TOBACCO STATION BULLETIN 5 MAY, 1925

Connecticut Agricultural Experiment Station
New Haven, Connecticut

Fertilizer Experiments

With

Tobacco

TOBACCO STATION
AT
WINDSOR

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

May, 1925.

The Wilson H. Lee Co.

Fertilizer Experiments With Tobacco*

N. T. Nelson and P. J. Anderson

Nowhere in the world does tobacco receive so expensive a ration of fertilizer as in New England. About one-third of the entire cost of producing tobacco here is the fertilizer item. Aside from the heavy cost, consideration of the fertilizer problem is extremely important because its composition affects the quality as well as the yield of cigar leaf. Yet, despite its vital importance to the tobacco grower, the investigation of commercial fertilizers for tobacco has received very scant attention from the experiment stations of New England. In the annals of tobacco growing in the Connecticut Valley, extending back for more than a century, there are found records of only two sets of fertilizer experiments. These two classical experiments were conducted thirty years ago at about the same time by Goessmann[1] in Massachusetts and Jenkins[2] in Connecticut. Conditions have changed so much in the last thirty years, both in fertilizers and in tobacco growing, that a considerable part of the conclusions from these experiments may not be applicable to present times. There is need for a reworking of the whole field of commercial fertilizers for tobacco.

There have been numerous fertilizer tests for tobacco in other sections of the country, but the results are of little value to the Connecticut grower because the type of tobacco grown is not the same, the soil and climate are different and the New England system of continuous cropping is different from that followed in other sections.

* The fertilizer experiments at the tobacco station at Windsor, were begun in 1922 by Dr. G. H. Chapman, and carried out under his direction until his resignation August 1, 1923. From that time until April 1924, they were continued by C. M. Slagg, and after April 1, by Dr. N. T. Nelson, physiologist in charge. These changes of administration have been unfortunate for the continuity of the experiments and have resulted in considerable loss since the data were recorded in different ways and are not supplemented by actual knowledge of their progress on the part of the present administration.

Since a considerable mass of data has accumulated in the files it has seemed best to publish all of it that is of significance in order to have on record all that has been done. With some modifications and additions the experiments are being continued and it is hoped that the data obtained from them will be published annually in the future. The data on the experiments of 1922 and 1923 are taken entirely from the reports of Dr. Chapman and Mr. Slagg and the present writers wish to give to them all credit for the work done.

[1] Goessmann, C. A. On field experiments with tobacco in Massachusetts. Mass. Agric. Expt. Station. Bulletin **47**:1-31, 1897.

[2] Jenkins, E. H. Experiments in growing tobacco with different fertilizers. Conn. Agric. Expt. Station Report **16**:1-35, **17**:112-144, **18**:254-284, **19**:128-156, **20**:285-333, **21**:230-256 (1892-1897).

Limitations of available space and time to devote to it made it necessary to restrict the experiments at the beginning to an attempt to solve only a few of the problems involved. The experiments were divided into series as follows:

1. *Nitrogen series.* Comparison of different carriers of nitrogen.
2. *Phosphoric acid series.* Comparison of different quantities of phosphoric acid.
3. *Potash series.* Comparison of high grade sulfate of potash with double manure salt.
4. *Manure series.* Comparison of different kinds of manure.
5. *Fractional application series.* Comparison of fertilizer applied all at once with the same amount, or less, divided between several applications.
6. *Sulfur-chlorine-magnesium series.* The purpose of this experiment was to determine the effect of these elements on the tobacco.[1]

In the following pages each of these series is followed separately throughout the three years of the experiment.

Nitrogen Series

The tests in this series were designed to answer these questions:

1. Can all of the nitrogen be furnished to the plant from mineral carriers,—nitrate of soda, nitrate of potash and sulfate of ammonia?
2. Can one-half of the nitrogen be supplied from these mineral sources, the other half being from cottonseed meal and castor pomace?
3. Can one-half of the nitrogen be supplied to advantage in dry ground fish?
4. Can one-half of the nitrogen be supplied in tankage?

