vulnerable parts from actual contact with it.



Arrangement of Engine, Pumps and Tank, for Spraying Large Trees.



Engine throwing Spray under pressure of 150 pounds to square inch.

another, two sizes larger (size D), using the smaller pump for boiler feed only. The BB size is quoted at $50 less 50%. This is too large for a feed pump to a boiler of this capacity, and did we not have it, would have bought the smaller size, which is quoted at $30, less 50%.

Our 300 gallon tank was made by Geo. F. Johnson, New Canaan, Conn., and is partitioned off to hold 75 gals. of water to feed the boiler, and 225 gals. of mixture for spraying. This tank was bolted and ironed all through, and cost $40. Our hose, from the Mineralized Rubber Co., was ¾"; but we advise getting ½" hose, as the strain is not so great, nor is it so heavy to handle. We used two lines of hose each 100 feet long. The McGowen nozzle does very good work, and is quite economical with the solution. We also found the Daisy nozzle, made in New Haven, excellent for tree spraying.

Although our boiler uses coal or wood for fuel, we bought it partly for another purpose, and would advise for spraying simply, to use a boiler heated by oil, as much more convenient. For a boiler feed-pump would suggest the Marsh, size B, and for spraying, a duplex high service pump, or one that would give a pressure of at least 150 lbs., such as are made by Worthington, Dean, Knowles or Snow.

The total cost of an outfit would average from $275 to $375, according to size.

Yours very truly,

STEPHEN HOYT, New Canaan, Conn.

ON A FRAUD IN MILK.

By E. H. Jenkins.

Four samples of milk, stated to have been supplied by a certain dairy, were sent to this Station, in June, 1895. They were tested with the following results:

	A.	B.	C.	D.
Specific Gravity	1.032	1.030	1.033	1.029
Solids, per cent.	11.09	10.47	11.36	9.68
Fat, per cent.	2.20	2.25	2.70	2.20
Solids not Fat, per cent.	8.89	8.22	8.66	7.48

The solids are below the normal average by one to three per cent. and the fat is too little by more than one per cent. These facts indicate removal of fat and addition of water; but the specific gravity is that of normal milk. Such exceptional milk might be the product of a single cow, perhaps, but that any herd of healthy animals can give such milk is contrary to all recorded experience.

The sender was advised to witness the milking of the herd and to send for analysis another fully authenticated sample.

Two days later we received two samples with the message:—"These two bottles were filled at the barn by a man who saw the whole process. He says he is sure there is no water in it." Examination of these samples gave the following results:

	A.	B.
Specific Gravity	1.0325	1.033
Solids, per cent.	11.00	11.29
Fat, per cent.	2.60	2.65
Solids not Fat, per cent.	8.40	8.64

We wrote, asking for the name and address of the witness present at the milking that we might get from him further particulars and an affidavit. In reply we were informed that the witness had since mentioned that "when the cows were about half milked, the calves were turned in to feed and finish the milking"!

The quality of these samples of "milk" is quite what would be expected under such circumstances.

It is well known that the portions of milk first drawn from the udder are watery and poor in fat and other solids, while the last

portions are rich in solids and fat. The following figures by Bouchardat and Quevenne* illustrate the extent of this difference. The milk of three cows, I, II and III, which gave 20, 14 and 20 liters (quarts†) respectively, was examined with results as follows:

			Per cent.				
		Sp. Gr.	Water.	Fat.	Casein.	Sugar.	Total Solids.
I.	First Liter	1.034	89.51	1.40	3.87	5.18	10.45
	Last Liter	1.026	83.82	7.37	4.09	4.72	16.18
II.	First Half	1.034	88.47	1.79	4.12	5.62	11.53
	Last Half	1.031	86.61	4.36	3.96	5.07	11.39
III.	First Liter	1.031	89.81	0.85	3.64	5.70	10.19
	Last Liter	1.027	84.95	6.39	3.35	5.31	15.05

Harrington (Report of Mass. Board of Health for 1889, p. 189)* found in milk of a Jersey cow:

	Per cent.		
	Water.	Fat.	Total solids.
In "fore milk"	86.66	3.88	13.34
In "middle milk"	84.60	6.74	15.40
In "strippings"	82.87	8.12	17.13

Allowing calves to take a part of the milk is a common and, in itself, proper practice; but any one who sells the first of the milking as whole milk, grossly defrauds the purchaser. This case is interesting in calling attention to a possible dishonesty which is not always fully and certainly met by legislation.

* Quoted from Zusammensetzung und Verdaulichkeit der Futtermittel, von Dietrich und König, pp. 837, 838.

† 100 liters equal 105 quarts.

OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND FOR EIGHT YEARS.

BY E. H. JENKINS.

In the years 1888 and 1889 a parcel of land containing $1\frac{1}{5}$ acres which had been a meadow for some years previous, was dressed with commercial fertilizers and planted to corn. Fertilizers and crops were weighed and analyzed each year and the enrichment of the soil by the dressing or its exhaustion by the cropping were determined as accurately as possible.

In the spring of 1890 this land was divided into four strips, each containing three-tenths of an acre, and was dressed as shown in the following diagram.

South.		North.
	Plot A.—Cow Manure at the rate of 10 cords per acre.	
	Plot B.—Hog Manure at the rate of $13\frac{1}{2}$ cords per acre.	
	Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.	
	Plot D.—No manure or fertilizer of any kind.	

Corn was planted in drills four feet apart and the stalks stood singly at distances of ten inches in the drill. The crop from each plot was separately weighed and analyzed.

Since 1890 the several plots have annually received the same dressing and have been under the same conditions of planting, cultivation and harvesting as in that year.

Full particulars regarding the details of the experiment and the results obtained from year to year will be found in the Reports of this Station for 1890, pages 183 to 194; 1891, pages 139 to 149; 1892, pages 122 to 129; 1893, pages 286 to 300; 1894, pages 245 to 253.

In the following paragraphs are placed on record the results of the observations for the year 1895.

Discussion of the results is reserved.

Considering simply the gross amounts of nitrogen, phosphoric acid and potash which the dressing added to the soil of the several plots and those which the crops removed, it appears from Table VII, to be noticed later, that, after the crop of 1895 was harvested, there had been added to plot A *per acre, in excess of what had been taken off in crops,* 1148 pounds of nitrogen, 788 of phosphoric acid and 799 of potash, all from cow manure.

The corresponding enrichment of plot B consisted, *per acre,* of 1879 pounds of nitrogen, 3446 of phosphoric acid and 64 of potash, all from hog manure. The very large excess of phosphoric acid in the hog manure is due to the fact that the hogs were fed chiefly on hotel garbage, which contained a large quantity of bones of fowls.

The enrichment of plot C, *per acre,* amounted to 520 pounds of nitrogen, 972 of phosphoric acid and 177 of potash, all from fertilizer-chemicals.

Plot D received fertilizer-chemicals in 1888 and 1889, but in the following six years no dressing of any sort; so that after the harvest of 1895 it had acquired, *per acre,* 54 pounds more of phosphoric acid (from the applications of 1888 and 1889), than the crops had removed, but had lost 316 pounds of nitrogen and 66 pounds of potash.

Plot B also received more "organic matter" from the dressing than plot A, while plot C acquired only an insignificant amount in the dressing of fertilizer-chemicals, and plot D none at all.

Plot A receives annually about 3,207 pounds, plot B about 5,440 pounds and plot C not more than 200 pounds of organic matter.

GROSS YIELD OF THE PLOTS IN 1895.

Table I presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly too high and that of the cobs slightly too low. But the error is small.

TABLE I.—GROSS YIELD OF THE PLOTS, POUNDS PER ACRE.

	Plot A. Cow Manure.	Plot B. Hog Manure.	Plot C. Chemicals.	Plot D. No Fertilizer.
Kernels	4890.5	5255.7	3895.0	2026.5
Cobs	674.5	684.3	560.0	268.5
Stover	7215.0	7950.0	4125.0	2235.0
Total	12,780.0	13,890.0	8580.0	4530.0

Since these crops contain a large and variable quantity of water, a strict comparison of the yields can only be made on the dry matter.

This appears in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE. 1895.

	In Kernels.	In Cobs.	In Stover.	Total.
Plot A, cow manure	3155.4	602.3	3650.1	7407.8
Plot B, hog manure	3370.0	611.1	4032.2	8013.3
Plot C, fertilizer chemicals	2446.8	500.1	2428.4	5375.3
Plot D, no fertilizer	1186.5	239.8	1416.0	2842.3

During the last six years there has been no striking difference in the crops of these four plots, as far as the proportions of kernels, cobs and stover are concerned, unless perhaps the crop on D, which received neither fertilizers nor manure for six years, had a rather larger proportion of stover than the others. The figures are as follows:

TABLE II[a].—PERCENTAGE OF WATER-FREE KERNELS, COBS AND STOVER, IN THE CROPS. AVERAGE OF SIX YEARS.

	Plot A.	Plot B.	Plot C.	Plot D.
Kernels	44.2	44.3	45.4	42.5
Cobs	7.8	8.0	9.0	7.7
Stover	48.0	47.7	45.6	49.8
	100.00	100.00	100.00	100.00

Excess of nitrogen has not made the crop "run to leaves" nor has deficiency of plant food strikingly affected the relative proportion of ears and stalks.

The relative yields of dry matter from these plots for the last six years are given in Table III, the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D FOR SIX YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
1894	100	95.6	96.9	66.9
1895	100	108.2	72.6	38.4
Average	100	101.8	85.4	56.1

It thus appears that during six years the two plots A and B, which were dressed with heavy applications of manure, have yielded on the average the same amount of water-free crop.

Plot C, dressed with fertilizer chemicals, supplying considerably more nitrogen, phosphoric acid and potash yearly than the crop removed, yielded on the average more than eight-tenths as much, and plot D, without fertilizers, yielded between five and six-tenths as much as plots A and B.

The relative yield on plot D fell steadily till 1894, when it rose very considerably, to drop again in 1895.

This would indicate that plot D suffered less from the prolonged drought of the summer of 1894 than the plots which had been dressed with manure for a term of years and which contained much more humus.

During five years there was a pretty regular falling off from year to year, in the yield of all four plots, as is shown in Table III[a], in which the yield of dry matter for each plot in 1890 is marked as 100; but in 1895 all the plots yielded more than in either of the two preceding years. In 1893 and 1894 crops, in this region generally, suffered more from drought than in 1892 or 1895.

TABLE III[a].—RELATIVE YIELD OF DRY MATTER IN THE SIX YEARS, 1890 TO 1895.

	Plot A.	Plot B.	Plot C.	Plot D.
1890	100	100	100	100
1891	96	81	83	81
1892	79	87	88	53
1893	58	53	48	34
1894	44	41	48	41
1895	82	85	67	43

The diminished yield of plot D is no doubt in part due to lack of plant food. In the other cases this cause cannot have been operative, except in reference to water supply.

YIELD OF EACH FOOD INGREDIENT.

In Table IV are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1895.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses, is used for the calculation.

TABLE IV.—YIELD OF FOOD INGREDIENTS IN POUNDS PER ACRE. 1895.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1735.1	72.2	3564.9	5372.2	1885.7	73.2	3917.8	5876.7	1448.2	59.9	1696.6	3204.7	840.0	28.7	819.0	1687.7
Ash	41.1	9.4	232.3	282.8	52.0	9.6	288.6	350.2	31.5	7.8	127.9	167.2	15.4	3.8	63.0	82.2
Albuminoids	370.2	16.2	257.6	644.0	411.0	16.4	267.1	694.5	282.3	13.4	144.4	440.1	109.4	6.4	65.9	181.7
Fiber	56.2	203 0	1222.2	1481.4	53.6	206.0	1400.8	1660.4	46.0	168.7	867.1	1081.8	22.5	80.8	485.0	588.3
Nitrogen-free extract	2525.5	370 3	1887.4	4783.2	2674.2	375.7	2019.3	5069.2	1963.1	307.4	1256.0	3526.5	982.5	147.4	782.0	1911.9
Fat	162.4	3.4	50.6	216.4	179.2	3.4	56.4	239.0	123.9	2.8	33.0	159.7	56.7	1.4	20.1	78.2
	4890.5	674.5	7215.0	12,780.0	5255.7	684.3	7950.0	13,890.0	3895.0	560.0	4125.0	8580.0	2026.5	268.5	2235.0	4530.0

TABLE V.—COMPOSITION, PER CENT., OF FIELD-CURED MAIZE, KERNELS AND STOVER, FROM PLOTS A, B, C, D. 1895.

	Analyses of Field-cured Maize.						Calculated Water-free.				
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.											
Plot A	35.48	.84	7.57	1.15	51.64	3.32	1.30	11.73	1.78	80.04	5.15
Plot B	35.88	.99	7.82	1.02	50.88	3.41	1.54	12.19	1.59	79.36	5.32
Plot C	37.18	.81	7.25	1.18	50.40	3.18	1.29	11.55	1.88	80.22	5.06
Plot D	41.45	.76	5.40	1.11	48.48	2.80	1.30	9.23	1.90	82.79	4.78
STOVER.											
Plot A	49.41	3.22	3.57	16.94	26.16	.70	6.38	7.05	33.49	51.69	1.39
Plot B	49.28	3.63	3.36	17.62	25.40	.71	7.16	6.63	34.75	50.06	1.40
Plot C	41.13	3.10	3.50	21.02	30.45	.80	5.24	5.95	35.71	51.75	1.35
Plot D	36.65	2.83	2.95	21.68	34.99	.90	4.47	4.66	34.23	55.22	1.42

The yield of each food ingredient from the four plots shows, in general, differences like those already noted in respect to the yield of total dry matter.

Table V shows the composition of the crops on the four plots, A, B, C and D, for the year 1895.

Table VI exhibits the striking differences in the percentage composition of the crop on the four plots calculated from the average of six years.

The crops, both of kernels and stalks, on A and B, which have been very heavily dressed each year, the one with cow manure, the other with hog manure, are practically identical as regards chemical composition.

The kernels of the crop on C, which receives each year a liberal dressing of fertilizer chemicals, 1500 pounds to the acre, contains in the kernels somewhat less ash or mineral matter and fat, and half a per cent. less of proteids, etc.,* than the crops on A and B, with correspondingly more nitrogen-free extract. Similar differences are found in the composition of the stalks.

The kernels in the crop on D, to which no fertilizer or manure has been applied since 1889, have 2.3 per cent. less proteids, etc., than that of plots A and B, somewhat less ash and fat, but more fiber and nitrogen-free extract.

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892, 1893, 1894 AND 1895.

	Ash.	Proteids, etc.*	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.					
Plot A	1.35	11.50	1.74	80.16	5.25
Plot B	1.48	11.61	1.64	80.00	5.27
Plot C	1.28	11.08	1.81	80.74	5.09
Plot D	1.27	9.38	1.88	82.62	4.85
STOVER.					
Plot A	6.59	6.73	33.15	52.09	1.44
Plot B	6.81	6.63	33.67	51.43	1.46
Plot C	5.87	6.30	34.21	52.24	1.39
Plot D	5.21	5.34	33.50	54.51	1.44

To complete the data regarding this experiment two other tables are presented.

* i. e. Nitrogen reckoned as proteids (including albumin, globulin, zein) and also amides and other compounds of nitrogen.

Table VII gives the quantities of nitrogen, phosphoric acid and potash which were added in the manure or fertilizers and remained in the crops of 1895.

It also gives the amounts of those fertilizing materials which have been added to the soil capital (+) or withdrawn (—) in the eight years during which accurate account has been kept.

Table VIII gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops.

TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY EIGHT YEARS' MANURING AND CROPPING WITH INDIAN CORN. POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After seven years' cropping	+934.6	+680.7	+711.7	+1571.0	+2898.0	+101.3	+418.6	+831.4	+158.7	−287.5	+65.4	−54.3
Applied in 1895	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1895	103.0	29.0	117.1	111.1	38.5	109.8	70.4	21.8	50.3	29.1	11.6	11.7
Excess (+) or Deficiency (−) after eight years' cropping	+1117.9	+788.1	+799.1	+1879.8	+3446.0	+63.9	+520.2	+971.6	+177.4	−316.6	+53.8	−66.0

TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR EIGHT YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter: Ash.	Proteids, etc.*	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2.8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3
Cow Manure	1894A	" 12 " "	4021	42	4.3	9.0	18.8	64.5	3.4
Hog Manure	1894B	" 12 " "	3845	40	4.2	9.2	18.1	65.2	3.3
Fertilizer Chemicals	1894C	" 12 " "	3898	42	4.3	8.7	18.2	65.5	3.3
No Manure or Fertilizer	1894D	" 12 " "	2691	27	3.6	7.2	20.0	66.2	3.0
Cow Manure	1895A	" 12 " "	7408	75	3.8	8.7	20.0	64.6	2.9
Hog Manure	1895B	" 12 " "	8013	80	4.4	8.7	20.7	63.2	3.0
Fertilizer Chemicals	1895C	" 12 " "	5375	58	3.1	8.2	20.1	65.6	3.0
No Manure or Fertilizer	1895D	" 12 " "	2842	28	2.9	6.4	20.7	67.3	2.7

POULTRY FOODS.

The following brands of Poultry Food were sent to this Station for examination by J. S. Adam, of Canaan:

4516. Bradley's Superior Meat Meal, stated to be made of beef, blood and bones. Made by the Bradley Fertilizer Co., Boston, Mass.

4517. Bowker's Animal Meat, stated to be made from fresh beef and fresh bones, which are dried and cooked by steam and then ground. Made by the Bowker Fertilizer Co., Boston, Mass.

4518. Breck's Poultry and Swine Meal. "In addition to the pure meat and bone we have combined in this preparation some of the most potent agents known for the production of eggs, not by stimulating, but rather by preventing disease and promoting general good health," etc. Made by Joseph Breck & Sons, 47 N. Market St., Boston, Mass.

4519. C. A. Bartlett's O. K. Feed. Stated to be made of material daily collected from the city butcher markets and cooked while perfectly fresh. It is then pressed, dried by steam heat and ground fine. Made by C. A. Bartlett, Worcester, Mass.

4520. Smith & Romaine's Boiled Beef and Bone. Made by Smith & Romaine, 109 Murray St., N. Y. City.

The samples were purchased from the manufacturer with the exception of **4517**, which was bought of Ives & Pierce, Canaan, Conn.