The advantage to be sought through the substitution of mineral for the organic sources of nitrogen is reduction in the cost of the fertilizer since the inorganic sources are only about one-half as expensive as the organic sources. In the case of fish, it was hoped also that there might be an improvement in the quality of the leaf. It is the general belief among tobacco growers that the use of inorganic sources of nitrogen produces tobacco of poor quality. In Dr. Jenkins' experiments it was found that where castor pomace was compared with a ration in which one-half of the nitrogen was supplied by pomace and one-half by nitrate of soda,[2] the latter formula did not produce tobacco of as good quality as where castor pomace alone was used, but the yield was increased. In his experiments he also found that the use of fish scrap as the *only* source of nitrogen reduced the yield but gave a superior quality. He did not try fish in combination with other sources of nitrogen.

[1] This series in cooperation with the Office of Tobacco Investigations, United States Department of Agriculture. Not reported on in this bulletin.

[2] Since the nitrate of soda was applied to the growing crop as a side dressing it is not possible to judge whether the results were due to mineral nitrogen or to fractional application.

The soil in the field on which the tests were made is Hartford sandy loam, and is fairly uniform in texture, drainage and fertility. It was laid out in plots of 1/40 acre, each containing four rows. Only three rows of each plot however, were harvested for the test because the fourth row was on the border and feeding from plots on each side of it treated in different ways. The whole series of seven plots was in triplicate making a total of twenty-one plots. All fertilizers were applied broadcast at one application about one week before setting. Rows were three feet four inches apart and the plants eighteen inches apart in the row. The variety of tobacco was Havana seed and all plots were set on the same day with plants as nearly uniform as could be obtained. The tobacco was primed in 1922 and 1923 but stalk cut in 1924.

After consultation with many growers in the Connecticut Valley and a careful study of previous field experiments, it was decided that a fertilizer containing approximately 260 lbs. ammonia; 225 lbs. phosphoric acid; and 240 lbs. potash to the acre would furnish ample quantities of these plant nutrients for an acre of tobacco. These amounts were considered as a basal ration in this experiment. Although such amounts of plant food materials are greatly in excess of that removed from the soil by the plant, farm practice in the Connecticut Valley has shown that the above quantities grow a good crop of tobacco. Accordingly, all the plots of this series received approximately the same number of pounds of the above plant nutrients per acre.

The fertilizer treatment of the seven plots was as follows:

Plot N1 Basal Ration. 1–7 of the Nitrogen in a Mineral or Inorganic Form (Sodium Nitrate). The Balance in Cottonseed Meal and Castor Pomace.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	300	.....	115.5	.....
Acid phosphate	200	.....	34.4	.....
Sulfate of potash	400	.....	.....	200.0
Total	4,000	264.2	224.9	239.5

Plot N2 One Half Nitrogen in Inorganic Carriers (Sodium Nitrate and Ammonium Sulfate*). The Balance of Nitrogen in Organic Carriers (Cottonseed Meal and Castor Pomace).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,270	104.1	36.9	19.1
Castor pomace	410	27.9	7.4	4.1
Nitrate of soda	365	68.6	.....	.....
Sulfate of ammonia	260	65.0	.....	.....
Precipitated bone	375	.....	144.4	.....
Acid phosphate	213	.....	36.6	.....
Sulfate of potash	433	.....	.....	216.5
Total	3,326	265.6	225.3	239.7

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N3 ALL NITROGEN IN MINERAL CARRIERS (SODIUM NITRATE AND AMMONIUM SULFATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	550	137.5	.....	.....
Nitrate of soda	676	127.1	.....	.....
Precipitated bone	460	.....	177.1	.....
Acid phosphate	280	.....	48.2	.....
Sulfate of potash	479	.....	.....	239.5
Total	2,445	264.6	225.3	239.5

PLOT N4 ONE HALF NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE*). THE BALANCE OF NITROGEN IN COTTONSEED MEAL AND CASTOR POMACE.

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,270	104.1	36.9	19.1
Castor pomace	410	27.9	7.4	4.1
Sulfate of ammonia	265	66.3	.....	.....
Nitrate of potash	435	65.3	.....	188.8
Precipitated bone	375	.....	144.4	.....
Acid phosphate	213	.....	36.6	.....
Sulfate of potash	55.5	.....	.....	27.8
Total	3,023.5	263.6	225.3	239.8

PLOT N5 ALL NITROGEN IN MINERAL CARRIERS (POTASSIUM NITRATE AND AMMONIUM SULFATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Sulfate of ammonia	724	178.0	.....	.....
Nitrate of potash	552	82.8	.....	239.6
Precipitated bone	460	.....	177.1	.....
Acid phosphate	280	.....	50.2	.....
Total	2,016	260.8	227.3	239.6

PLOT N6 ONE HALF NITROGEN FROM FISH, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1–7 OF THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,150	94.3	33.4	17.3
Dry ground fish	1,250	130.5	95.0	.....
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	200	.....	77.0	.....
Acid phosphate	115	.....	19.8	.....
Sulfate of potash	444	.....	.....	222.0
Total	3,359	262.4	225.2	239.3

* These two materials used in amounts which theoretically would not change the soil reaction.

PLOT N7 ONE HALF NITROGEN FROM FINE TANKAGE, THE BALANCE FROM COTTONSEED MEAL AND SODIUM NITRATE (1–7 THE TOTAL NITROGEN IN THE NITRATE).

Carrier Name	Lbs. per acre	Plant nutrients per acre NH_3	P_2O_5	K_2O
Cottonseed meal	1,150	94.3	33.4	17.3
Tankage	1,359	130.46	108.7	.....
Nitrate of soda	200	37.6	.....	.....
Precipitated bone	180	.....	69.3	.....
Acid phosphate	80	.....	13.8	.....
Sulfate of potash	444	.....	.....	222.0
Total	3,413	262.4	210.7	239.3

From the above figures it is seen that the slight variation in the amounts of ammonia applied to the different plots is negligible. There is, however, a wide difference as to the type of substances used as nitrogen carriers. Plot N1 had one seventh of its nitrogen in mineral form; Plot N2, one half mineral nitrogen; Plot N3, all mineral nitrogen; Plot N4, one half mineral nitrogen; Plot N5, all mineral nitrogen; Plot N6, and Plot N7, one seventh mineral nitrogen. The amounts of potash and phosphoric acid added to the above plots was the same in all cases, approximately 240 pounds K_2O, and 225 pounds P_2O_5 per acre.

SEASON OF 1922

The average yield and quality of the triplicate plots in 1922 as recorded by Chapman is presented in Table I.

TABLE I. EFFECTS OF DIFFERENT SOURCES OF NITROGEN ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Lbs. ammonia per acre Mineral	Organic	Av. yield cured leaf, lbs. per acre	General Quality
N1....	37.6	226.6	1,396	Excellent
N2....	133.6	132.0	1,204	Fair
N3....	264.6	.....	1,456	Poor
N4....	131.6	132.0	1,360	Fairly good
N5....	260.8	.....	1,460	Excellent
N6....	37.6	224.8	1,382	Excellent
N7....	37.6	224.8	1,280	Good

A study of the above table shows that plots treated with all mineral nitrogen fertilizer had a tendency to give greater yields but poorer quality tobacco than plots receiving nitrogen of vegetable or animal origin. The quality of the tobacco on Plots N3 and N5, which received all the nitrogen in a mineral form, was so poor as to warrant an appraisal of fifteen cents a pound less than any other tobacco grown in this series. Not only was the tobacco of the first and second primings very poor, but the fourth was also of little character. The colors especially were poor, running almost entirely to a yellowish red, and not clean. Plots N1 and N6 were of the best quality and had a better finish than any of the

others. The body, grain, texture, and color, were highly satisfactory on these two plots, but plots N3 and N5 produced tobacco of harsh texture, poor color, and too close a grain. Plot N7, on which tankage was used, while yielding a large percentage of desirable colors, gave a more of less dark greenish tobacco after fermentation.