ANALYSES.

	Bradley's. 4516	Bowker's. 4517	Breck's. 4518	Bartlett's 4519	Smith & Romaine's 4520
Moisture	5.03	4.81	12.86	4.69	5.13
Fat	11.37	11.50	10.95	11.50	13.75
Protein *	36.62	41.75	29.81	40.68	38.00
Other Volatile and Organic Matters	3.72	4.49	4.90	5.49	5.15
Phosphate of Lime†	36.89	30.82	25.50	31.23	33.38
Sand and Soil	1.76	2.32	1.25	.57	1.03
Other Mineral Matters	4.61	4.31	14.73	5.84	3.56
	100.00	100.00	100.00	100.00	100.00
*Containing Nitrogen	5.86	6.68	4.77	6.51	6.08
†Containing phosphoric acid	16.86	14.11	11.67	14.29	15.27

The "protein" is calculated by multiplying the nitrogen found, by the factor, 6.25.

All the preparations appear to consist chiefly of meat and bone having about the composition of "bone tankage," which is used as a fertilizer.

They are quite alike in composition excepting that Breck's Poultry and Swine Meal contains less protein and phosphate of lime than either of the others, and correspondingly more moisture and mineral matters, which consist in part of carbonate of lime.

ANALYSES OF FEEDING STUFFS.

Maize Kernel.

5443. Bloody Butcher Corn, a 16-rowed, red dent variety, grown in Guilford, from seed brought from Iowa. "It grows two feet higher here than at the west."

5442. Hearst Corn, a 14-rowed yellow dent, grown in Guilford, from Iowa seed.

5441. Early Sciota Corn, a 14-rowed dent, grown in Guilford.

The three samples just named were brought to the Station by Richard Wilcox, of Guilford. Analyses are given on page 231.

The Bloody Butcher variety contains decidedly more protein and correspondingly less nitrogen-free extract than the other two.

The sample of early Sciota corn contains less protein and more starch than corn of average composition. Fertilizers, climate and rate of planting all affect the composition of the maize kernel and probably have more effect than any differences of variety.

By fertilization, variations in weather conditions in a given locality during a course of years and rate of planting, greater differences may be caused in the composition of a single variety of maize kernel, than will be found in the composition of different varieties of dents or flints raised for a course of years under like conditions.

Gluten Meal and Gluten Feed.

These are bye-products of the manufacture of corn-starch and glucose:

4487. King Gluten, granulated. Sent by R. E. Holmes, West Winsted. Cost $22.00 per ton.

4529. King Gluten, ground fine. Sent by Horace Burr, Winchester, to ascertain if it was pure.

5603. Gluten Meal. Made by Chicago Sugar Refining Co. Cost $14.75 in car lots.

5617. Atlas Gluten Feed. Made by Chicago Sugar Refining Co. Cost $15.50 in car lots.

5604. Gluten Meal. Made by National Starch Works, of New York City. Cost $15.50 per ton in car lots.

5605. Gluten Meal. Sold by Stein, Hirsch & Co. Hammond, Ill. Cost $14.90 per ton in car lots.

Nos. 5603, 5617, 5604 and 5605 were sampled and sent by T. A. Stanley, New Britain.

4488. Buffalo Gluten Feed. Sent by R. E. Holmes, West Winsted. Cost $19.00.

4486. Gluten Feed. Sold by Horace Burr, Winchester. Sent by R. E. Holmes, West Winsted. Cost $18.00.

The analyses given on page 231, show that the protein of "Gluten Feed" now ranges from 37 per cent. down to 17.8 per cent.

5603. Chicago Gluten Meal is the clear "gluten" from the settling tanks, containing little oil, but over 40 per cent. protein, only three per cent. less of this ingredient than cotton seed. The two feeds have about the same place in a cattle ration.

5604 and **4487** appear to consist of "gluten," mixed with maize "chits" or germs* which are rich in oil, thus lowering the per cent. of protein about two per cent. but increasing the fat to nearly 20 per cent. In general, feeds containing so large a proportion of fat are not easy to combine with others in a balanced ration.

5647. Contains besides gluten, the corn hulls, as shown by the larger per cent. of fiber, and probably also the chits.

"Buffalo Gluten Feed," **4488,** made by the American Glucose Co., of Buffalo, consists of all the parts of the kernel except the starch, which has been removed for conversion into glucose. It consists therefore, of the hulls, gluten, chits and oil, and has from year to year a pretty uniform composition.

Wheat Bran.

4505 and **4504.** Sent by W. H. Olcott, South Manchester, to learn which was the more concentrated feed. **4505** appeared to him to contain much less "middlings" (starchy matter?) than 4504.

* In some manufactories a good share of the oil is extracted from the chits before the latter are mixed with the gluten.

The analyses show that **4505** contains $3\frac{1}{2}$ per cent. more protein, $1\frac{1}{2}$ per cent. more each of fat and of mineral matter, and $3\frac{3}{4}$ per cent. more of fiber than the other sample, but some 9 per cent. less of non-nitrogenous extract (starch).

Rice Flour.

4496 and **5510** are samples of refuse rice flour sold at the South for cattle food. Sampled and sent by Joseph D. Weed, Noroton, one sample in January, the other in November. The samples have the composition of a mixture of rice flour or "polish" with rice hulls. They contain about the same per cent. of protein as maize kernel with considerably more fiber and fat.

Miscellaneous Feeds.

5268. Barley Feed. Sent by W. H. Olcott, South Manchester. This contains over two per cent. more of protein and 7 per cent. more of fiber than maize kernel, the same amount of fat, but 10 per cent. less of nitrogen-free extract.

4566. Rye Bran. Sent by E. C. Birge, Southport. The cows fed on this appeared to dislike it from the first and in two or three days after being put on the feed the herd, with one or two exceptions, were badly scoured and the milk-yield sunk one-third.

The determination of protein showed the average amount for rye bran, and we were unable to find anything which could explain the effects attributed to it.

4479. "Cattle Feed." A mixed feed, sold by C. A. Parsons, Boston, Mass., for $15.00 per ton in Boston.

The printed circular accompanying it claims for the feed that it is richer than shorts, "and contains the most nourishment for the money of anything you can buy, and no mistake."

It cost, delivered at East Bolton, $17.40 per ton, and was sampled and sent by A. H. Pomeroy, Coventry.

Assuming that this mixture contains no refuse material of any kind but is made of sound grain or mill products, it is not nearly as concentrated or "rich" a feed as wheat bran, as a comparison of the analyses in the table shows, and it is not worth as much by at least $2.00 per ton.

5508 and **4530.** Hall's Dairy Ration. The first-named sample was sent by W. H. Olcott, South Manchester. The second by Chas. T. Hotchkiss, West Cheshire. Cost in Cheshire, $22.00 per ton, delivered.

This claims to be made of "mill-feeds, gluten and cotton seed meal from the best of stocks and according to the analyses and tables of eminent men in the science of feeding cattle with the desired end in view of making a perfectly balanced ration."

The mixture contains about the same quantity of protein or "flesh formers" as wheat bran of average quality, twice as much fat and 7½ per cent. less of nitrogen-free extract.

The quantity of "ash" in Hall's Dairy Ration is large and more than one-quarter of it—2.37 per cent.—consists of sand and silica.

The intelligent dairyman can have but little use for ready-mixed rations of any sort. The grain and mill feed which he uses will be adjusted by him both in kind and in amount to balance the course fodder which he has on hand, and with greater economy and skill than by others whose business is selling feed and not dairying.

The dairymen's opportunities for informing himself regarding the compounding of rations are ample. His chances of detecting adulterations, or the mixtures of mill wastes of inferior value, are much better when he buys cotton seed, gluten and bran separately, each of which has a tolerably definite and constant composition, than when he buys a mixture of a number of feeds, with no such definite understanding as to its composition.

Cost and Analyses of Feeding Stuffs.

No.	Cost per Ton.	Kind of Feed.	Analyses. Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
5443	------	Maize Kernel, Bloody Butcher	11.00	1.43	10.50	1.27	71.38	4.42
5442	------	" " Hearst	10.60	1.34	8.87	1.15	73.79	4.25
5441	------	" " Early Sciota	11.95	1.05	8.12	1.50	72.82	4.56
		Gluten Meals and Gluten Feeds.						
4487	$22.00	King Gluten	7.25	.70	35.19	1.33	37.10	18.43
4529	------	" "	------	------	36.25	------	------	------
5603	14.75*	Gluten Meal	8.02	1.05	40.50	2.08	41.28	7.07
5617	15.50*	Atlas Gluten Feed	5.93	1.85	37.37	11.69	28.08	15.08
5604	15.50*	Gluten Meal	6.75	.78	38.60	1.64	32.35	19.88
5605	14.90*	" "	8.12	.85	30.81	1.68	48.09	10.45
4488	------	Buffalo Gluten Feed	7.44	.79	23.25	8.11	46.99	13.42
4186	18.00	Gluten Feed	6.09	.92	17.87	9.11	54.15	11.86
		Wheat Bran.						
4505	------		8.55	5.35	18.94	8.85	53.33	4.98
4504	------		10.07	3.65	15.37	5.13	62.28	3.50
		Rice Flour.						
4496	------		7.66	10.45	9.94	17.01	47.10	7.84
5510	------		7.69	9.28	10.38	14.76	48.13	9.76
		Miscellaneous Feeds.						
5268	------	Barley Feed	9.50	3.53	12.62	8.56	61.44	4.35
4566	------	Rye Bran	------	------	14.81	------	------	------
4479	17.40	"Cattle Feed"	9.24	3.78	12.12	7.80	63.44	3.62
5508	22.00	"Hall's Dairy Ration."	9.35	8.50	18.06	7.90	45.76	10.43
4530	23.00	" " "	------	------	20.75	------	------	------

* Car lots.

THE CHEMICAL NATURE OF DIASTASE.

Second Paper.

By Thomas B. Osborne and George F. Campbell.

In a former paper, by one of us, printed in the Eighteenth Annual Report of this Station, pp. 192–207, (also Jour. Am. Chem. Society, XVII, pp. 587–603,) the results of some attempts to isolate diastase have been detailed. This work has been continued, but as yet no preparations of diastase have been realized more active than those there described. The results given in the former paper, however, have been confirmed, and details of the process for obtaining highly active diastase have been determined more exactly.

Here follows a concise account of this later work so far as it is worth placing on record.

Fifteen kilograms of fine ground malt were treated with 30 liters of 5 per cent. sodium chloride brine, and after standing some time, with frequent stirring, the extract was pressed out and filtered, yielding 16 liters of clear filtrate. The meal residue was again treated with 15 liters of 5 per cent. brine and 15 liters more of clear extract obtained. The united solutions were then saturated with ammonium sulphate and the precipitate filtered out, dissolved in brine and filtered perfectly clear. This liquid was saturated with ammonium sulphate, the precipitate was suspended in two liters of water and dialyzed during two days. The ammonium sulphate which adhered to the precipitate, at first prevented solution of the substance, but after two days enough sulphate was removed by dialysis to allow the proteid to dissolve. The solution was filtered clear and dialyzed seven days longer. The globulin thus precipitated was filtered out and the solution, which measured 5800 c. c., was dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours. The precipitate, VI,* was filtered out and the solution, which then measured 3500 c. c., was again dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours, yielding precipitate VII. The filtrate from VII measured 2700 c. c. and was dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours, giving precipitate VIII, the filtrate from

* The precipitates and preparations described in this paper are numbered consecutively with those specified in the former article on Diastase.

which measured 2000 c. c. and was dialyzed into 2500 c. c. of alcohol of 0.82 sp. gr. for 18 hours. This gave precipitate IX, the filtrate from which measuring 1800 c. c. was dialyzed into twice its volume of alcohol of 0.81 sp. gr., giving precipitate X. The solution filtered from X was then treated with absolute alcohol until nothing further separated, giving precipitate XI.

These six fractions were all, separately, treated with water; X and XI dissolved completely, the others partially. The aqueous solutions, filtered clear, containing the proteoses and albumin of the six fractions, were then separately dialyzed into water, to remove all freely diffusible substances and, as no globulin was precipitated from any of them, the dialyzers were transferred to alcohol, in order to concentrate their contents, and absolute alcohol was finally added until the proteids were completely thrown down.

In this way six preparations were obtained, which, when dehydrated with absolute alcohol and dried over sulphuric acid, weighed respectively, **18,** 1.37 gm.; **19,** 1.47 gm.; **20,** 4.05 gm.; **21,** 4.82 gm.; **22,** 2.17 gm.; and **23,** 0.63 gm.

The diastatic power of these preparations was determined in the manner described in the former paper (Report of this Station for 1894, p. 194) and found to be as follows: **18**=0; **19**=60; **20**=300; **21**=300; **22,** trace; and **23**=0.

It will be noticed that nearly all the enzyme was thrown down in fractions VIII and IX, which gave preparations **20** and **21.** These were but half as active as preparation **15,** described in the former paper.

In order to purify this diastase, **20** and **21** were united, dissolved in 100 c. c. of water, the insoluble matter filtered out and washed with 35 c. c. of water (these first washings being added to the filtrate), then with more water, and finally with absolute alcohol. Dried over sulphuric acid, this preparation, **24,** weighed 0.53 gm. The filtrate and first washings from **24** were treated with 200 c. c. of alcohol of 0.885 sp. gr., making a solution containing 36.5 per cent. of alcohol. A small precipitate resulted, **25,** which when filtered out and dried over sulphuric acid, weighed 0.25 gm. and had a diastatic value of 15. The filtrate from this precipitate was mixed with 160 c. c. of alcohol of 0.84 sp. gr., raising the per cent. of alcohol to 50.7, and the precipitate, **26,** thus produced when dried as usual weighed 2.35

gm. and had a diastatic value of 86. To the filtrate from **26** 100 c. c. of alcohol of 0.84 sp. gr. and 100 c. c. of absolute alcohol were added, raising the alcohol-content to 61.6 per cent. The precipitate, **27,** which resulted, was filtered out, weighed 2.87 gm. and had a diastatic value of 600, just twice that of **20** and **21,** from which it had been derived, and just equal to that of the most active preparation, **15,** of the former paper. To the filtrate 200 c. c. of absolute alcohol were added, giving a precipitate, **28,** which weighed 1.00 gm. and had a diastatic value of 100.

The filtrate from **28** mixed with 200 c. c. more of absolute alcohol, gave a precipitate, **29,** which weighed 0.40 gm. and showed only a trace of diastatic power. The filtrate from **29,** mixed with 400 c. c. of absolute alcohol, yielded 0.17 gm. of substance, **30,** that was totally inactive, and the filtrate from this when evaporated to dryness left a residue weighing 0.65 gm.

The results of this experiment showed that little diastase was precipitated by bringing the alcohol-content of the malt-extract to 50 per cent. by weight, while nearly all the diastase was thrown down, under the conditions described, when the proportion of alcohol in the malt-extract was made 60 per cent.

In order to still further concentrate or purify the diastase contained in precipitate **27,** this was treated with 100 c. c. of water and, without filtering from the substance which had been coagulated by precipitation and drying, 100 grams of absolute alcohol were added. The precipitate so produced was filtered out and extracted with water. The insoluble matter, after washing and drying, weighed 0.50 gm. The aqueous filtrate, from this insoluble matter, was then completely precipitated with absolute alcohol and 0.45 gm. of substance, **31,** obtained having a diastatic value of 200. The solution, filtered from the first precipitate, produced by adding an equal weight of alcohol to the solution of **27,** as just described, was mixed with enough absolute alcohol to raise this ingredient to 50 per cent. and the substance thereby thrown down, **32,** weighed when dry 1 gm. and had a diastatic value of 400. The filtrate from **32** was completely precipitated with absolute alcohol and yielded 0.2 gm. of inactive proteid. It is thus seen that the diastase instead of increasing in power under this treatment declined to two-thirds of its original activity.

Having thus learned more exactly the conditions under which diastase may be so far separated from the other malt proteids, an attempt was made to prepare a large quantity of material with which to carry the purification farther. Through the kindness of Mr. C. Von Eggloffstein, of the Maltine Manufacturing Company, at Yonkers, N. Y., a considerable supply of malt-extract, rich in diastase, was placed at our disposal. For this favor and much information respecting malt-extracts, we wish to express our especial thanks.

One gallon (3.785 c.c.) of this malt-extract, which had been concentrated at a low temperature *in vacuo* until it contained about 50 per cent. of solid matter, was dialyzed into water for 48 hours, whereby a large part of the sugar was removed and a thin liquid remained. This was saturated with ammonium sulphate and the precipitated proteids were filtered out, suspended in water and dialyzed for five days. To the liquid contents of the dialyzer, filtered clear from insoluble matters, alcohol was added to make 50 per cent. of the resulting mixture. This threw down a precipitate which was filtered out, dehydrated with absolute alcohol and dried over sulphuric acid.

This white, easily powdered precipitate, XII, weighed 95 grams. One-half of it was insoluble in water and salt solution. By extraction with water and precipitation with alcohol, added first to 50 per cent. and afterwards to 60 per cent., two preparations, **33** and **34**, resulted, weighing respectively 4.85 gm., and 7.21 gm., that had little diastatic power.

The solution from which the first precipitate, XII, had been separated was treated with enough alcohol to make 75 per cent., and the resulting precipitate, XIII, filtered out and found to weigh, when dried over sulphuric acid, 70 grams. This precipitate included the chief part of the diastase of this extract. It dried to a light, dusty powder of pale straw-yellow color, almost entirely soluble in water and had a diastatic value of 200.

XIII was dissolved in water and fractionally precipitated, but, for some unknown reason, the resulting fractions were almost entirely inactive.

In another attempt to make a large quantity of diastase, 3 gallons (11.4 liters) of the highly concentrated malt-extract were mixed with half their weight of water and enough alcohol to make a mixture containing 46 per cent. of alcohol. A very large precipitate, XIV, resulted, which was filtered out and as it consisted almost entirely of insoluble matter (probably globulin), it was not further examined.