The growth of the tabacco on all of the plots of the nitrogen series was very satisfactory as far as judged by measurements. Topping time showed that there was less than ten percent difference in the average height of plants on the different plots. No fixed growth difference as to height could be attributed to the different fertilizer treatments. Although not suffering in growth, there was one particularly noticeable variation on these plots in 1922. Those plots which were fertilized with a large percentage of nitrogen in the mineral form developed a marked *chlorosis*, apparently directly proportionate to the amount of mineral nitrogen present in the fertilizer. Chlorosis was noticed especially at the base of the plant on those plots supplied with large amounts of mineral nitrogen. On those plots where half the nitrogen was supplied in mineral form and a half from organic sources, chlorotic effects extended upward on the bottom five leaves. Chlorosis extended half way up the plant on the plots which had all the nitrogen applied in mineral form; eight and sometimes ten leaves were affected. This chlorosis was in every respect similar to that called "sand drown" by Dr. W. W. Garner of the United States Department of Agriculture. Immediately adjacent to the nitrogen plots was another series of plots to determine the effects of magnesium deficiency. These plots were specially treated to show the cause of sand drown and were run in cooperation with the United States Department of Agriculture. The chlorosis in the nitrogen plots was in every way similar to the chlorosis which accompanied magnesium starvation on the cooperative plots. For the season of 1922, at least, it was possible that the fertilizers high in mineral nitrogen did not supply adequate amounts of magnesium to fill the deficiency. The plots supplied with an abundance of organic nitrogen, on the other hand, did not develop chlorosis or "sand drown". Organic nitrogen carriers such as cottonseed meal apparently contain magnesium in amounts sufficient to meet the magnesium needs of the tobacco plant on an average Connecticut soil. The season of 1922 was very wet at times, and excessive leaching probably took place (which accentuated the effects). In a drier year, magnesium starvation probably would not follow the application of a heavy mineral nitrogen mixture. No chlorosis was noted in 1923.

Season of 1923.

In 1923 the nitrogen plots were the same as to location and treatment as they were in 1922. It was a much more favorable season, inclined to be dry, while 1922 was extremely wet. The

tobacco was primed. Total weights of the triplicate plots were taken and figured to the acre basis as given in Table II. Each of the four primings was kept separate and a certain number of leaves taken from each for securing sorting data. All data (except total weights) are based on number of leaves. Burn tests were also made. Sorting results are recorded in the table.

In general the results seem inconsistent and no general tendency can be traced. As in the preceding year, the use of all mineral ammoniates resulted in the highest yields. The data on burn and percentage of high grades do not show that the quality was worse than where only one-seventh of the ammonia was from mineral sources. The fact that the burn was always best on the first priming is very apparent. Both dry ground fish and tankage appear to be superior to the basal ration in yield, percentage of higher grades and burn.

Season of 1924.

In 1924 the nitrogen plots were treated in the same manner as in 1923, being set with Havana seed on June 13 and 14, topped August 1 and 2, and harvested August 15 and 16.

Throughout the growing season no significant growth differences were observed between the different plots of the series. The tobacco on Plot N3 was slightly taller than that on the other plots but it also was more mature, being in full bloom when the others were only early and medium bloom at the date of topping. The average number of plants on the plots at harvest (about 160) indicates that the stand was practically uniform throughout the test.

The weather was extremely dry during both the growth and curing periods. The season was too dry for normal growth and a good cure. Scanty "damps" caused some difficulty in getting the crop in proper "case" until late in the fall. The tobacco was taken down in the middle of November and weights in the bundle were made November 28th, 1924.

In February, 1925, the tobacco was sorted by an experienced sorter, Mr. Frank Solkowski, and accurate weights were recorded on the different grades and lengths as indicated in tables III and IV.

TABLE II. SORTING DATA ON NITROGEN PLOTS FOR 1923.

Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
N 1	Basal ration 1–7 ammonia in minerals	1,768	564	1	28	....	....	....	70	30–25–24–18
				2	90	....	....	58	....	4– 6–12–10
				3	4	117	10	53	....	7– 6– 7– 9
				4	....	....	134	....	....	3– 5– 4– 3
				Total	122	117	144	111	70	
				%	21.63	20.74	25.54	19.68	12.41	Av. 11 secs.
N 2	½ ammonia in minerals (sulf. am. and nitr. soda)	1,795	535	1	77	....	....	39	35	37–31–28–39
				2	87	....	....	39	....	8–11– 9– 7
				3	49	78		15	....	5– 7– 7– 9
				4	....	6	110	....	....	1– 0– 2– 1
				Total	213	84	110	93	35	
				%	39.81	15.7	20.56	17.38	6.55	Av. 13 secs.
N 3	All ammonia in minerals (sulf. am. and nitr. soda)	1,857	567	1	46	....	....	63	46	20–27–15–33
				2	88	....	....	50	9	7– 6– 6– 5
				3	34	82	....	21	....	3– 5– 7– 9
				4	....	3	125	....	....	1– 0– 1– 2
				Total	168	85	125	134	55	
				%	29.63	14.99	22.05	23.63	9.7	Av. 9 secs.
N 4	½ ammonia in minerals (sulf. am. and nitr. potash)	1,789	543	1	24	....	....	40	90	67–42–59–53
				2	56	....	....	75	....	25– 7–32– 6
				3	15	90	....	34	....	7–14– 6– 7
				4	....	....	129	....	....	14–10–15–11
				Total	95	90	129	149	90	
				%	17.50	16.58	23.76	27.26	16.57	Av. 23 secs.

SORTING DATA ON NITROGEN PLOTS FOR 1923—*Continued.*

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
N 5	All ammonia in minerals (sulf. am. and nitr. potash)	1,955	567	1	30	....	....	70	70	61–83–75–79
				2	81	....	....	52	....	9– 6– 7– 8
				3	20	85	....	40	....	8– 5– 6– 7
				4	....	4	115	....	....	3– 1– 2– 2
				Total	131	89	115	162	70	
				%	23.1	15.69	20.28	28.59	12.34	Av. 22 secs.
N 6	½ ammonia in fish	1,927	563	1	69	....	....	56	25	40–45–20–30
				2	82	....	....	50	....	37– 9–30– 7
				3	12	95	10	19	....	3–21–14– 6
				4	....	20	125	....	....	6–14– 7– 6
				Total	163	115	135	125	25	
				%	28.95	20.43	23.98	22.20	4.44	Av. 23 secs.
N 7	½ ammonia in tankage	1,919	552	1	47	....	....	71	35	45–58–95–63
				2	74	....	....	53	....	13–11–15– 9
				3	30	92	3	20	....	7– 6– 7–13
				4	....	20	107	....	....	6– 3–11– 7
				Total	151	112	110	144	35	
				%	27.35	20.29	19.95	26.08	6.34	Av. 23 secs.

TABLE III. SORTING RESULTS FOR 1924 CROP. TOTAL WEIGHT OF GRADES AND LENGTHS IN OUNCES.

Plot No.	Fillers	Brokes	Tops	Darks				Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
N1.....	31	63	24	26	63	55	3	5	21	36	15	1	343
N1*.....	45	122	68	10	34	59	8	0	5	15	17	2	385
N1**....	51	68	88	8	45	66	12	5	23	36	14	0	416
N2.....	44	99	53	8	39	76	18	3	11	27	19	2	399
N2*.....	46	113	57	14	39	41	9	2	10	23	23	3	377
N2**....	45	62	56	13	49	64	6	4	23	48	15	4	389
N3.....	32	97	36	14	60	89	9	0	11	27	13	0	388
N3*.....	49	123	117	0	16	31	6	0	3	23	25	3	396
N3**....	17	78	86	5	31	67	13	0	10	26	17	0	350
N4.....	49	75	51	30	65	55	4	3	15	23	10	0	380
N4*.....	48	106	70	12	53	61	7	3	13	19	3	0	404
N4**....	55	76	99	13	53	63	14	2	14	28	10	0	427
N5.....	44	106	82	20	61	30	2	0	4	9	4	0	362
N5*.....	32	168	83	4	14	29	7	0	1	8	6	0	352
N5**....	50	141	115	3	21	21	1	0	5	9	4	0	370
N6.....	45	73	45	7	48	77	49	0	4	15	18	7	388
N6*.....	32	136	47	9	29	48	16	0	5	18	16	2	358
N6**....	68	131	51	9	36	28	2	0	11	29	22	7	394
N7.....	58	149	60	7	35	36	6	0	10	17	23	3	404
N7*.....	74	127	95	3	14	22	9	0	8	21	32	10	415
N7**....	43	113	66	6	33	40	16	0	13	24	19	1	374

In the above table the brokes include poor quality tobacco (better than fillers) such as variegated, mixed, and off colors, also broken leaves and other damaged tobacco.