The filtrate from precipitate XIV was treated with alcohol, raising the strength to 60 per cent; the precipitate so produced was filtered out and, as it contained a large amount of sugar, it was dissolved in about five liters of water, the resulting solution was saturated with ammonium sulphate, the precipitate filtered out, suspended in one liter of water and dialyzed for five days. The precipitate in the dialyzer was filtered out and the clear solution was treated with alcohol sufficient to make 50 per cent. of the resulting mixture, but as only a little substance separated, the amount of alcohol was increased to 60 per cent. This threw down a considerable precipitate, XV, which, when dehydrated with absolute alcohol and dried over sulphuric acid, weighed 57 grams and had a diastatic value of 300.

Numerous attempts were made to obtain from portions of precipitate XV, by fractional precipitation with alcohol, diastase of greater power than 300, but without success.

Several hundred trials were made with the object to determine precisely the influence of certain conditions, such as the age of the diastase solution, and of certain substances, added in systematically varied quantities, especially sodium chloride, disodium orthophosphate, tripotassium orthophosphate, orthophosphoric acid, acetic acid and citric acid (using the amount of copper reduction as the measure of effect), but, while the results were decisive in some cases—e. g. citric acid, in the minutest quantities, always depressed or destroyed diastatic action—in the majority of instances, no such uniform results were attainable as would lead to safe conclusions in regard to the circumstances that insure a high degree of diastatic activity.

From our experience in testing these preparations it would seem that the purer the diastase is made, the more sensitive it is to external conditions, and that the method of testing the purity of the ferment by its maltose-producing power thus becomes of uncertain value and perhaps fails to furnish a safe criterion of the purity of the enzyme. That the proteid is not the only factor involved in the amylolytic action of diastase is indicated by the great influence on its activity that often accompanies the addition of various substances to its solution. In view of these facts it is not at all improbable that in thus attempting to purify diastase we remove some substance that favors, or is essential to its action, and that we may have in hand what may be properly termed the enzyme itself, which is feeble in its operation through the absence or deficiency of some accessory substance. Thus the addition of sodium chloride in many cases increases the diastatic action several fold. That the albumin is an essential factor in diastatic action could not be positively proved, but the results of further experience have tended to strengthen this belief. Of all the preparations that we have made, none from which albumin was absent showed amylolytic power, and those containing the most albumin were the most active. It was always possible to roughly judge of the diastatic power of a preparation, by heating a portion of its solution to 65° C. and observing the amount of coagulum formed.

The fact that active diastase was obtained only from solutions whose alcohol content lies between 50 and 60 per cent., may, we think, be regarded as probable evidence that the enzyme is not something carried down mechanically with the proteid.

JUNE, 1895.

THE PROTEIDS OF MALT.

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

As is well known, water extracts a considerable quantity of proteid matter from ground malt. This we find to consist of at least five distinct bodies, namely, a globulin, an albumin and three proteoses. Whether true peptones are present was not determined, for the malt extracts are so strongly colored that the biuret test entirely fails. Besides the proteids soluble in water another exists that may be taken up by dilute alcohol (of 0.9 sp. gr.) After extracting malt with saline solutions and alcohol, a further quantity of proteid matter remains, the nature of which we have not been able to determine.

Malt-globulin.—Ten kilograms of air dried malt, freshly prepared by ourselves in the laboratory, and ground to a fine meal were treated with twenty liters of water and, after standing three hours, were squeezed out in a press and the solution filtered clear. The residual meal was treated with eight liters more of water and the second solution was pressed out and filtered. The united solutions were saturated with ammonium sulphate, the precipitate was suspended in about four liters of water and dialyzed for three days, when it dissolved, with the exception of a slight residue. In order to reduce its volume and separate impurities, the filtered solution was again saturated with ammonium sulphate, the precipitated substance was suspended in fifteen hundred cubic centimeters of water and dialyzed until the greater part of the ammonium sulphate had been removed, when the solution was filtered clear. The matters now remaining undissolved were treated with ten per cent. salt solution to extract any soluble globulin which might have been deposited during dialysis, and the substance not taken up in salt-solution was filtered out. This last unquestionably consisted almost entirely of insoluble globulin, but as it separated from an unfiltered solution and was small in quantity it was not further examined. The salt-solution was then dialyzed free from chlorides, and the globulin thus precipitated was filtered out, washed with alcohol and dried over sulphuric acid. But 0.5 gm. of substance was obtained which, dried at 110°, gave 0.93 per cent. of ash and, reckoned ash-free, 15.70 per cent. of nitrogen. This was marked preparation **1**.

The solution of the ammonium sulphate precipitate, containing the bulk of the malt-proteid, from which the insoluble matter yielding preparation **1** had been filtered, was dialyzed, first, into water, until the salts were mostly removed, and then into an equal volume of alcohol of 0.84 sp. gr. for forty-eight hours. The proteid thus precipitated was filtered out and the filtrate was dialyzed into alcohol. After filtering out the second precipitate, the filtrate was dialyzed into stronger alcohol, and this process was repeated, thus depositing the proteids in four fractions, a fifth being obtained by adding absolute alcohol to the remaining solution as long as anything was thrown down. Each of these five fractions was then treated with water to dissolve albumins and proteoses and the resulting solutions were dialyzed in water for several days. The first four fractions were but partly soluble in water, and accordingly, the insoluble parts, after washing with water, were treated with ten per cent. sodium chloride solution, and the portion which in each case remained undissolved was filtered out, washed thoroughly with water and alcohol and dried at 110° for analysis. The four saline extracts were then dialyzed, but those from the third and fourth fractions were found to contain only trifling quantities of proteids. That from the second fraction gave no precipitate of globulin on dialysis, but by adding alcohol to the solution 0.49 gram of preparation **2** was obtained, having 4.33 per cent. of ash and, calculated ash-free, 15.18 per cent. of nitrogen. The sodium chloride extract from the first fraction gave a precipitate on dialysis which, after washing with water and with alcohol, weighed 1.2 grams, **3**.

The filtrate from **3**, by precipitation with alcohol, yielded **4**, weighing 1.54 grams.

After extracting the four fractional precipitates with water and with salt solution, the undissolved residue, in each case, was washed thoroughly with salt solution, with water and with alcohol and dried over sulphuric acid, giving, in the order named, preparation **5** weighing 8.0 gm., **6** weighing 5.0 gm., **7** weighing 2.87 gm. and **8** weighing 0.9 gm. These preparations, dried at 110°, had the following composition:

MALT-GLOBULIN, BYNEDESTIN.

	3	4		5	6	7	8
Carbon	53.11	53.58		53.55	53.51	53.25	53.42
Hydrogen	6.45	6.70		7.01	6.75	----	7.15
Nitrogen	15.78	15.86	15.87	15.72	15.87	16.12	16.65
Sulphur } Oxygen }	24.66	23.86		1.23	1.12	1.38	} 22.78
Oxygen				22.49	22.75		
	100.00	100.00		100.00			100.00
Ash	0.75	1.43		1.09	0.66	0.55	0.24

Preparations **5** and **6** have the same composition as the globulin **3** and **4** obtained from the sodium chloride extracts of the fractional precipitates, while **8** contains nearly one per cent. more nitrogen, and as will be seen later, has nearly the same composition as malt albumin and is unquestionably for the most part albumin coagulated by the action of the alcohol. **7** appears to be a mixture of coagulated globulin and albumin. In a similar manner three other preparations of the coagulated globulin **9, 10** and **11** were obtained from another lot of malt.

MALT-GLOBULIN, BYNEDESTIN.

	9	10	11
Carbon	52.90	52.99	53.15
Hydrogen	6.74	6.64	6.52
Nitrogen	15.33	15.31	15.81
Sulphur	1.17	} 25.06	1.47
Oxygen	23.86	}	23.05
	100.00	100.00	100.00
Ash	0.44	0.32	0.23

Preparations **9** and **10** are lower in carbon and nitrogen than those just described, probably because, having been prepared in a smaller quantity, they carried down a larger proportion of impurities when thrown out of solution by alcohol.

From a malt extract that had been concentrated *in vacuo* at a low temperature, for which we are indebted to Mr. C. von Egloffstein, alcohol, added to make forty-six per cent. by weight of the mixture, threw down a large quantity of coagulated globulin that was not further examined, the filtrate from which, on increasing the content of alcohol to sixty per cent., gave a second precipitate that was largely soluble in water. It was accordingly mixed with water and with ammonium sulphate in excess, and the substance thus thrown down was suspended in a liter of water and dialyzed for five days. The insoluble residue in the dialyzer, when washed with water and alcohol, gave preparation **12**, weighing 26.78 grams. From this same extract by fractional precipitation with alcohol another small preparation of coagulated globulin, **13**, was obtained.

SUMMARY OF ANALYSES OF MALT GLOBULIN, BYNEDESTIN.

	1	2	3	4	5	6	9	10	11	12	13
Carbon			53.11	53.58	53.55	53.51	52.90	52.99	53.15	53.04	52.96
Hydrogen			6.45	6.70	7.01	6.75	6.74	6.64	6.52	6.57	6.83
Nitrogen	15.70	15.18	15.78	15.86	15.72	15.87	15.33	15.31	15.81	15.94	15.96
Sulphur					1.23	1.12	1.17		1.47		24.25
Sulphur and Oxygen			24.66	23.86				25.06			
Oxygen					22.49	22.75	23.86		23.05	23.61	
			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Although considerable differences exist among these analyses, they agree with each other as well perhaps as could be expected considering the difficulty of preparing the substance in a state of purity.

Whether other globulins occurred in the malt could not be determined by fractional precipitation owing to the small total quantity of globulin present.

The malt residue remaining after extracting with water, in the case first described, was treated with ten per cent. salt solution and the clear filtered liquid was dialyzed until free from chlorides. The precipitated globulin was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **14**, weighed 4.12 grams and had the following composition :

MALT-GLOBULIN, BYNEDESTIN.

	14		
	I.	II.	Average.
Carbon	52.94	52.78	52.86
Hydrogen	6.87	6.79	6.83
Nitrogen	16.16	16.18	16.17
Sulphur	1.14		1.14
Oxygen			23.00
			100.00
Ash	0.96		

It is to be noted that the carbon is a little lower and the nitrogen higher than the average of the figures previously obtained. This is perhaps due to presence of a little edestin,* the globulin of ungerminated barley. Edestin is not readily soluble in dilute saline solutions, such as are formed on treating seeds with water, and, if occurring in the malt, ought to be present in the salt extract of the meal after it has been exhausted with water. Owing to the incomplete extraction with water, the preparation obtained in this case should be a mixture of the two globulins, if both are present. Edestin can only occur in extremely small quantity in malt, since but 4.12 grams of globulin were obtained by extracting ten kilograms of malt with salt solution after treatment with water, and most of this consisted of the more soluble globulin first described. It is interesting to note the practically complete disappearance of edestin during germination and the formation of the more soluble globulin with three per cent. less nitrogen and two per cent. more carbon. It is, of course, not demonstrated that the malt globulin is derived from edestin, but that the proteids undergo extensive changes before conversion into proteoses and peptones is very evident.

When dissolved in considerable quantity in salt solution, bynedestin is precipitated by water, is not precipitated by saturation with sodium chloride, and but partly by saturation with magnesium sulphate. With the biuret test it gives a violet color. Dissolved in ten per cent. sodium chloride solution and heated to 65°, a turbidity is produced which increases to flocks at 84°. The coagulum gradually augments as the temperature rises but, after heating to 100°, the filtrate from the coagulum yields an abundant precipitate on adding dilute hydrochloric acid. The solution in ten per cent. sodium chloride brine gives a precipitate with acetic acid which is soluble in an excess of the acid. These reactions show that this body is in no sense a proteose, but has characters common to plant globulins. Bynedestin formed about sixty per cent. of the total water-soluble proteid matter in the malt extract first described in this paper. Out of a total of 33.27 gm. of proteid recovered in the different preparations from 100.00 gm. of malt, 19.88 gm. consisted of bynedestin.

* Annual Report of this Station for 1894, p. 172, and Journal of American Chemical Society, vol. 17, p. 545.

Malt Albumin, Leucosin.—Under the name Leucosin, one of us has described an albumin occurring in small quantity in the seeds of wheat, rye and barley. In the aqueous malt-extracts an albumin is found identical with leucosin in properties and composition. As stated in previous papers, this albumin is so intimately associated with diastatic action as to make probable that it is either diastase itself or an essential factor in diastatic amylolysis. In attempts to fractionally separate malt-leucosin from the associated proteids, many preparations have been made which are mixtures of leucosin with proteose. In several cases these mixtures have been analyzed and have so nearly the composition of leucosin as to make certain that one of the proteoses of malt has very nearly the same ultimate composition as the albumin. Analyses of these mixtures may therefore be taken to represent the composition of either of these proteids.

In the extraction first described in this paper, two preparations, **15** and **16**, of albumin coagulated by alcohol, were obtained from solutions out of which the globulin had been precipitated by alcohol. If, as is invariably assumed, proteose cannot be rendered insoluble by contact with alcohol, these preparations may be taken to represent the composition of malt albumin. Their composition is here compared with that of leucosin coagulated by heat.

LEUCOSIN.

	Malt.		Wheat, Rye and Barley.
	15	**16**	Average.
Carbon	53.23	52.90	52.93
Hydrogen	6.64	6.79	6.80
Nitrogen	17.00	16.41	16.70
Sulphur }			1.37
Oxygen }	23.13	23.90	22.20
	100.00	100.00	100.00
Ash	0.84	0.55	

The following figures give the composition of preparations derived from three different samples of malt. These were all obtained by precipitating the proteids with ammonium sulphate, dissolving the precipitates in water, dialyzing away the greater part of the salt and fractionally precipitating the solutions with alcohol. The fractions were dissolved in water as far as possible, filtered from the undissolved globulin and the aqueous solutions dialyzed for several days in water and then in alcohol. The proteids thus precipitated were mixtures of proteose and albumin. It will be noted that they all agree fairly well with one another and with leucosin in composition. Since these mixtures contained from six and a half to fifty per cent. of albumin, it is evident that the two proteids have a very similar composition.

MALT LEUCOSIN AND PROTEOSE.

	17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Carbon	53.16	53.19	52.80	52.50	52.38	52.85	52.61	52.55
Hydrogen	7.03	6.71	6.96	6.72	6.63	6.67		
Nitrogen	16.50	16.60	16.09	16.10	16.51	16.25	16.35	16.41
Sulphur }		1.38	1.45					
Oxygen }	23.31	22.12	22.70	24.68	24.48	24.23		
	100.00	100.00	100.00	100.00	100.00	100.00		
Ash	0.84	0.78	0.59	0.66	1.55	0.22	0.51	

The preparations containing the most albumin, when dissolved in water, became turbid on heating to 50° and formed flocculent coagula at 58°. By saturating their solutions with magnesium sulphate the albumin was completely thrown out, and together with it much of the proteose. Saturating solutions of these preparations with sodium chloride, gave no precipitate when they contained but little albumin, but a heavy precipitate appeared on adding acetic acid to the salt-saturated solution. Solutions of the preparations containing much albumin gave precipitates on saturating with sodium chloride.

PROTEOSES OF MALT.

The proteose associated with albumin has the properties of a *protoproteose*, since it is readily and abundantly precipitated from its salt-saturated solution on adding acetic acid.

When malt extract is fractionally precipitated with alcohol a considerable quantity of proteose is thrown down before the albumin, so that the water-soluble part of the first fraction is chiefly proteose. The proportion of albumin in the precipitates increases as the alcohol is made stronger up to the point where it is all precipitated. At this stage much proteose remains dissolved which behaves differently from that first thrown down. A large quantity of concentrated malt extract was precipitated by alcohol added to 60 per cent., and after filtering, the proportion of alcohol was raised to 72 per cent. The substance thereby precipitated, when dried over sulphuric acid, weighed 38 grams. This was dissolved in water, the solution was heated to boiling, the coagulated albumin was filtered out and 20 per cent. of sodium chloride added to the solution. This caused a slight precipitate which was evidently the alcohol-soluble proteid, to be described later. The filtrate from this substance was then treated with a little acetic acid, which produced a copious precipitate that was filtered out and dissolved in water. This solution, exactly neutralized with sodium carbonate and fully saturated with salt, yielded a considerable precipitate, which was filtered out, dissolved in water and dialyzed free from chlorides.

A very small deposit, consisting of minute spheroids, was found in the dialyzer. This dissolved readily in exceedingly dilute salt solution, from which it was thrown down by much water. On adding nitric acid to the solution of this substance a precipitate was produced that dissolved on warming and reappeared on cooling, gave a clear pink biuret reaction and was precipitated by copper sulphate. On boiling its solution not even a turbidity was produced. Except for its behavior on heating, this substance has all the reactions of a *heteroproteose*. The amount obtained was exceedingly small, only enough for the above reactions. The solution filtered from this heteroproteose was concentrated by gently boiling over a low flame.

During concentration of the solution filtered from the heteroproteose a coagulum developed as a film on the surface of the liquid and sides of the dish. We have frequently noticed that plant proteoses from various seeds coagulate in this manner although behaving in most other respects like typical proteose. This coagulum, **25**, filtered out, washed with water and alcohol and dried over sulphuric acid, weighed 0.29 gm. and contained 16.84 per cent. of nitrogen.

The filtrate from **25** was precipitated by alcohol and gave 1.45 gm. of **26**, having the following composition, when dried, at 110°:

MALT PROTEOSE, 26.

	I.	II.	Average.
Carbon	50.61	50.64	50.63
Hydrogen	6.72	6.61	6.67
Nitrogen	16.69		16.69
Sulphur } Oxygen }			26.01
			100.00
Ash			1.29

As will be remembered, in making these preparations, **25** and **26**, the proteose was precipitated, first, by adding acetic acid to the solution containing 20 per cent. of salt and, second, by dissolving the precipitate thus produced in water and saturating the neutralized solution with salt. The filtrate, **A**, from the first, as well as the filtrate, **B**, from the second precipitation, still contained proteose.

A was therefore neutralized with sodium carbonate and saturated with salt, but, as no precipitate resulted, acetic acid was added as long as any proteid was thrown down.

B was treated similarly with acetic acid and the two precipitates thus obtained from the salt-saturated solutions were collected on the same paper and the filtrates were united and marked **C**. The precipitates were dissolved in water, the solution carefully neutralized, dialyzed free from chlorides and then concentrated by slow boiling. During concentration a small coagulum separated which was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **27**, weighed 0.22 gm. and contained, without correcting for ash, 16.40 per cent. of nitrogen.

An excess of alcohol was added to the filtrate from **27**, and the precipitate produced, after treating in the usual manner, gave 1.49 gm. of preparation **28**, which, dried at 110°, had the following composition:

MALT PROTEOSE, 28.

	I.	II.	Average.
Carbon	49.82	49.87	49.85
Hydrogen	6.69	6.64	6.67
Nitrogen	16.00		16.00
Sulphur } Oxygen }			27.48
			100.00
Ash			1.54

The salt-saturated filtrate, **C**, from which **27** and **28** had been precipitated, was neutralized and dialyzed until much of the salt had been removed, then concentrated and dialyzed until free from chloride. The solution was finally concentrated to small volume and precipitated with alcohol. The substance so obtained, after treating as usual, weighed 6.25 gm., but was found to contain 4.70 per cent. of ash and only 8.91 per cent. of nitrogen, reckoned ash-free. This precipitate, which was expected to contain *deuteroproteose*, evidently included much non-proteid matter.

It will be noticed that of the 38 grams of substance taken, only a very small part was recovered. It is probable that a large share of the substance (p. 246) was non-proteid, and also that during the dialysis much proteose was lost by diffusion.

Preparation **26** has the properties of a proto-proteose and may be regarded as such. Preparation **28** is a mixture of proto- and deuteroproteose. Pure deuteroproteose was not obtained, it having been impossible to separate the non-proteid substances associated with it.

It thus appears that at least two protoproteoses exist in malt, for **26** has much less carbon than the mixtures of proteose and albumin **17** to **24.** Preparation **17** contains about 95 per cent. of proteose and has 53.16 per cent. of carbon, whereas **26** has only 50.63 per cent. of carbon. This difference can scarcely be due to non-proteid impurities, for **26** contains even more nitrogen than **17.** According to the definitions now accepted, a protoproteose is any form of proteid which is soluble in pure water, uncoagulable by heat, precipitable by saturation with sodium chloride, and gives a pink biuret reaction and a precipitate with nitric acid that dissolves on warming and reappears on cooling. The protoproteoses obtained by artificial digestion, usually have a composition varying with that of the proteids from which they are derived, and the proteoses of malt may also be expected to differ according as they originate from one or another of the several proteids of barley. While the plant proteoses resemble the digestive proteoses in the reactions just specified, some of their physical properties are so different that it is not improbable that they are quite distinct substances.

Malt Proteid soluble in dilute Alcohol. Bynin.

Three kilograms of ground malt were extracted with alcohol of 0.90 sp. gr. The extract was filtered clear, and concentrated to about one-third its original volume, on a water bath. When cool, the solution was poured off from the separated proteid and the latter was washed with dilute salt solution, with water, with ether to remove adhering water, and finally, with absolute alcohol. Dried over sulphuric acid, this preparation, **29,** weighed 33.1 gm., being 1.11 per cent. of the malt.

Dried at 110° it had the following composition :

Bynin, **29.**

	I.	II.	Average.
Carbon	55.01	54.93	54.97
Hydrogen	6.77	6.49	6.63
Nitrogen	15.98	16.13	16.06
Sulphur	0.94		0.94
Oxygen			21.40
			100.00
Ash			0.67

In order to fraction this substance, 27 grams were dissolved in alcohol of 0.90 sp. gr., the solution filtered perfectly clear, concentrated to small volume and poured into absolute alcohol, a few drops of ten per cent. salt solution being added to cause the proteid to separate. The precipitate so produced was filtered out, treated with absolute alcohol and dried over sulphuric acid. This preparation, **30,** weighed 20 gm., and when dried at 110° had the following composition :

Bynin, **30.**

	I.	II.	Average.
Carbon	54.74	55.08	54.91
Hydrogen	6.61	6.62	6.62
Nitrogen	16.21	16.06	16.14
Sulphur	0.83		0.83
Oxygen			55.07
			100.00
Ash			0.40

Of preparation **30,** 16 grams were dissolved in 180 c.c. of warm alcohol of 50 per cent. by volume, and a part of the proteid precipitated by cooling to 0° C. The solution was decanted and the precipitate, **30***a*, was treated as just described for **30.** The substance now separated, **30***b*, was treated in the same manner. **30***c*, thus obtained, was dissolved in a little strong alcohol and the perfectly clear solution poured into absolute alcohol, adding also a few drops of ten per cent. salt solution. The precipitate was then dehydrated with absolute alcohol and dried over sulphuric acid. This preparation, **31,** weighed 8.3 grams and gave the following results on analysis:

BYNIN, 31.

	I.	II.	Average.
Carbon	55.07		55.07
Hydrogen	6.75		6.75
Nitrogen	16.18	16.42	16.30
Sulphur	0.84		0.84
Oxygen			21.04
			100.00
Ash			0.10

The solutions, containing 50 per cent. of alcohol, which had been decanted from 30*a*, 30*b* and 30*c*, were united, concentrated to small volume, cooled and the liquid poured off from deposited substance. The latter, dehydrated with absolute alcohol and dried over sulphuric acid—preparation **32**—weighed 5.0 grams.

As seen from the following table, these analyses show that the proteid has not been separated into fractions of differing composition.

SUMMARY OF ANALYSES OF BYNIN.

	29.	30.	31.	32.	Average.
Carbon	54.97	54.91	55.07	55.16	55.03
Hydrogen	6.63	6.62	6.75	6.67	6.67
Nitrogen	16.06	16.14	16.30	16.53	16.26
Sulphur	0.94	0.83	0.84	0.76	0.84
Oxygen	21.40	21.50	21.04	20.88	21.20
	100.00	100.00	100.00	100.00	100.00
Ash	0.67	0.40	0.10	0.16	

These figures are, except for hydrogen, in remarkably close agreement with those given by Chittenden and Osborne for the composition of zein, the alcohol-soluble proteid of maize; but in properties the two bodies are very distinctly different. Compared with hordein, the alcohol-soluble proteid of barley, this malt-proteid contains about one per cent. more carbon and one per cent. less nitrogen.

ALCOHOL-SOLUBLE PROTEIDS.

	Hordein, of Barley.	Bynin, of Barley-Malt.	Zein, of Maize.
Carbon	54.29	55.00	55.23
Hydrogen	6.80	6.67	7.26
Nitrogen	17.21	16.26	16.13
Sulphur	0.83	0.84	0.60
Oxygen	20.87	21.20	20.78
	100.00	100.00	100.00

MALT PROTEID INSOLUBLE IN WATER, SALT SOLUTION AND DILUTE ALCOHOL.

The proteid remaining undissolved, after extracting malt with water, salt solution and alcohol, was not separated or identified, but its presence in considerable quantity was shown, as follows:

After extracting 100 grams of malt, first, with ten per cent. sodium chloride solution and then, with alcohol of 0.90 sp. gr., dehydrating with absolute alcohol and drying in the air, a residue was obtained which weighed 75 grams and contained 0.82 per cent. of nitrogen, equivalent to 0.62 per cent. reckoned on the original malt. Assuming, as is probably true, that this nitrogen belongs to proteid matter, we have in the residue, 3.8 per cent. of proteid, insoluble in the reagents named.

SUMMARY.

In the malt used in this investigation we have found:

1. *Bynedestin*,* readily soluble in very dilute salt solution, therefore largely passing into the aqueous extracts because of the soluble salts of the seed. This globulin contains two per cent. more carbon and three per cent. less nitrogen than edestin, the globulin of barley, and is much more soluble in very dilute salt solutions than edestin.

The composition of this globulin, as shown by the average of eleven analyses, is:

BYNEDESTIN.

Carbon	53.19
Hydrogen	6.69
Nitrogen	15.68
Sulphur	1.25
Oxygen	23.19
	100.00

Bynedestin, dissolved in ten per cent. sodium chloride solution, gives a turbidity at 65° and a flocculent coagulum at 84°, but, even after heating for some time at 100°, the coagulation is far from complete.

This proteid is not precipitated by saturating its solutions with sodium chloride, and but partly precipitated by saturating with magnesium sulphate.

* From βυνη, malt and εδεστὸς, edible.

2. *Leucosin*, an albumin, identical in composition and properties with the leucosin found in wheat, rye and barley. The composition of this proteid was found to be :

MALT-ALBUMIN, LEUCOSIN.

Carbon	53.07
Hydrogen	6.72
Nitrogen	16.71
Sulphur } Oxygen	23.50
	100.00

Leucosin is intimately associated with diastase*. Heated to 50°, solutions of this proteid become turbid, and at 58° a flocculent coagulum occurs. Coagulation, however, is incomplete unless the solution is heated for some time and the temperature raised to about 70°. Saturation with sodium chloride or with magnesium sulphate partly precipitates leucosin.

3. A *Protoproteose* readily precipitated from aqueous solution by adding an equal weight of alcohol. No preparations of this body were obtained free from albumin. Its composition is nearly the same as that of leucosin, since preparations containing from 90 to 50 per cent. of it, together with from 10 to 50 per cent. of leucosin, are not distinguishable by analysis.

4. A *Protoproteose* less readily precipitated by alcohol than the preceding, and of a different composition as shown by the following figures :

MALT-PROTOPROTEOSE.

Carbon	50.63
Hydrogen	6.67
Nitrogen	16.69
Sulphur } Oxygen	26.01
	100.00

That this is not an impure preparation of the preceding, is indicated by the fact that the amount of nitrogen is alike in both, while the carbon differs by two per cent. This difference would probably not be caused by non-proteid impurities. It is possible

* See papers on Diastase, Annual Reports of this Station, 1894 pp. 202, 204 and 1895, p. 238.

that the deuteroproteose, next to be described, may not have been completely separated by the process employed.

5. A *Deuteroproteose* which could not be separated from non-proteid impurities.

6. A *Heteroproteose* in extremely small amount.

7. *Bynin* a proteid insoluble in water and saline solutions, but readily soluble in dilute alcohol. About 1.25 per cent. of this proteid was obtained from the malt, having the following composition :

BYNIN.

Carbon	55.03
Hydrogen	6.67
Nitrogen	16.26
Sulphur	0.84
Oxygen	21.20
	100.00

8. A proteid insoluble in water, in salt solution and in alcohol, amounting to 3.80 per cent. The composition and properties of this proteid we have been unable to determine.

PROPORTIONS OF THE VARIOUS PROTEIDS IN MALT.

Assuming 21 per cent. of the total nitrogen of the malt to exist in non-proteid bodies, and admitting the malt proteids to contain on the average 16.3 per cent. of nitrogen, we have, in the malt investigated, a total of 7.84 per cent. of proteids.

As already indicated, p. 251, proteid equal to 3.8 per cent. of the malt was insoluble in alcohol and in salt solution.

It was shown on page 248 that 1.11 per cent. of proteid was recovered from alcohol solution, and making allowance for loss, we may place the amount of alcohol soluble proteid at 1.25 per cent.

Subtracting the sum of the insoluble proteid and the alcohol soluble proteid from the total malt proteids, we have 2.79 per cent. for proteids soluble in salt solution, viz : globulin, albumin, and proteoses.

The amount of coagulable proteids was found to be 1.50 per cent., consisting of albumin and a part of the globulin. There remains then 1.29 per cent. for the uncoagulated globulin and the various proteoses. We have accordingly, in the malt used for these determinations, approximately :

		Per cent.
Proteid, insoluble in salt solution and in alcohol		3.80
Bynin, soluble in dilute alcohol		1.25
Bynedestin, leucosin and proteoses soluble in water and salt solution	Coagulable	1.50
	Uncoagulable	1.29
Total proteids		7.84

The results of this study show: that, in germination, the proteids of barley undergo extensive changes without acquiring, or before acquiring the properties of proteoses; that hordein disappears and an alcohol soluble proteid of entirely different composition takes its place; that edestin also disappears and a new globulin is formed very different both in composition and properties. The albumin, on the other hand, appears to be unchanged in its characters, but its quantity is increased. It is to be noted also that hordein and edestin are both replaced by proteids much richer in carbon and poorer in nitrogen.

THE PROTEIDS OF THE POTATO.

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

So far as we can ascertain, the only investigations of the proteids obtained from the tubers of the potato have been made by Rüling (Liebig's Annalen LVIII, 306), Ritthausen (Pflüger's Archiv XXI, 101), Zöller (Ber. d. Deutsch. Chem. Ges. XIII, 1064), and Vines (Journal of Physiology, vol. 3, p. 93).

Rüling contributes a partial analysis of the coagulum obtained by boiling the juice of the potato.

Ritthausen states that nearly the whole of the proteid of the potato is contained in the juice. He obtained two preparations from the juice by heating to 65° C., filtering off the coagulum and heating the filtrate to 76°. The two coagula were analyzed with results as stated beyond. He says "these results do not contradict the assumption that the potato contains albumin, yet the content in sulphur is only one-half as great as in albumin of serum egg and muscle.

Zöller extracted the pressed and washed potato pulp with ten per cent. sodium chloride brine and obtained a globulin, precipitable by saturating its solution with sodium chloride and when dissolved in ten per cent. sodium chloride brine coagulating on heating to 59° or 60°. From his results he concludes that the potato contains a globulin resembling myosin.

On investigating the juice of the potato Zöller obtained results which led him to conclude that the proteids therein dissolved are also globulins, but that further study was needed to explain their "peculiar deportment," especially, it is to be inferred, the fact of coagulation occurring at from 43° to 48°, and again, at 62°.

Vines states that prolonged treatment of the "crystalloids" of the potato with ten per cent. sodium chloride solution produces an apparent effect, but that they dissolve readily in a saturated solution of this salt, thus differing from all other protein crystals which he had observed.

Having had occasion to prepare a quantity of pure starch from the potato, we took advantage of the opportunity to examine the associated proteids.

After removing the skins, the tubers were crushed and squeezed in a drug press. The juice was strained through cloth and allowed to stand and deposit the greater part of the suspended matters. It was then saturated with ammonium sulphate and the precipitate so produced was filtered out. The potato pulp was washed with water and the washings after clearing were also saturated with ammonium sulphate. The two precipitates thus obtained were united, dissolved in salt solution, filtered clear and dialyzed.

The washed pulp was then treated with ten per cent. sodium chloride solution; the proteid, thus extracted, was precipitated with ammonium sulphate, dissolved in salt solution, filtered clear and also dialyzed. The globulin precipitated very slowly on dialysis, and after fourteen days was filtered out. The proteid obtained from the juice was much greater in amount than that from the salt extract of the pulp. The globulin, from both juice and salt extract, was then dissolved in salt solution, the solutions were united, filtered from a considerable quantity of insoluble globulin (rendered insoluble by long contact with water,) and the solution again dialyzed. After freeing from chlorides, the contents of the dialyzer were filtered, the reprecipitated globulin was washed with water and alcohol and dried over sulphuric acid, giving preparation **1**, weighing 7.34 grams.

The filtrate, from preparation **1**, still contained proteid and was therefore saturated with sodium chloride, which completely precipitated the remaining globulin. This was then dissolved in dilute salt solution and dialyzed in water until free from chlorides and, as the proteid was not thus precipitated, the dialyzer was transferred to alcohol, which soon threw down all the proteid. This was filtered out, washed in water and absolute alcohol and dried, giving 0.5 of a gram of preparation **2**.

The solutions, filtered from the globulin precipitated by the dialysis first described, were united and, in order to obtain the proteid in a solution of smaller volume, the liquid was saturated with ammonium sulphate, the precipitate produced was dissolved in a little water and the clear solution dialyzed, first in river water and then in distilled water. The globulin so precipitated was filtered out, washed with water and absolute alcohol and dried, yielding preparation **3**, weighing 3.40 grams. The filtrate from this preparation was dialyzed into alcohol and the resulting precipitate filtered out, washed with absolute alcohol and dried, forming preparation **4**, which weighed 1.74 grams.

The filtrate from **4** was further dialyzed in alcohol and the proteid completely precipitated by adding absolute alcohol. This

substance after filtering out, washing with absolute alcohol and drying, weighed 0.53 of a gram and formed preparation **5**.

These several preparations were analyzed, after drying them at 110°, with the following results:

POTATO GLOBULIN. TUBERIN.

	Osborn and Campbell					Ritthausen.	
	1	2	3	4	5	I	II
Carbon	53.62	----	53.58	53.64	----	----	53.87
Hydrogen	6.80	----	6.91	6.83	----	----	7.30
Nitrogen	16.15	16.29	16.36	16.34	16.07	15.76	15.98
Sulphur	1.22	----	1.27	23.19 (Sulphur and Oxygen)	----	----	0.86
Oxygen	22.21	----	21.88		----	----	21.99
	100.00		100.00	100.00			100.00

The close agreement in composition among our five fractions is in itself, strong evidence that, besides this globulin, but little proteid is present in the potato. These five fractions practically include the whole of the proteid matter dissolved in the juice and salt extracts. The above figures given by Ritthausen for the composition of the proteid, obtained by coagulation of the juice at 65° and 76°, are also in close agreement with ours, excepting those for sulphur. The slightly lower nitrogen content of the coagulated globulin is to be expected, since proteids generally, if not always, yield some ammonia when coagulated by heat.

The potato globulin, when heated slowly in a double water bath, shows a wide range of variation in its coagulation point depending on the conditions under which it is dissolved.

A solution of this globulin prepared by treating a portion of preparation **1** with 10 per cent. sodium chloride solution and filtering out the insoluble matter, became turbid at 56° and a flocculent coagulum separated at 64°. After heating some time at 70° the coagulum was filtered out and the filtrate, when again tested, gave a turbidity at 72° and a flocculent coagulum at 76°.