The tops include short darks, 16" or less, and poor quality long darks. Leaves in the class called darks probably are not of wrapper quality but are of heavy body and dark color. No light or medium wrappers were found in sufficient amount to make separate weighings, therefore they are included in the seconds or the darks.

TABLE IV. SORTING RESULTS FOR 1924 CROP. PERCENTAGE OF GRADES.

Plot No.	Fillers %	Brokes %	Tops %	% of Darks				% of Lights					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
N1.....	9	18	7	8	18	16	1	2	6	11	4	0	100
N1*.....	11	32	18	3	9	15	2	0	1	4	4	1	100
N1**....	12	16	21	2	11	16	3	1	6	9	3	0	100
Ave. %..	10.7	22.0	15.3	4.3	12.7	15.7	2.0	1.0	4.3	8.0	3.7	.3	100
N2.....	11	25	13	2	10	19	4	1	3	7	5	0	100
N2*.....	12	30	15	4	9	11	2	1	3	6	6	1	100
N2**....	11	16	14	3	15	16	1	1	6	12	4	1	100
Ave. %..	11.3	23.7	14.0	3.0	11.4	15.3	2.3	1.0	4.0	8.3	5.0	.7	100
N3.....	8	25	9	5	15	23	2	0	3	7	3	0	100
N3*.....	12	31	29	0	4	8	2	0	1	6	6	1	100
N3**....	5	22	25	1	9	19	4	0	3	7	5	0	100
Ave. %..	8.3	26.0	21.0	2.0	9.3	16.7	2.7	0.0	2.3	6.7	4.7	.3	100
N4.....	13	20	13	8	17	14	1	1	4	6	3	0	100
N4*.....	12	26	17	3	13	15	2	1	3	5	3	0	100
N4**....	13	18	23	3	12	15	3	1	3	7	2	0	100
Ave. %..	12.7	21.3	17.6	4.7	14.0	14.7	2.0	1.0	3.3	6.0	2.7	0.0	100
N5.....	12	29	23	6	17	8	0	0	1	3	1	0	100
N5*.....	11	47	24	1	4	8	2	0	0	2	1	0	100
N5**....	13	38	31	1	6	6	0	0	1	3	1	0	100
Ave. %..	12.0	38.0	26.0	2.7	9.0	7.3	0.7	0	0.7	2.6	1.0	0.0	100
N6.....	12	19	12	2	12	20	12	0	1	4	4	2	100
N6*.....	9	38	13	3	8	14	4	0	1	5	4	1	100
N6**....	17	34	13	2	9	7	1	0	3	7	5	2	100
Ave. %..	12.7	30.3	12.7	2.3	9.7	13.6	5.7	0.0	1.7	5.3	4.3	1.7	100
N7.....	14	37	15	2	9	9	1	0	3	4	5	1	100
N7*.....	18	30	23	1	3	5	2	0	2	5	8	3	100
N7**....	12	30	18	2	9	11	4	0	3	6	5	0	100
Ave. %..	14.7	32.3	18.7	1.7	7.0	8.3	2.3	0.0	2.7	5.0	6.0	1.3	100

The above results indicate that the use of inorganic compounds (such as ammonium sulfate and nitrates) as the only sources of applied ammonia tends to produce increased percentages of the lower grades of tobacco, included largely in the brokes and the tops. This is accompanied by a decrease in the percentage of the more desirable grades especially the seconds.

During sorting, samples were taken from the darks and the seconds which were pooled March 14, 1925, on the basis of color and general quality by Mr. Walter Edwards, official grader for the Connecticut Valley Tobacco Association. Applying 1923 prices, average prices per pound and per acre were computed. The price per pound of the different grades of tobacco grown on the different plots is given in Table V.