Another preparation of this globulin was extracted, in the same way, with 10 per cent. salt solution, and the dissolved proteid was filtered from the insoluble matter and precipitated by saturating the solution with sodium chloride. The precipitated globulin was washed with saturated salt solution and removed from the paper mixed with a considerable quantity of the concentrated brine. Distilled water was gradually added until all of the proteid dissolved. The resulting solution was therefore almost completely saturated with the proteid. This solution when slowly heated in the double water bath to 44° C. and held at this temperature some minutes, became turbid and after a time flocculent, although the temperature remained perfectly constant. After raising the temperature to 50° it was filtered from the small coagulum which had formed and again heated, turbidity occurring at 50¼° and flocks separating at 51°. After heating some time at 56° the solution was filtered from the second small coagulum and again tested. Turbidity occurred at 58° and flocks separated at 59°, gradually increasing to a large coagulum at 66° which was filtered out. The filtrate now became turbid at 63°, flocks forming at 66°, and increasing to a considerable coagulum at 70°. The temperature was raised to 80° and the coagulum, which was about the same in amount as that formed at 66°, was filtered out. The filtrate gave only a trace of coagulum on boiling. The two coagula first formed were very small compared with the last two.

This test was then repeated with the same solution diluted with an equal volume of water. This solution was heated for some time at 44°, but remained perfectly clear. The temperature was then very slowly increased and at 53° a turbidity formed which, however, was scarcely greater at 56°. Above this temperature the turbidity increased until flocks separated at 62°, and a large coagulum formed at 65°. The solution filtered at 66°, gave a turbidity at 66°, with flocks at 68°, which formed a large coagulum on gradually raising the temperature to 80°, the filtrate from which gave no more coagulum on boiling.

The test was again repeated by mixing four parts of the same solution with one of water, and the same results obtained as with the solution diluted with an equal volume of water. This shows that within wide limits the temperature of coagulation does not depend on the relative quantity of dissolved proteid, but that the very low coagulation point of the undiluted solution was probably due to the presence of nearly enough sodium chloride to cause precipitation of the globulin. It will be noticed that coagulation of the proteid, which began at 56°, was not completed until the temperature had reached about 80°. This does not necessarily show the presence of several proteids, for such gradual coagulation is characteristic of most plant globulins, many being only very slowly coagulated, even by long boiling (Chittenden & Mendel, Jour. Phys. XVII, p. 52). The coagulum separated

by heating solutions of this globulin to 75° C. is very soluble, on gently warming, in extremely dilute hydrochloric acid, even acid of $\frac{1}{100}$ per cent. dissolving the substance readily at 40°–50° C. The coagulum dissolves quickly and completely in $\frac{1}{10}$ per cent. caustic potash solution at 20° and in one per cent. sodium carbonate solution at 70° C. These solutions are precipitated by neutralization, but the substance thrown down is not soluble in salt solutions. The low heat-coagulation point obtained for the solution of the globulin precipitated with salt and dissolved in a minimum quantity of water is in accord with that given by Zöller for the proteid similarly obtained by him from the juice of the potato, and our observations explain to some extent the questions which he considered to require further investigation.

In order to determine more definitely whether other proteids were present with the globulin, a larger quantity of filtered potato juice, obtained from potatoes which had been washed carefully, but from which the skins had not been removed, was saturated with ammonium sulphate, the precipitate was dissolved in dilute salt solution, which was then filtered and saturated with sodium chloride. The globulin thus precipitated was filtered out, the filtrate was dialyzed for twenty-four hours in order to remove a considerable part of the salt, and was then saturated with ammonium sulphate. The small quantity of proteid thus precipitated was filtered out, dissolved in a little dilute salt solution and sodium chloride added to complete saturation. A considerable part of the dissolved proteid was thereby precipitated, which was filtered out and dissolved in dilute salt solution. The resulting liquid became turbid on heating to 58° C. and flocculent at 60°. The substance was evidently a part of the globulin which had escaped precipitation on the first saturation with salt, probably owing to the presence of some constituent of the juice.

The solution filtered from the salt saturation precipitate *last* described, was diluted with two volumes of water and then saturated with ammonium sulphate. The proteid thus separated was filtered out, dissolved in water and found to yield a turbidity at 52° and a flocculent coagulum at 58°, a coagulation point not essentially differing from that of the globulin.

The whole solution was then heated for some time at 70° C. in a water bath, the coagulum which separated was filtered out, and the filtrate, after removing a small quantity of coagulum, which separated on heating to 75°, was boiled and found to remain clear. This solution was then saturated with ammonium sulphate and the very small precipitate produced was filtered out, dissolved in a small amount of water and tested with the following results: nitric acid added to the solution in the cold gave no precipitate; saturation with sodium chloride gave no precipitate even when acetic acid was added. The biuret test was without result owing to the strong brown color of the solution. This substance therefore failed to give the most characteristic reactions of the proteoses, yet it must be considered as a proteose since in its essential properties it agrees more closely with this class of proteids than with any other.

The experiments made by Zöller on the juice of the potato were repeated by us with the same results as described by him, except that we found the solution of the precipitate produced by saturation with salt, to yield a flocculent coagulum at 52°, while Zöller's solution coagulated at 46°–48°. It has already been shown that a solution of the globulin similarly prepared gave a coagulum at 44°, and on dilution with one volume, as well as with one-fourth volume of water, the same solution coagulated at 62°. It is thus evident that the temperature of coagulation is not to be depended upon as a means of identifying this proteid with certainty. The other reactions described by Zöller are those given by the potato globulin. From these results then it would appear that by saturating the juice of the potato with sodium chloride the greater part of the globulin is precipitated, but that a not inconsiderable part remains in solution. If this is separated by saturation with ammonium sulphate and the precipitate so produced is dissolved in water, a large part of this globulin can be precipitated by again saturating with salt. The proteid still remaining in solution is nearly all coagulable and the solution on heating behaves exactly like a solution of the globulin.

CONCLUSION.

The proteids of the potato tuber consist of a globulin, for which we propose the name *Tuberin*, and a proteose, the latter occurring in very small amount. The properties of tuberin were found to be as follows:

It is precipitated by saturating its solutions with sodium chloride, sodium sulphate, magnesium sulphate, or ammonium sulphate. By acetic acid or nitric acid a precipitate is given readily soluble in an excess of acid even in the presence of salts.

Potassium ferrocyanide gives no precipitate until acetic acid is added. Mercuric chloride gives no precipitate, but picric acid or tannic acid throw down the globulin. With the biuret, Millon's, and the xanthoproteic tests the usual reactions are given.

Tuberin is soluble in very dilute saline solutions and therefore the juice of the potato contains the greater part of this proteid. By dialysis it is precipitated slowly and incompletely because of the difficulty of removing *all* soluble salts by this process. Like other easily soluble globulins it readily changes to the insoluble modification, so that preparations made by dialysis are to a great extent insoluble in saline solutions. In contact with alcohol it very quickly loses its solubility.

When dissolved in ten per cent. sodium chloride solution tuberin shows a somewhat variable heat-coagulation point depending on the conditions under which it is tested. In general a flocculent coagulum is formed on heating to 60°–65° C. Coagulation is, however, not complete until the solutions have been heated for some time at 80° C. The composition of this globulin was found from an average of several accordant analyses to be:

TUBERIN.

Carbon	53.61
Hydrogen	6.85
Nitrogen	16.24
Sulphur	1.25
Oxygen	22.05
	100.00

LEGUMIN AND OTHER PROTEIDS OF THE PEA AND THE VETCH.

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

Legumin.

Under the name Legumin, many preparations, obtained from various seeds, have been described, but in such different and often conflicting terms as to leave us completely in doubt with regard to the nature of this substance.

This confusion appears to have arisen largely through the mistaken idea, which formerly was very generally held, that all the proteids extracted from seeds by water and precipitated by acids are one and the same substance.

The methods of analysis employed by the earlier chemists were too crude or uncertain to set forth the slight differences in composition of the various plant proteids, and the difficulty of making pure preparations tended, as the subject was further studied, to add to the confusion. Since the methods of analysis have been perfected and the more recently developed modes of studying proteids introduced, legumin has received little or no attention. In recent literature legumin is most commonly referred to as a substance extracted from seeds by caustic alkalies, and more or less altered by the action of the solvent, but nothing has been done, to our knowledge, to show the nature of the original proteid.

The object of our investigation has been to examine the seeds in which legumin is said to exist and to determine as definitely as possible the composition and character of this substance.

In 1806 Einhof (Gehlens Jour. d. Chem. 6, 543) recognized a proteid in beans and lentils which he considered to be different from the bodies of this class previously known.

Braconnot (Ann. de Chim. et de Phys., 34, (2), 68, 1827) named this substance legumin.

Noad (Chem. Gaz., 1847, p. 357) prepared and analyzed legumin from peas and beans.

Norton (Amer. Jour. Sc. (2), 5, 22, 1847) prepared legumin from peas, sweet almonds and oats, and gave analyses of his preparations.

Loewenberg (Pogg. Ann., 78, 327) considered that legumin, as previously prepared, contained albumin and devised a method for the separation of these two proteids and gave analyses of the substances so prepared from almonds and peas.

Liebig (Ann. d. Chem. u. Pharm., 39, 138) obtained plant casein (legumin) from beans, lentils and peas and gave an account of the properties of this proteid and two analyses. He concluded that the substance was identical in properties and composition with milk casein.

Dumas and Cahours (Jour. f. Prakt. Chem., 28, 398) prepared legumin from peas, lentils, beans, almonds, plums, filberts and white mustard. They considered all these seeds to contain the same proteid substance; that obtained from the three first named seeds being less pure than that from the others and therefore, containing somewhat less nitrogen.

They gave analyses of preparations from all these seeds and an extended account of the properties of legumin, based on a study of the preparation obtained from the almond.

Contrary to Liebig, they concluded that this substance is not identical either with milk casein or plant casein. The latter designation they applied to the body which separates out on cooling a concentrated hot alcoholic extract of wheat gluten.

Rochleder (Ann. d. Chem. u. Pharm., 46, 155) pointed out that the substance obtained from beans, lentils and peas by Liebig was different from that of the almond described by Dumas and Cahours, and that for this reason these investigators did not reach the same conclusions. Rochleder prepared and analyzed legumin from two varieties of beans.

In 1868 Ritthausen undertook a study of legumin, the results of which are recorded in a series of papers whose publication extended over a period of fifteen years.*

He recognized that the seeds of almonds, plums, filberts and white mustard, which had been previously stated to yield legumin, really contain a different proteid, which he called

* Jour. f. Prakt. Chem., 103, 65,	1868.
Die Eiweisskörper, etc., Bonn.,	1872.
Pflügers, Archiv, 15, 269,	1877.
Ibid., 16, 293,	1878.
Ibid., 18, 236,	1878.
Jour. f. Prakt. Chem. (2), 24, 221,	1881.
Ibid., (2), 26, 504,	1882.

conglutin. Up to this time legumin was considered to be the proteid that is extracted from seeds with simple water and is precipitated by acids from the aqueous extract.

All proteids thus obtained had been regarded as identical by most investigators and were known either as legumin or plant casein. Although it had been suggested that different seeds yield different proteids, Ritthausen appears to have been the first to make this fact evident. Ritthausen prepared "legumin" from blue lupins, yellow, green and gray field peas, yellow garden peas, lentils, vetches, horse beans (Vicia faba), white and yellow beans (Phaseolus) and colza cake. The proteid of Phaseolus, Ritthausen afterwards found to be distinct from legumin, and one of us has, in the main, confirmed his later result and has named the proteid phaseolin.* Ritthausen afterwards considered the proteid which he obtained from colza cake to be an impure preparation of a different substance. His early analyses† of preparations from the leguminous seeds were fairly accordant, but he afterwards found that the soda lime method which was used in determining nitrogen gave too low results. He thereupon determined nitrogen anew by Dumas' method, and published a revised statement of the mean composition of legumin.‡

In another paper published shortly afterwards, Ritthausen withdrew the corrected figures for nitrogen, having found that they were too high, because the nitrogen of his later analyses was mixed with hydrogen. He therefore published a third set of figures for nitrogen and made a second revised statement of the mean composition of legumin.§

At this time Hoppe-Seyler (Physiol. Chemie, p. 75) and Th. Weyl (Zeitschrift f. Physiologische Chemie, 1, 72) stated that the proteids of plants are chiefly globulins and Weyl examined qualitatively a number of seeds, by extracting them with ten per cent. sodium chloride solution, and found proteids resembling in their reactions animal myosin and vitellin. They asserted that the substance called legumin by Ritthausen was doubtless originally a globulin and that the preparations of this substance described and analyzed by him were altered by the alkali which

* Report of the Conn. Agricultural Experiment Station, 1893, p. 186, and Journal of the American Chemical Society, vol. 16, p. 633.

† Die Eiweisskörper, &c., Bonn, 1872, pp. 159, 176.

‡ Pflüger, Archiv, XVI, 293, 1877.

§ Pflüger, Archiv, XVIII, 236, 1878.

he used in extracting them and were not the proteids originally contained in the seeds. Ritthausen contended strongly against this view and maintained that his preparations were wholly unaltered by the alkali. He extracted several kinds of seeds with salt solution, precipitated the proteid by dilution with water and found that the preparations of legumin so made were not essentially different in composition from those obtained by extracting with dilute potash water.* He then examined his older preparations, made by extracting the seeds with weak alkali and showed that they were to a very considerable extent soluble in salt solution. The substance thus extracted had, in many cases, a different composition from that of the original preparation, and Ritthausen then concluded that all the preparations which he had previously described as legumin were, in fact, mixtures of the two proteids, one, soluble in salt solution after dissolving in potash water and precipitating with acid, similar to, but distinct from conglutin, and the other, originally soluble in salt solution but rendered insoluble in that fluid by treatment with alkalies. This latter he called legumin.

He then purified the legumin by extracting the mixed proteids from the seed with dilute alkali, neutralizing with acid, extracting the precipitate so produced with sodium chloride solution to remove proteids soluble in that fluid and then redissolving the residue, consisting mostly of legumin, in dilute alkali and reprecipitating with acetic acid.

Two preparations were so obtained, one from the pea and another from the horse bean (*Vicia faba*).

Ritthausen regarded his study of these preparations as showing that the substance from *Vicia faba* was a compound of tannic acid with the salt soluble proteid and that it was doubtful whether the horse bean contains legumin at all.

The preparation from the pea he finally considered to be legumin, having the following composition :

LEGUMIN OF PEA, RITTHAUSEN.

Carbon	51.34
Hydrogen	6.98
Nitrogen	17.48
Sulphur	0.45
Oxygen	23.75
	100.00

* Jour. f. Prakt. Chemie, 26, 504.

This analysis represents the composition of legumin not in its original condition, but so altered as to be insoluble in saline solutions. Of the reactions of legumin we know little more than that it dissolves in salt solution and is precipitated by diluting with water.

In the following pages we give the outcome of our recent investigation into the composition and properties of legumin as contained in the seeds of the pea and the vetch.

Here as in former papers we have described our procedure with considerable, perhaps unnecessary, detail, but having often experienced great difficulty in understanding and repeating the work of our predecessors because of the vagueness of their statements, we have endeavored to describe our methods and results so fully and accurately that any who may wish to review our investigations experimentally may find it practicable to do so.

I. Proteids of the Pea.

One hundred grams of garden peas ground to pass a sieve of 1^{mm} mesh were extracted with petroleum naptha to remove oil, then dried by exposure to the air, and finally treated with one liter of ten per cent. sodium chloride solution. As the very viscid extract could scarcely be filtered through paper, an equal volume of ten per cent. sodium chloride solution was added, and after some time one half the solution passed the filter clear. This was saturated with ammonium sulphate, the resulting precipitate was filtered out, dissolved in salt solution and the liquid dialyzed free from chlorides. The proteid separated, as do all vegetable globulins thus far observed, in spheroids. No distinct crystals could be detected in this or any of our preparations from the pea. When the chloride had been removed by dialysis the precipitate was filtered out, washed with water and alcohol, dried over sulphuric acid and found to weigh 3.5 grams, being about 7 per cent. of the meal. Dried at 110° this preparation was analyzed with the following results:

Pea Legumin, 1.

Carbon	52.03
Hydrogen	6.96
Nitrogen	17.98
Sulphur } Oxygen }	23.03
	100.00
Ash	0.41

Another preparation was made by extracting 500 grams of pea meal with three liters of ten per cent. sodium chloride brine and after allowing the mixture, protected with thymol, to stand three days in a cool place, 1500^{cc} of the extract were decanted. Although very turbid, this was saturated with ammonium sulphate without filtering, and the precipitate produced was filtered out and dissolved in brine. The resulting solution was then filtered without much trouble and the clear filtrate dialyzed free from chlorides. After washing and drying, the globulin thus precipitated, and amounting to ten grams or about 5 per cent. of the meal, had the following composition:

Pea Legumin, 2.

	I.	II.	Average.
Carbon	52.08	52.19	52.14
Hydrogen	7.06	6.95	7.01
Nitrogen	18.01	17.91	17.96
Sulphur	0.49	----	0.49
Oxygen	----	----	22.40
			100.00
Ash	0.33		

In order to obtain larger quantities of this proteid for fractional precipitations 800 grams of pea meal were treated with four liters of *twenty* per cent. sodium chloride solution, and by draining on filters over night about one half the solution applied to the meal, or two liters, was obtained as a clear yellow filtrate, which was saturated with ammonium sulphate, but for a reason, then unknown, very little proteid separated. Dilute acetic acid saturated with ammonium sulphate was then added in small amount and the proteid separated as a flocculent precipitate. This was filtered out and in order to remove the acid as completely as possible the precipitate was suspended in about four liters of saturated ammonium sulphate solution and again filtered out. The precipitate was then dissolved in ten per cent. sodium chloride solution and calcium carbonate added to neutralize the acid retained by the proteid. The solution then reacted alkaline with litmus owing to ammonium carbonate set free from the sulphate. The solution was next filtered very nearly clear and dialyzed until a large precipitate had formed. This precipitate was filtered out, dissolved in salt solution, filtered clear and dialyzed free from chlorides. The precipitated globulin was washed with water and alcohol and dried over sulphuric acid, giving fifty-two grams, in whose analysis, after drying at 110°, the following figures were obtained:

solves than in a ten per cent. salt solution, not enough, in fact, to completely precipitate the proteid. The meal residue was therefore treated with water enough to reduce the strength of the salt solution still adhering to it to about ten per cent. A further considerable quantity of nearly clear extract was thus obtained, which, when saturated with ammonium sulphate, readily and completely parted with the proteid. This was filtered out, dissolved in ten per cent. brine, the solution filtered perfectly clear and dialyzed. After a large quantity of globulin had separated in the dialyzer its contents were filtered off, the precipitate was dissolved in ten per cent. salt solution and treated in exactly the same way as **3** had been. This preparation, **5**, weighed 37.5 grams and, dried at 110°, had the following composition:

PEA LEGUMIN, **6.**

	I.	II.	Average.
Carbon	52.37	----	52.37
Hydrogen	6.90	----	6.90
Nitrogen	17.95	17.95	17.95
Sulphur	0.39	----	0.39
Oxygen	----	----	22.39
			100.00
Ash	0.28		

The filtrate from the first precipitation, by dialysis, of this substance, when saturated with ammonium sulphate gave a precipitate which was dissolved in a little water and the resulting solution was filtered clear and dialyzed. After most of the salts were thus removed the separated globulin was filtered out, washed and dried, and gave 2.44 grams of preparation **7**, having the following composition, when dried at 110° :

PEA PROTEID, **7.**

	I.	II.	Average.
Carbon	52.09	52.02	52.06
Hydrogen	6.96	7.08	7.02
Nitrogen	16.75	16.57	16.66
Sulphur	0.55	----	0.55
Oxygen	----	----	23.71
			100.00
Ash	0.20		

This analysis is in fair accord with that of the similarly obtained preparation **4.**

The filtrate from **7** was dialyzed into alcohol and then absolute alcohol was added to the solution until all the proteids separated. The precipitate thus produced was filtered out, washed with absolute alcohol, dried over sulphuric acid and found to weigh 7.1 grams. Since this preparation might be a mixture of any unprecipitated globulin, with albumin and proteose, if these were present, it was treated with water and the considerable quantity of proteid coagulated by alcohol was filtered out, washed thoroughly with water and then with absolute alcohol and dried over sulphuric acid. This gave 4.05 grams of preparation **8**, which, when dried at 110°, had the following composition :

PEA PROTEID, **8.**

	I.	II.	Average.
Carbon	53.60	53.47	53.54
Hydrogen	6.99	6.98	6.99
Nitrogen	16.72	16.65	16.69
Sulphur	1.01	----	1.01
Oxygen	----	----	21.77
			100.00
Ash	0.32		

The analysis of **8** agrees well with that of **5** and it is probable that these figures pretty nearly represent the composition of a second proteid (globulin or albumin) readily soluble in very dilute salt solutions.

Having thus found evidence of the presence of at least two proteids in the pea extract, one less soluble than the other in very dilute salt solutions, it became necessary to subject the less soluble and more abundant globulin to thorough fractioning in order to learn whether it was homogeneous or a mixture.

Twenty-five grams of **3** were therefore dissolved in 250^{cc} of five per cent. sodium chloride solution, filtered clear and the filter washed with 50^{cc} of the same salt solution. A portion of the preparation had, as is usually the case with vegetable globulins when dried, passed into an insoluble form. This insoluble matter when treated with salt solution gave a gummy residue, which was difficult to filter out. No estimate of the amount of this substance could be made.

The clear salt solution of the globulin was diluted with twice its volume of water, making 750^{cc} of a 1.67 per cent. solution, of sodium chloride. After standing over night the proteid which had precipitated on dilution was collected on a filter, washed with water and alcohol and dried over sulphuric acid. Preparation **9** was so obtained, weighing 5.1 grams and having, when dried at 110°, the composition given below.

The solution filtered from this substance was treated with an equal volume of water making 1500^{cc} of a brine containing 0.84 per cent. of salt, from which after standing some time a part of the proteid separated as a viscid layer at the bottom of the beaker. The solution was decanted and the precipitate washed and dried in the usual manner. This, **10,** weighed 5.29 grams. The decanted liquid was then dialyzed free from salt and the precipitated globulin treated in the usual manner, giving **11,** weighing 4.10 grams. About three-fifths of the original substance was thus recovered in three nearly equal fractions. The other two-fifths consisted largely of insoluble globulin. The composition of the fractions so obtained was as follows:

PEA LEGUMIN, FRACTIONS OF **3.**

	9.			**10.**			**11.**		
	I.	II.	Average.	I.	II.	Average.	I.	II.	Average.
Carbon	52.49	52.23	52.36	52.31	52.09	52.20	52.25	52.25	52.25
Hydrogen	7.11	7.10	7.11	7.09	6.92	7.01	7.08	----	7.08
Nitrogen	17.96	18.05	18.01	17.98	17.96	17.97	17.88	17.84	17.86
Sulphur	0.35	----	0.35	0.35	----	0.35	----	----	22.81
Oxygen	----	----	22.17	22.27	----	22.47	----	----	
			100.00	100.00		100.00			100.00
Ash	0.22			0.61			0.20		

Again, twenty-five grams of preparation **5** were dissolved in 250^{cc} of five per cent. brine, the solution filtered, the residue washed with 50^{cc} of the same brine and the clear filtrate diluted with one and a half volumes of water, thus giving a two per cent. salt solution. After standing over night the precipitate was filtered out, washed with water and alcohol and dried over sulphuric acid. Preparation **12** so obtained weighed 8.58 grams.

The filtrate from **12,** on adding an equal volume of water and treating the precipitate as just described, yielded **13,** weighing 2.84 grams.

The filtrate from **13,** dialyzed free from salt, gave **14,** weighing 4.2 grams.

PEA LEGUMIN, FRACTIONS OF **5.**

	12.			**13.**	**14.**		
	I.	II.	Average.		I.	II.	Average.
Carbon	52.26	----	52.26	52.08	52.01	52.02	52.02
Hydrogen	6.96	----	6.96	7.04	----	7.20	7.20
Nitrogen	17.96	18.06	18.01	17.88	17.81	18.03	17.92
Sulphur	0.44	----	0.44	23.00′	----	----	23.86
Oxygen	----	----	22.33		----	----	
			100.00	100.00			100.00
Ash	0.40		0.19	0.17			

Comparing the analyses of these fractions with each other and with that of the original substance, it is plain that they all represent a single proteid.

SUMMARY OF ANALYSES OF PEA LEGUMIN.

	1.	**2.**	**3.**	**6.**	**9.**	**10.**	**11.**
C.	52.03	52.14	52.29	52.37	52.36	52.20	52.25
H.	6.96	7.01	7.02	6.90	7.11	7.01	7.08
N.	17.98	17.96	17.76	17.95	18.01	17.97	17.86
S.	23.03	0.49	0.30	0.39	0.35	0.35	22.81
O.		22.40	22.63	22.39	22.17	22.47	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	12.	**13.**	**14.**	Average.
C.	52.26	52.08	52.02	52.20
H.	6.96	7.04	7.20	7.03
N.	18.01	17.88	17.92	17.93
S.	0.44	23.00	22.86	22.45
O.	22.33			
	100.00	100.00	100.00	100.00

Ritthausen obtained from peas by extraction with salt solution and precipitation with water two preparations, the analyses of which are given below, A and B.*

By treating peas with very weak potash water, adding acid to neutralization, extracting the precipitate thus produced with salt solution and filtering out the insoluble matter, he obtained a solution from which, by adding water, a precipitate was thrown down whose composition is given below under C.

*Jour. f. prakt. Chem., 26, 504.

PEA LEGUMIN.

	Ritthausen. A.	B.	C.	Osborne & Campbell. Average of 18 analyses on 10 preparations.
Carbon	52.83	51.61	51.62	52.20
Hydrogen	7.27	7.08	6.96	7.03
Nitrogen	17.26	17.23	18.26	17.90
Sulphur } Oxygen }	22.64	24.08	0.33	0.39
			22.83	22.48
	100.00	100.00	100.00	100.00

Ritthausen's preparation C agrees fairly well with the average of our results. The preparations extracted directly from peas by salt solution would appear to be the same substance but less pure. We see no ground for Ritthausen's idea that his older preparations were mixtures of two proteids both originally soluble in salt solution, one of which, legumin, is rendered insoluble in salt solution by treatment with alkalies. It is much more probable that a part of the globulin in his preparations had assumed the insoluble condition during the process of separating, since nearly all globulins, to a greater or less extent, are prone to this change. The difference in composition between Ritthausen's original "legumin" and the substance extracted from it by salt solution is doubtless due to the greater purity of the latter. This view is supported by the close agreement in composition of this substance with those extracted by us directly from the pea. For this, the chief proteid of the pea, it is proper to retain the name *Legumin* first proposed by Braconnot.

The properties of legumin are as follows:

In water it is entirely insoluble.

In ten per cent. sodium chloride solution, when freshly prepared and not dried, it is readily soluble, but after washing with alcohol and drying over sulphuric acid, more or less becomes insoluble in salt solution. Dissolved in ten per cent. sodium chloride solution legumin is not precipitated by saturating the solution with magnesium sulphate, or sodium chloride. Saturated with sodium sulphate at 20°, no precipitate is produced; saturated at 25°, a turbidity appears; but saturated with sodium sulphate at 34°, all but a trace is thrown out of solution. By saturation with ammonium sulphate at common temperatures it is completely precipitated.

Dissolved in salt solution, legumin is not precipitated by mercuric chloride but gives a heavy precipitate on adding either picric, tannic, hydrochloric, nitric, sulphuric or acetic acid.

In water containing a very small quantity of acid, legumin readily dissolves and is precipitated by adding sodium chloride. It is readily soluble in dilute alkalies and alkali carbonates.

Adding to its solution glacial acetic acid and concentrated sulphuric acid, a violet color is produced. With cupric sulphate and caustic potash, after standing, a crimson red color appears, almost as red as that given by peptones. With Millon's and the xanthoproteic tests the usual reactions are given. When dissolved in ten per cent. sodium chloride solution and gradually heated, the solution becomes turbid at 97° and on long heating in a boiling water bath, a coagulum gradually separates.

II. PROTEIDS OF THE VETCH.

One hundred grams of finely ground meal of the seed of the common vetch (*Vicia sativa*) were treated with water and the extract after filtering clear was saturated with ammonium sulphate. The small precipitate thereby produced was filtered out and dissolved in water; the resulting solution was filtered clear and dialyzed until free from chlorides. The globulin thus precipitated, after washing with water and with alcohol, weighed 1.04 grams. The meal residue was then treated repeatedly with ten per cent. sodium chloride solution and after filtering clear the extract was saturated with ammonium sulphate, the precipitated proteid filtered out and dissolved in brine. The resulting solution was filtered clear and dialyzed until free from chlorides. The globulin thus precipitated, when washed with water and alcohol, and dried over sulphuric acid, weighed 5.0 grams. When dried at 110° this preparation, **15**, had the following composition:

VETCH LEGUMIN. 15.

Carbon	52.45
Hydrogen	6.98
Nitrogen	18.04
Sulphur	0.50
Oxygen	22.03
	100.00
Ash	0.27

The meal residue was next treated with two-tenths per cent. potash water, the extract filtered clear and neutralized with very dilute hydrochloric acid; the precipitate thus produced was dissolved in two-tenths per cent. potash water, the clear solution was neutralized with dilute hydrochloric acid and the precipitated proteid washed with water and alcohol and dried. This preparation **16** weighed 4.4 grams and gave the following results on analysis:

VETCH PROTEID, **16.**

	I.	II.	Average.
Carbon	52.41	52.43	52.42
Hydrogen	7.13	7.02	7.07
Nitrogen	16.55	----	16.55
Sulphur } Oxygen }	----	----	23.96
			100.00
Ash	0.74		

Four kilograms of vetch meal were next treated with twelve liters of ten per cent. sodium chloride brine and the residue washed with the same solution. The extract and washings were partly cleared by subsidence, then saturated with ammonium sulphate. The precipitate so produced was dissolved in brine, but the resulting solution was very difficult to filter. The greater part of the suspended impurities was removed by passing the extract through a loose bed of filter paper pulp and the proteid was again separated by saturation with ammonium sulphate. This precipitate was dissolved in brine and the solution, kept cold, then filtered perfectly clear. This solution was dialyzed in two portions, D and E. After nearly freeing from chlorides, a large precipitate formed in each dialyzer, which was filtered out. That obtained from E was washed with water and with alcohol as long as any coloring matter was extracted, and was then dried over sulphuric acid giving 120 grams of a slightly pink powder, which will be designated F. That from D was redissolved in ten per cent. sodium chloride brine, the solution filtered perfectly clear and dialyzed until free from chlorides. All but a trace of proteid was thus thrown down. The precipitate was washed thoroughly with water and with alcohol and dried over sulphuric acid yielding preparation **17**, which weighed 90 grams and was very slightly colored. After drying at 110°, this preparation had the following composition:

VETCH LEGUMIN, **17.**

	I.	II.	Average.
Carbon	51.98	51.97	51.98
Hydrogen	6.94	6.89	6.92
Nitrogen	17.96	18.00	17.98
Sulphur	0.45	----	0.45
Oxygen			22.67
			100.00
Ash	0.20		

The filtrates from the first dialysis of solutions D and E were separately saturated with ammonium sulphate, the precipitates obtained were dissolved in water and the solutions filtered and dialyzed. The precipitate from D, thrown down by dialysis, was redissolved in salt solution and again precipitated by dialysis. The two preparations of globulin thus obtained were washed with water and with alcohol and dried over sulphuric acid, that from D weighed 4.11 grams, forming preparation **18**, and that from E gave preparation **19**, weighing 7.67 grams. On analyzing these preparations, dried at 110°, the following results were obtained:

VETCH LEGUMIN.

	18.	**19.**
Carbon	52.21	52.18
Hydrogen	6.82	6.82
Nitrogen	17.99	17.99
Sulphur	0.37	0.36
Oxygen	22.61	22.65
	100.00	100.00

The filtrate from the first precipitation by dialysis of **18** was united with the filtrate from **19** and the heat coagulation point determined in a portion of the solution, in which ten per cent. of sodium chloride had been dissolved. This solution became turbid at 56° and flocks separated at 63° in considerable quantity. After heating to 70° for some time and filtering, turbidity occurred on heating to 71° and a flocculent coagulum formed at 73°, about the same in amount as at 63°. After heating to 78°, the solution was filtered and again heated, the turbidity forming a third time at 79° and flocks at 83° in smaller quantity than before. This slow and incomplete coagulation does not necessarily indicate the presence of several coagulable proteids in the solution, for there is no temperature-interval between the successive coagula, the temperature at which turbidity occurs and a flocculent coagulum develops being determined, after the first coagulum has formed, by the temperature at which the solution was filtered. Each time the solution becomes turbid at a temperature just above that to which it had been previously heated and a flocculent coagulum separates at three or four degrees higher.

The presence of salts has much influence on the coagulation point, for another portion of this same solution, to which no salt had been added, became turbid at ten degrees lower than the portion wherein ten per cent. of sodium chloride had been dissolved and gave the last flocculent coagulum at a temperature ten degrees higher.

The solution, portions of which had served for the foregoing observations, was then dialyzed into alcohol until concentrated to one half its original volume, when a considerable precipitate formed which was filtered out, washed with alcohol and dried over sulphuric acid. This substance consisted of a mixture of all the proteids remaining in solution after separating the globulin, as described. Any albumin or globulin which might be contained in this precipitate would probably be largely if not wholly coagulated by the long treatment with alcohol and the subsequent drying. This preparation was therefore very finely pulverized and extracted thoroughly with water. The insoluble residue was then washed with alcohol and dried, yielding 13.52 grams of preparation **20**, which was found to have the following composition:

VETCH PROTEID, **20**.

	I.	II.	Average.
Carbon	53.45	53.65	53.55
Hydrogen	6.67	6.73	6.70
Nitrogen	16.46	----	16.46
Sulphnr	1.02	----	1.02
Oxygen	----	----	22.27
			100.00
Ash	0.29		

The solution filtered from **20** was further dialyzed into alcohol and a second precipitate obtained, which, when washed with alcohol and dried, weighed 5.64 grams and was composed as follows:

VETCH PROTEID, **21**.

	I.	II.	Average.
Carbon	52.55	52.66	52.60
Hydrogen	6.70	6.95	6.83
Nitrogen	16.53	16.76	16.69
Sulphur	1.23	----	1.23
Oxygen	----	----	22.65
			100.00
Ash	0.65		

The filtrate from the precipitate produced by the first dialysis into alcohol, from which preparations **20** and **21** had been obtained, was further dialyzed into alcohol yielding a second precipitate which, when washed with alcohol and dried over sulphuric acid, weighed 2.21 grams and formed preparation **22**. This consisted of proteose and, after drying at 110°, had the composition as follows:

VETCH PROTEOSE, **22**.

	I.	II.	Average.
Carbon	50.95	50.76	50.85
Hydrogen	6.78	6.72	6.75
Nitrogen	16.53	16.79	16.65
Sulphur } Oxygen }	----	----	25.75
			100.00
Ash	2.18		

Comparing the composition of **21** with that of **20**, it is seen that, excepting carbon, the figures agree quite well. **21**, however, contains one per cent. less carbon than **20**, which is easily explained by its being a mixture of the proteose represented by **22**, and the proteid represented by **20**. Such a mixture would be expected from the method of preparation.

If **20** is compared with **5** and **8**, obtained in a similar manner from the pea, by dialysis of its extracts into alcohol, after precipitation of the greater part of the globulin contained in these extracts by dialysis in running water, it will be observed that they rather closely agree. It is hardly possible by this method to obtain entirely pure preparations, but our results show that the vetch and pea both contain another proteid that is different from legumin in composition and in properties.

To facilitate comparison these analyses are here tabulated.

	Pea Proteid. 5.	Pea Proteid. 8.	Vetch Proteid. 20.
Carbon	53.33	53.54	53.55
Hydrogen	6.98	6.99	6.70
Nitrogen	16.14	16.69	16.46
Sulphur	1.00	1.01	1.02
Oxygen	22.55	21.77	22.27
	100.00	100.00	100.00

It will be noted that this proteid contains more carbon and less nitrogen than legumin and nearly twice as much sulphur.

Whether it is a globulin soluble in extremely dilute salt solutions or an albumin soluble in pure water, we have not as yet undertaken to ascertain, for want of time.

The residue of the meal extracted, as described, with salt solution, was treated with two-tenths per cent. potash solution, a portion of the alkali extract was filtered clear and neutralized with very dilute hydrochloric acid. The precipitate which resulted was dissolved in two-tenths per cent. potash water, and after filtering perfectly clear, again thrown down by neutralizing with hydrochloric acid. After drying, 12.4 grams of **23** were obtained, having the following composition:

Vetch Proteid, 23.

	I.	II.	Average.
Carbon	53.00	52.99	53.00
Hydrogen	6.91	7.02	6.97
Nitrogen	16.45	----	16.45
Sulphur	0.53	----	0.53
Oxygen			23.05
			100.00
Ash	0.92		

If this analysis is compared with that of **16**, it will be noted that, although they agree in nitrogen content, they differ as respects carbon. The sulphur found in **23** would indicate that **23** is a mixture of legumin with other substances. It seems to us probable that it is mainly legumin which escaped extraction by the salt solution through imperfect pulverization of the meal or its incomplete exhaustion by the brine, or because it was present in

the salt-insoluble form, a form which it may have assumed in the seed itself, or under the action of the solvents to which the meal was subjected. It has been our experience with other seeds that extractions with alkali, after exhausting the seed with salt solution, yields products which, in most cases, it is impossible to purify.

In order next to determine whether the legumin found in the vetch seed is a single proteid or a mixture, the following fractional precipitations were made.

One kilogram of the meal was extracted with ten per cent. sodium chloride solution and, after filtering clear, the extract was saturated with ammonium sulphate and the proteids, thus precipitated, dissolved in 300 c.c. of ten per cent. brine. The solution now measured 400 c.c. and contained about eight per cent. of salt. After filtering perfectly clear, from a small amount of insoluble matter, an equal volume of distilled water was added. On standing a short time the proteid thus precipitated collected on the sides and bottom of the beaker as a sticky deposit, leaving the solution nearly clear. The latter was then decanted and the translucent, gummy mass of proteid washed with water, which caused it to turn opaque and become brittle, so that it was easily rubbed to a coarse powder.

After washing repeatedly with water the proteid was thoroughly washed with dilute alcohol, then with absolute alcohol, and dried over sulphuric acid. This preparation, **24**, weighed 13.4 grams.

The solution decanted from **24** was cooled in an ice box over night and the clear supernatant liquid poured from the perfectly transparent semifluid layer which had thus formed on the bottom of the beaker. After washing and drying, 12.9 grams of preparation **25** were obtained. The solution decanted from **25** was mixed with an equal volume of distilled water and left over night in the ice box. A transparent layer of proteid was again deposited, which, when washed and dried, yielded 4.00 grams of **26**.

The solution decanted from **26** was saturated with ammonium sulphate, the precipitated proteid dissolved in salt solution, and after filtering, the proteid was precipitated by dialysis. The globulin thus separated, after washing and drying, weighed 3.35 grams, and formed preparation **27**.

The following figures were obtained by analyzing these preparations when dried at 110°.

VETCH LEGUMIN.

	24.	25.	26.	27.
Carbon	52.05	51.78	52.17	52.04
Hydrogen	6.99	6.89	6.92	7.06
Nitrogen	18.02	18.06	17.70	18.02
Sulphur	0.56	0.48 }	23.21	22.88
Oxygen	22.38	22.79 }		
	100.00	100.00	100.00	100.00

Several grams of preparation E, described on page 276, were dissolved in a very little two-tenths per cent. potash water, the solution was diluted considerably with distilled water and carbonic acid gas passed through it. At first the solution remained clear, but after a time the proteid suddenly and almost completely separated as a voluminous precipitate, the filtrate from which yielded but a trace of proteid on saturating with ammonium sulphate. The precipitate was washed with water and then treated with salt solution. A part dissolved and the rest was converted into a swollen gelatinous mass which rendered filtration impossible. After standing over night the solution was poured off and the gummy residue was washed by decantation, at first with salt solution and then with water. On washing out the salt, the residue lost its gummy character and became a dense, rapidly settling precipitate which was readily collected on a filter and completely washed with water and then with alcohol. After drying over sulphuric acid it furnished 2.62 grams of preparation **28.** This peculiar behavior of legumin which has lost its solubility in salt solution, we have observed in a number of cases.

E, when treated directly with salt solution, behaved in exactly the same manner as the precipitate obtained by passing carbonic acid through its solution in dilute potash water, that is, a part dissolved and a part remained as a gummy residue, which was dehydrated (?) by washing with water. The saline solution described above, which had been decanted from the part of the carbonic acid precipitate which was insoluble in salt solution, was filtered clear and dialyzed free from chlorides. The precipitate which resulted was filtered out, washed and dried in the usual manner, and yielded **29.** These two preparations were found to have the following composition:

VETCH LEGUMIN.

	28.	29.
Carbon	52.11	51.89
Hydrogen	6.82	6.88
Nitrogen	18.17	18.09
Sulphur	0.53	0.40
Oxygen	22.37	22.74
	100.00	100.00
Ash	0.27	0.13

Several grams of preparation **17** were dissolved in a little two-tenths per cent. potash water and the resulting clear solution was neutralized with dilute acetic acid, thereby precipitating the proteid. A portion of this precipitate was tested with ten per cent. sodium chloride solution and found to dissolve to a large extent and on warming to 50° nearly all went into solution. The remainder of the precipitate was washed, dried and analyzed with the following results:

VETCH LEGUMIN, 30.

Carbon	52.06
Hydrogen	6.80
Nitrogen	17.98
Sulphur	0.53
Oxygen	22.63
	100.00
Ash	0.15

Another portion of preparation **17** was treated with two-tenths per cent. hydrochloric acid and yielded a clear solution, which was neutralized with one-half per cent. sodium carbonate solution. The resulting precipitate was partly soluble in ten per cent. salt solution. It was washed and dried and, as preparation **31,** gave the following figures when analyzed:

VETCH LEGUMIN, 31.

Carbon	52.12
Hydrogen	6.68
Nitrogen	18.20
Sulphur	0.40
Oxygen	22.60
	100.00
Ash	0.15

For convenience of comparison the analyses of legumin from the vetch are brought together in the following tables:

SUMMARY OF ANALYSES OF VETCH LEGUMIN.

	15.	16.	18.	19.	21.	25.
Carbon	52.45	51.98	52.21	52.18	52.05	51.78
Hydrogen	6.98	6.92	6.82	6.82	6.99	6.89
Nitrogen	18.04	17.98	17.99	17.99	18.02	18.06
Sulphur	0.50	0.45	0.37	0.36	0.56	0.48
Oxygen	22.03	22.67	22.61	22.65	22.38	22.79
	100.00	100.00	100.00	100.00	100.00	100.00

	26.	27.	28.	29.	30.	31.
Carbon	52.17	52.04	52.11	51.89	52.06	52.12
Hydrogen	6.92	7.06	6.82	6.88	6.80	6.68
Nitrogen	17.70	18.02	18.17	18.09	17.98	18.20
Sulphur } Oxygen	23.21	22.88	0.53	0.40	0.53	0.40
			22.37	22.74	22.63	22.60
	100.00	100.00	100.00	100.00	100.00	100.00

It will be seen from the following statement that the composition of legumin from the pea is identical with that from the vetch.

LEGUMIN.

	PEA Average of 18 analyses on 10 preparations.	VETCH Average of 13 analyses on 12 preparations.
Carbon	52.20	52.09
Hydrogen	7.03	6.88
Nitrogen	17.93	18.02
Sulphur	0.39	0.46
Oxygen	22.45	22.55
	100.00	100.00

What we have already stated concerning the properties and reactions of pea legumin applies strictly to that from the vetch except in two particulars. The solutions of pea legumin in ten per cent. brine when heated nearly to boiling become turbid and, after a time, a considerable coagulum separates in the form of a semi-solid clot. Similar solutions of the vetch legumin, on the other hand, remain perfectly clear, even after prolonged boiling.

Many carefully conducted experiments made with the legumin from each of these seeds, wherein the same quantity of globulin was dissolved in the same amount of salt solution of the same strength, were carried out side by side, but always with the same results, the pea legumin coagulating to a greater or less extent while the vetch legumin remained wholly unaffected.

That this difference is due to some foreign substance is indicated by the following experiment. A quantity of ten per cent. sodium chloride extract of pea meal was filtered clear and divided into two parts, one of which was dialyzed directly, the other was saturated with sodium chloride and filtered clear. The latter solution was less viscid and much more easily filtered, presumably due to the removal of gum. This solution, saturated with salt, was then dialyzed.

The globulin precipitated by dialysis from each of the above-named solutions, was dissolved in brine to new solutions containing ten per cent. of globulin and eight per cent. of sodium chloride. When these two solutions were heated, side by side, in the same water bath and for the same length of time, a most marked difference was observed in the quantities of coagulum that appeared. Each solution contained a small quantity of the proteid coagulating at about 80°, so that after heating to 85° for some time, they were filtered clear and again heated.

Each solution then became turbid at 93° and, after heating the bath to boiling for a little time, the solution of the globulin from the salt saturated extract became curdy, from the separation of a moderate quantity of coagulum, while that from the unsaturated extract set to a firm opaque jelly, so that the tube could be inverted without displacement of its contents.

The second difference noted was very slight, but appeared to be constant. By precipitating the legumin from the pea by dialysis, the proteid was obtained in the forms of spheroids which showed little tendency to adhere in masses, while that from the vetch was always obtained in more or less coherent lumps which, however, were not at all fluid and gummy, but were easily broken up on stirring. In our opinion, the legumin from these two seeds is one and the same substance, or must, at least for the present, be so regarded.

SUMMARY.

1. So far as we have investigated, peas and vetches contain the same proteids, which are nearly if not entirely soluble in ten per cent. sodium chloride solution.

2. The greater part of these proteids consists of a globulin, the *Legumin* of Braconnot, which is readily precipitated by dialyzing its salt solutions.

The prevalent idea that legumin is soluble only in acids and alkalies is erronous, it having been proved, notably by Ritthausen, to be a true globulin. The composition of legumin, as shown by the average of our accordant analyses of thirty-one preparations obtained from the seeds of peas and vetches, is the following:

LEGUMIN.

Carbon	52.15
Hydrogen	6.96
Nitrogen	17.98
Sulphur	0.43
Oxygen	22.48
	100.00

Legumin is abundantly soluble in solutions containing above five per cent. of sodium chloride, in those containing less salt it is not so soluble, the amount held in solution decreasing as the salt content diminishes, so that it is but sparingly soluble in solutions containing less than one per cent. of salt. By dilution with water, strong saline solutions of legumin are abundantly precipitated.

By saturation with sodium chloride or magnesium sulphate, its sodium chloride solutions are not precipitated; by saturation with sodium sulphate at 25° they are not precipitated, but at higher temperatures more or less is thrown down, and by saturation with sodium sulphate at 34°, precipitation is very nearly complete. With nitric acid, Millon's and Adamkiewic's reagents it gives the usual proteid reactions.

With strong solutions of legumin the biuret test gives a violet color at first, which on standing becomes crimson red, similar to the color produced by peptones.

The legumin obtained by us from the vetch is not coagulated by heat nor even rendered turbid by prolonged boiling of strong solutions.

The legumin prepared by us from the pea is partly coagulated by heating strong solutions in a boiling water bath, and sets to a firm jelly after thus heating for some time. These differences in their behavior on heating, and a greater tendency of the vetch legumin to cohere in semi-solid lumps when precipitated by dialysis, are the only points of dissimilarity which a rigid comparison of preparations from the two seeds has revealed.

These differences, in our opinion, are due to the substances with which the proteid is associated in the two seeds, for saturation of the pea extracts with sodium chloride, before precipitating the legumin by dialysis, greatly diminished the amount of coagulum given by the pea legumin.

3. Besides the legumin, the pea and vetch contain another proteid in small amount, either an albumin or a globulin, soluble in extremely dilute salt solutions, and coagulated by heating its solutions to 80°. This substance we have not studied further than to make two preparations for analysis from the pea and one from the vetch. These were obtained in an insoluble form by coagulating with alcohol, so that the properties and reactions were not determined. The composition of this proteid is shown by the following average of three closely agreeing analyses:

PROTEID OF PEA AND VETCH.

Carbon	53.48
Hydrogen	6.89
Nitrogen	16.43
Sulphur	1.01
Oxygen	22.19
	100.00

4. In addition to the foregoing proteids a very little *proteose* was found in the extracts of both these seeds.

5. No attempt has yet been made to determine the total quantity of proteids in these seeds, nor to study minutely the proteids that occur in them in small proportion.

resulting solution filtered perfectly clear and dialyzed until free from chlorides. The proteid which on dialysis deposited with the same appearance and characters as the first preparation, was washed with water, dilute alcohol, stronger alcohol and then dehydrated with absolute alcohol and dried over sulphuric acid. Sixteen grams were obtained, equal to sixteen per cent. of the meal. This preparation, owing to the seed-integument, which had been but partly removed, was somewhat red in color. After drying at 110°, analysis gave the following results:

AMANDIN, 2.

			Average.
Carbon	51.49	----	51.49
Hydrogen	6.85	----	6.85
Nitrogen	19.27	19.05	19.16
Sulphur	0.44	----	0.44
Oxygen	----	----	22.06
			100.00
Ash	0.80		

For a third preparation Jordan almonds were drenched with hot water for a moment to loosen the skins, which were then easily detached; the meats were squeezed in a drug press to separate the greater part of the oil. The remainder of the oil, after dehydrating the pressed meats with absolute alcohol, was extracted with naphtha. The residue was freed from naphtha by evaporation and ground to a fine powder. There was thus obtained from 900 grams of almonds 380 grams of oil-free meal. This was thoroughly extracted with ten per cent. sodium chloride brine and the extract filtered. A turbid liquid resulted which was saturated with ammonium sulphate. The proteid thus precipitated was dissolved in ten per cent. sodium chloride brine and the solution after filtering perfectly clear was dialyzed until nearly free from chlorides. The solution was then decanted from the semi-fluid, viscid precipitate which had formed, and this was washed with water and alcohol, dehydrated with absolute alcohol and dried over sulphuric acid. The proteid thus obtained weighed sixty-six grams. The filtrate from this preparation was saturated with ammonium sulphate, the precipitate was filtered out, dissolved in a little water and the filtered solution was dialyzed. This second dialysis yielded twenty-seven grams more of globulin, which were added to that before obtained, making in all ninety

three grams, being twenty-four and one-half per cent. of the oil-free meal. Analysis of this preparation, **3**, dried at 110°, gave results as follows:

AMANDIN, 3.

			Average.
Carbon	51.18	----	51.18
Hydrogen	6.99	----	6.99
Nitrogen	19.30	19.37	19.33
Sulphur	0.48	----	0.48
Oxygen	----	----	22.02
			100.00
Ash	0.35		

A portion of **3** was dissolved in sodium chloride solution and dialyzed into dilute alcohol in the hope of obtaining the globulin in the form of crystals. No distinct crystals resulted, and after remaining about two weeks in alcohol the precipitated proteid was readily redissolved in salt solution, not having been coagulated by the alcohol, and the clear solution was dialyzed in water until free from chlorides. After washing and drying in the usual manner this preparation, **4**, was analyzed:

AMANDIN, 4.

	I.	II.	Average.
Carbon	51.39	51.32	51.36
Hydrogen	6.99	6.90	6.95
Nitrogen	19.32	19.36	19.34
Sulphur	0.45	----	0.45
Oxygen	----	----	21.90
			100.00
Ash	0.20		

Peach Kernel.

Ritthausen states that peach seeds contain the same proteid as the almond, a fact in harmony with the close botanical relations of the two plants.

We obtained this proteid from peach pits in the following manner: The seeds were freed from the skin (tegmen) by cutting it away with a knife and were then ground with ether to a powder and freed from oil. Only a small quantity of seeds, yielding but twenty grams of oil-free meal, were at the time available. This was extracted with ten per cent. sodium chloride solution and the clear filtered extract dialyzed. The globulin separated in spheroids, which settled to a translucent viscid semi-fluid mass like that from the almonds. The solution, when freed from chlorides by dialysis, was decanted from the precipitate and the latter was washed with water, alcohol and absolute alcohol and dried over sulphuric acid; 2.44 grams or 12.2 per cent. of the meal were so obtained. Analysis of this preparation gave the following results:

AMANDIN, FROM THE PEACH, 5.

			Average.
Carbon	51.06	51.02	51.04
Hydrogen	6.86	6.79	6.83
Nitrogen	19.20	19.35	19.28
Sulphur	0.48	----	0.48
Oxygen			22.37
			100.00
Ash	0.62		

Owing to the small quantity of **5**, it was not possible to compare its reactions throughout with those of amandin from the almond, but, so far as could be observed, the two were identical in all respects, and there can be no doubt that they are the same substance.

In the following table the foregoing results may be compared with those obtained by earlier investigators, in their work upon the proteid of the almond, peach and plum:

AMANDIN.

	Dumas and Cahours.		Löwenburg.	Norton.		
	Almonds.	Plums.	Almonds.		Almonds.	
Carbon	50.89	50.93	51.10	50.50	50.97	49.16
Hydrogen	6.71	6.73	7.20	6.56	6.64	6.51
Nitrogen	18.93	18.64	----	17.33	17.15	17.43
Sulphur	----	----	----	0.32	0.27	0.41
Phosphorus	----	----	----	1.05	0.57	2.21
Oxygen	23.47	23.70		24.24	24.40	24.27
	100.00	100.00		100.00	100.00	100.00

	Ritthausen.	
	Almonds.	Peach.
Carbon	50.44	50.82
Hydrogen	6.85	6.94
Nitrogen	18.61	18.60
Sulphur	0.43	0.32
Oxygen	23.67	23.32
	100.00	100.00

AMANDIN.

	Osborne and Campbell. Almonds.				Peach.	
	1.	2.	3.	4.	5.	Average.
Carbon	51.41	51.49	51.18	51.36	51.04	51.30
Hydrogen	6.86	6.85	6.99	6.95	6.83	6.90
Nitrogen	19.47	19.16	19.33	19.34	19.28	19.32
Sulphur	0.39	0.44	0.48	0.45	0.44	0.44
Oxygen	21.87	22.06	22.02	21.90	22.37	22.04
	100.00	100.00	100.00	100.00	100.00	100.00

Amandin, that has been dried over sulphuric acid, when mixed with cold water dissolves to a very slight extent and forms a gummy plastic mass. In water heated to about 98° amandin melts to a transparent mass and a considerable portion goes into solution, which in part separates out on cooling, and is redissolved on heating again. Boiling the solution causes but a slight turbidity.

The precipitate formed by cooling the hot water solution of amandin, dissolves completely on addition of a little nitric acid, but if more nitric acid be added, a precipitate falls which dissolves on warming and reappears on cooling in exactly the manner of a proteose.

In ten per cent. sodium chloride solution this proteid dissolves readily to a slightly opalescent liquid, no insoluble "albuminate" being formed by drying, as is the case with most vegetable globulins.

A solution containing ten per cent. of amandin dissolved in ten per cent. sodium chloride brine gives an abundant precipitate when poured into much distilled water, but if only a small amount of proteid is dissolved in the brine no precipitate is produced by dilution.

Salt solution of amandin is not precipitated by saturating with sodium chloride. By saturating with magnesium sulphate it is partly thrown down. Saturation with sodium sulphate or ammonium sulphate completely precipitates it.

Nitric acid added to the sodium chloride solution forms a precipitate soluble in an excess of acid which, on heating, gives the usual xanthoproteic reaction.

With mercuric chloride solution no precipitate is formed.

With picric acid and also with tannic acid heavy precipitates are produced.

Amandin is readily soluble in very dilute acetic acid. The acetic solution yields an abundant precipitate with potassium ferrocyanide that is difficultly soluble in an excess of this salt to a solution precipitable by diluting with water. In concentrated glycerine the dry proteid dissolves quite readily, the clear solution yielding a considerable precipitate on adding absolute alcohol.

Concentrated hydrochloric acid dissolves it, with development of a violet-blue color on standing. By heating in quite dilute sulphuric acid a solution is obtained which becomes turbid on cooling, the proteid being far less soluble in sulphuric than in hydrochloric or acetic acids. With the biuret test and also with glacial acetic acid and concentrated sulphuric acid together, solutions of this globulin give a fine violet color.

After solution in very dilute potash water and precipitation by neutralizing with acetic acid, amandin retains its original solubility in salt solutions.

A ten per cent. sodium chloride solution, containing five per cent. of amandin, becomes turbid when heated to 75°, and at 80° flocks form in small quantity which slowly increase on gradually raising the temperature, but only a small part of the proteid is coagulated even by boiling.

Having thus, as we believe, established this proteid as a chemical species quite distinct from all others hitherto investigated, it is proper to restore the designation *Amandin* given it by Proust, its discoverer, and to discard for it the names vitellin and conglutin, which are associated with many erroneous statements as to its occurrence, composition and characters.

Walnut, Juglans regia.

Ritthausen (Jour. f. prakt. Chem., 24, 257) prepared the proteid from this seed, but owing to the large amount of tannin present in the skins, he found much difficulty in obtaining satisfactory results.

As Ritthausen's preparations differed widely in composition, and as he has published nothing respecting the properties of this proteid, we have made several preparations with the following results.

A quantity of walnut meats was crushed, freed from oil by extracting with petroleum naphtha, and the greater part of the skins removed by sifting. One hundred grams of this meal were then extracted with ten per cent. sodium chloride brine and, after filtering, eight-tenths of the salt solution applied was recovered as a

clear extract corresponding to about eighty grams of meal. This was saturated with ammonium sulphate and the resulting precipitate filtered out and treated with salt solution. Much that failed to dissolve was separated by filtration and the clear solution was dialyzed until free from chlorides. During dialysis the proteid was deposited in spheroids which did not, like amandin, unite to a confluent mass. The precipitated globulin was then filtered out, washed with water, alcohol and absolute alcohol and dried over sulphuric acid. Only 2.87 grams were obtained, equal to about 3.6 per cent. of the meal. This small yield was undoubtedly due to tannin, which rendered the greater part of the proteid insoluble in salt solution.

Dried at 110° this preparation, **6**, had the following composition:

WALNUT GLOBULIN, CORYLIN, 6.

			Average.
Carbon	50.32	50.32	50.32
Hydrogen	6.63	6.74	6.69
Nitrogen	19.06	19.12	19.09
Sulphur	----	---- }	23.90
Oxygen	----	---- }	
			100.00
Ash	0.63		

The part of the ammonium sulphate precipitate which was not taken up by salt solution at 20° was treated with brine at 60°. In this it dissolved almost completely and did not precipitate on cooling. The clear filtered solution was dialyzed free from chlorides, and by the usual process, 2.82 grams or 3.5 per cent. of globulin were obtained, having the following composition:

WALNUT GLOBULIN, CORYLIN, 7.

Carbon	50.83	
Hydrogen	6.79	
Nitrogen	19.05	19.04
Sulphur	0.89	
Oxygen	22.44	
	100.00	
Ash	0.15	

In order to avoid the presence of tannin, another lot of walnut seeds were drenched for a moment with hot water, whereupon the skins were easily stripped off. The crushed meats were then treated with ether to extract the oil and, after removal of ether by exposure to the air, the coarse meal was finely ground and fifty grams were extracted with fifteen hundred cubic centimeters of ten per cent. brine of common salt. The extract was filtered clear, saturated with ammonium sulphate, the resulting precipitate dissolved in salt solution at 40° and the extract dialyzed free from chlorides. The precipitated globulin was then filtered out and treated in the usual manner, giving preparation **8**, weighing 10 grams, equal to 20 per cent. of the meal, and having the following composition:

WALNUT GLOBULIN, CORYLIN, 8.

			Average.
Carbon	50.77	50.74	50.76
Hydrogen	6.94	6.83	6.89
Nitrogen	19.10	19.02	19.06
Sulphur	----	----	} 23.29
Oxygen	----	----	
			100.00
Ash	0.32		

Hazel-nut or Filbert, Corylus tubulosa.

Ritthausen (Jour. f. prakt. Chem., 24, 257) has detailed the results of his examination of the proteid of this seed and concluded it to be identical with the conglutin which he obtained from almonds.

In order to satisfy ourselves respecting this substance a quantity of hazel-nut meats was freed from skins and oil as already described in case of walnuts, and finely pulverized. The meal was then extracted with ten per cent. sodium chloride brine and the filtered extract saturated with ammonium sulphate. The precipitated proteid was filtered out, dissolved in salt solution, and the liquid, after filtering clear, was dialyzed free from chlorides.

During dialysis the globulin separated in spheroids which, like those of walnut globulin, settled down, without adhering together to a plastic mass, after the manner of amandin. The precipitated globulin was filtered out and treated in the usual way. When dried at 110° this preparation had the following composition:

CORYLIN, FILBERT GLOBULIN, 9.

			Average.
Carbon	50.64	50.80	50.72
Hydrogen	lost	6.86	6.86
Nitrogen	19.14	19.19	19.17
Sulphur	0.83	----	0.83
Oxygen	----	----	22.42
			100.00
Ash	0.28		

In properties this preparation exactly resembled the globulin obtained from the walnut. That the two are identical in composition is shown by the following statement:

CORYLIN.

	Walnuts 6	Walnuts 7	Walnuts 8	Filberts. 9
Carbon	50.32	50.83	50.76	50.72
Hydrogen	6.69	6.79	6.89	6.86
Nitrogen	19.09	19.05	19.06	19.17
Sulphur }	} 23.90	0.89	} 23.29	0.83
Oxygen }		22.44		22.42
	100.00	100.00	100.00	100.00

The properties of this proteid, after drying over sulphuric acid, as exhibited by preparations **8** and **9**, are as follows. In the dry state it forms a heavy snow-white powder which, unlike amandin, is entirely insoluble in distilled water at 20° or at 40°. In ten per cent. sodium chloride solution it dissolves readily and completely, as also in exceedingly dilute acids and alkalies. Sulphuric acid, however, dissolves it much less readily than acetic, hydrochloric or nitric acid.

The solution in ten per cent. sodium chloride brine, containing ten per cent. of this globulin, gives an abundant precipitate when diluted with an equal volume of water. More dilute solutions give precipitates on sufficient dilution. Corylin is very much more readily precipitated by dilution than amandin. Hydrochloric acid and acetic acid each gives a precipitate insoluble in considerable excess of acid, when added to saline solutions of the proteid. With mercuric chloride, picric acid, or tannic acid dissolved in ten per cent. sodium chloride brine, heavy precipitates are produced. Saturation with sodium chloride gives a slight precipitate. Saturation with magnesium sulphate produces a considerable though partial precipitation. Saturation with sodium sulphate or ammonium sulphate effects a complete precipitation.

Dissolved in a little acetic acid, a precipitate is produced by sufficient nitric acid, which dissolves on heating and partly reprecipitates on cooling. The solution in acetic acid gives a precipitate with ferrocyanide of potassium, but slightly soluble in a large excess of the latter.

With the biuret test the usual violet color is obtained. With Millon's and the xanthoproteic tests the ordinary proteid reactions appear. Dissolved in concentrated hydrochloric acid and boiled, a violet blue color develops on standing.

With glacial acetic acid and concentrated sulphuric acid, solutions of corylin give a violet color. When five per cent. of this proteid is dissolved in ten per cent. sodium chloride brine and the solution heated, turbidity ensues at about 80° and flocks form in small amount at 99°. On boiling the solution, a little more coagulates, but the corylin is precipitated by heat very slowly and incompletely.

When dissolved in dilute potash water and precipitated by neutralization, the proteid dissolves completely in ten per cent. salt solution. These reactions and the results of analysis show this body to be entirely distinct from either amandin or edestin. We therefore propose the name *Corylin*, from the generic name of the filbert, *Corylus tubulosa*, in which this proteid was first found by Dumas and Cahours (Jour. f. prakt. Chem., 28, 398).

Brazil-nut, Bertholletia excelsa.

Weyl (Zeitschr. f. physiol. Chem., 1, 85) described the globulin of the Brazil-nut under the name of vegetable vitellin, and first determined its composition with a close approach to accuracy.

One of us has already investigated this substance as to its composition and properties, when prepared both in the form of spheroids and as perfectly distinct crystals (Osborne, Am. Chem. Jour., 14, 662). This proteid, being evidently different from all others hitherto examined, deserves a distinct name, and we accordingly propose to designate it *Excelsin*.

Oat-kernel.

From the oat-kernel one of us (Osborne, Reports of this Station 1890 and 1891, and Am. Chem. Jour., 14, 212 and 682) obtained a crystallized globulin very similar in composition to excelsin, but different in its reactions as well as in crystalline form. This globulin might be classed as a vitellin, and for that reason is here referred to. As yet this proteid has received no specific name and we now propose to call it *Avenalin*.

Hemp, Cannabis sativa; Squash, Cucurbita maxima, and Castor Bean, Ricinus communis.

Proteid preparations from the seeds of hemp, squash and castor bean have been described under the names of conglutin and vitellin. One of us (Osborne, Am. Chem. Jour., 14, 671–689) has shown that these seeds contain, as their chief and characteristic proteid, one and the same substance and has named it *Edestin*. This has been found in a larger number of seeds than any proteid yet discovered, and is the body most commonly called vegetable vitellin. It is readily obtained pure in octahedral crystals, from several seeds, and owing to this fact has been employed in physiological investigations. That it is a different substance from the proteids already described in this article appears to have been mostly overlooked. The properties and composition of edestin are detailed in the paper above mentioned, and in the Annual Reports of this Station for 1893, pp. 179, 214, 216, and 1894, pp. 155, 170, 190.

Coconut, Cocos nucifera.

The proteid of the coconut was examined by Ritthausen (Pflüger's Archiv., 21, 96), who, without identifying it with conglutin, assigned to it a similar composition. Chittenden (Medical Record, 45, 450, and Digestive Proteolysis, New Haven, 1895, p. 32), under the general name phytovitellin, gives the composition of this proteid in close accord with that of edestin, and as he obtained it partly crystallized in octahedra it probably is edestin.

Lupin, Lupinus.

The principal proteid contained in lupin seeds is the body to which Ritthausen first gave the name conglutin (Eiweisskörper, Bonn, 1872, and Jour. f. prakt. Chem., 25, 422). We have devoted much labor to the study of this proteid, but the results of our work are not yet complete and will form the subject of a future paper. We find that it is distinctly different in composition and properties from the proteids which we have hitherto noticed, and we take especial pleasure in confirming to it the name *Conglutin* proposed by its veteran discoverer.

We give on page 301 the composition of conglutin as found by us in accordant analyses of six preparations from the blue lupin.

Sunflower, Helianthus.

The proteid of the sunflower seed as described by Ritthausen (Pflüger's Archiv., 21, 81) appears to be identical with edestin, but our investigation of this substance, which is still in progress, shows that the proteid prepared by the usual methods is contaminated with the helianthotannic acid described by Ludwig and Kromayer (N. Br. Arch., 99, 1 and 285). As yet we have been unable to obtain this proteid in the pure state.

To the best of our knowledge the proteids noticed in this paper include all which have been hitherto designated either as conglutin or vitellin. Of late years many seeds have been described as containing vitellin, but its presence has been inferred from qualitative reactions and not, except in those cases mentioned in this paper, from a study of the isolated proteid.

We have accordingly at least six perfectly distinct proteids which have been confounded together under the name vitellin or conglutin. The following table shows the present state of our knowledge concerning the composition of these globulins and sets forth the characters in which they have been found to differ.

PROTEIDS FORMERLY KNOWN AS VITELLIN OR CONGLUTIN.

	EDESTIN.	AMANDIN.	CORYLIN.	EXCELSIN.	AVENALIN.	CONGLUTIN.
Carbon	51.65	51.30	50.72	52.18	52.18	51.00
Hydrogen	6.89	6.90	6.86	6.92	7.05	6.90
Nitrogen	18.75	19.32	19.17	18.30	17.90	17.99
Sulphur	0.85	0.44	0.83	1.06	0.53	0.40
Oxygen	21.86	22.04	22.42	21.54	22.34	23.71
	100.00	100.00	100.00	100.00	100.00	100.00
Salt solution saturated with— Sodium chloride.	No pp.	No pp.	No pp.	No pp.	Complete pp.	No pp.
Magnesium sulphate.	Complete pp.	Partial pp.	Partial pp.	Slight pp.	Complete pp.	No pp.
$HgCl_2$.	Pp.	No pp.	Pp.	No pp.	Pp.	No pp.
Solution of 10% proteid and 10% sodium chloride diluted with equal volume of water gives—	Pp.	No pp.	Pp.	Slight pp.	Pp.	No pp.
Heat coagulation— Turbidity.	88°	75°	80°	70°	No coagulation even on boiling.	Trace of coagulation at 99°, sets to jelly on cooling.
Flocks.	95°	80°	99°	84°		
Precipitate by dialysis,	Octahedral crystals or spheroids, pulverulent.	Spheroids, uniting to viscid fluid.	Spheroids, pulverulent.	Hexagonal plates or spheroids, pulverulent.	Spheroids, pulverulent.	Spheroids uniting to plastic mass.
Found in seeds of—	Hemp, Castor bean, Squash, Flax, Cotton, Wheat, Rye, Barley, Maize, Cocoanut.	Almond, Peach.	Walnut, Filbert.	Brazil-nut.	Oat.	Lupin.

RECENT LEGISLATION AFFECTING THE STATION.

In the Report of the Board of Control, page xv, mention is made of Acts affecting this Station, passed by the General Assembly at the January session, 1895.

The text of these Acts is here printed in full.

It was intended to print in this Report an account of work done under the Food Act during the last quarter of the State fiscal year of 1895, but various causes have rendered it impracticable to do so, and with consent of the Governor this account will be printed in the next Report and at an early date.

[Substitute for House Bill No. 16.]

An Act making an Appropriation to the Connecticut Agricultural Experiment Station.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The further sum of two thousand dollars annually is hereby appropriated to the Connecticut Agricultural Experiment Station, to be paid in the same manner as now provided by section 1714 of the general statutes; and the treasurer of the board of control of said station, before any of the money hereby appropriated is paid, shall give an additional bond in the sum of four thousand dollars, and hereafter on any subsequent appointment such treasurer shall give bond with surety to the State of Connecticut in the sum of fourteen thousand dollars, for the faithful discharge of his duties as such treasurer.

SEC. 2. The sum of two thousand five hundred dollars is hereby appropriated to the Connecticut Agricultural Experiment Station for the purpose of better equipping, and making additions to, the chemical and botanical laboratories of said station, for building and equipping vegetation houses on the land of said station, to be used for the purposes of said station, and to aid in experiments in the fermentation and cure of tobacco on the land of the Connecticut Tobacco Experiment Company in the town of Windsor; the said sum to be paid only on vouchers approved by the director or vice-director of said station, and filed with the comptroller, who is hereby directed to draw his order for the payment of the same.

SEC. 3. This act shall take effect from its passage.

Approved, June 26, 1895.

[Senate Bill No. 167.]

CHAPTER CCXXXV.

An Act regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Manufacture or sale of misbranded or adulterated food.

SECTION 1. It shall be unlawful for any person, persons, or corporation within this state to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

Term food defined. Term misbranded defined.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

When an article shall be deemed to be adulterated.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated: First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength; second, if any inferior substance or substances be substituted wholly or in part for the article; third, if any valuable constituent of the article has been wholly or in part abstracted; fourth, if it be an imitation of or sold under the name of another article; fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is; sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer; seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter; *provided*, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases: (*a*) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section; (*b*) in the case of articles labeled, branded, or tagged, so as plainly and correctly to show that they are mixtures, compounds, combinations, or blends; (*c*) when any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption, and not fraudulently to increase the bulk, weight, or measure of the food or to conceal the inferior quality thereof; (*d*) when a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

ticut tural nent to make s.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it deems necessary; who shall have free access, at all reasonable hours, for the purpose of examining, into any place wherein it is suspected any article of food adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent or agents upon tendering the market price of said article may take from any person, firm, or corporation samples of any article suspected of being adulterated as aforesaid, and the said station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute.

to prose- officers.

SEC. 5. Whenever said station shall find by its analysis that adulterated food products have been on sale in the state, it shall forthwith transmit the facts so found to a grand juror or prosecuting attorney of the town in which said adulterated food product was found.

SEC. 6. The said station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

riation.

SEC. 7. To carry out the provisions of this act, the additional

sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

Penalty.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

Action not maintained illegal sale

SEC. 9. No action shall be maintained in any court in this state on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

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