TABLE V. SCHEDULE OF PRICES PER POUND.

Plot	Price per lb. on basis of pooling and 1923 prices								
			Darks				Light seconds		
	Fil.	Tops	Brks.	16–18″	18–20″	20–30″	14–16″	16–18″	18–30″
N1	10	15	20	17	27	42½	30	45	72
N1*	10	15	20	17	27	42½	30	45	72
N1**	10	15	20	17	27	42½	30	45	72
N2	10	15	16	17	27	42½	25	37½	65
N2*	10	15	20	17	27	42½	30	45	72
N2**	10	15	20	17	27	42½	30	45	72
N3	10	15	16	17	27	42½	25	37½	65
N3*	10	15	16	17	27	42½	25	37½	65
N3**	10	15	20	17	27	42½	30	45	72
N4	10	15	16	17	27	42½	25	37½	65
N4*	10	15	20	17	27	42½	30	45	72
N4**	10	15	16	17	27	42½	25	37½	65
N5	10	12	16	15	20	35	25	37½	65
N5*	10	12	16	15	20	35	25	37½	65
N5**	10	12	16	15	20	35	25	37½	65
N6	10	15	20	17	27	42½	30	45	72
N6*	10	15	20	17	27	42½	30	45	72
N6**	10	15	20	17	27	42½	30	45	72
N7	10	15	16	17	27	42½	25	37½	65
N7*	10	15	20	17	27	42½	30	45	72
N7**	10	15	20	17	27	42½	30	45	72

Considering the percentage of the different grades as decimal parts of a pound and applying the pool prices, an average price per pound was figured for each plot. After deducting 11 cents per pound for sorting, sweating, storage and overhead (the Association charge for the 1923 crop) the net return per pound is presented in Table VI.

TABLE VI. SUMMARY OF RESULTS FOR 1924 ON NITROGEN PLOTS.

Plot No.	Treatment	Yield per acre in lbs.	Net price per lb.[1] (cents)	Net value of tobacco per acre	Fert. cost per acre	Net return per acre
N1	1/7 Min. N. (Nitr.	1,307	22.04	$288.06	.....	.....
N1*	Soda)	1,387	16.30	226.08	.....	.....
N1**		1,493	19.58	292.33	.....	.....
Ave.		1,396	19.31	268.82	$94.65	$174.17
N2	½ mineral N.	1,360	18.05	245.48	.....	.....
N2*	(Nitr. soda and	1,307	18.10	236.57	.....	.....
N2**	amm. sulf.)	1,387	22.43	311.10	.....	.....
Ave.		1,351	19.53	264.38	84.65	179.73
N3	All min. N. (Nitr.	1,387	18.31	253.96	.....	.....
N3*	soda and amm.	1,440	13.67	196.85	.....	.....
N3**	sulf.)	1,387	20.02	277.68	.....	.....
Ave.		1,405	17.33	242.83	69.56	173.27
*N4	½ Min. N. (Nitr.	1,333	15.18	203.46	.....	.....
N4*	pot. and amm.	1,440	16.56	238.46	.....	.....
N4**	sulfate)	1,467	15.26	223.25	.....	.....
Ave.		1,413	15.67	221.72	79.37	142.35
*N5	All min. N. (Nitr.	1,280	7.68	98.30	.....	.....
N5*	pot. and amm.	1,360	6.90	93.84	.....	.....
N5**	sulf.)	1,360	6.53	88.80	.....	.....
Ave.		1,333	7.04	93.65	62.15	31.50
N6	½ Nitrogen in D.	1,440	20.63	297.07	.....	.....
N6*	Gr. fish	1,413	17.42	246.14	.....	.....
N6**		1,360	17.05	231.88	.....	.....
Ave.		1,404	18.37	258.36	95.06	163.30
N7	½ Nitrogen in fine	1,413	13.22	186.80	.....	.....
N7*	tankage	1,440	16.63	239.47	.....	.....
N7**		1,440	21.47	309.17	.....	.....
Ave.		1,431	17.11	244.81	86.19	138.62

SUMMARY OF THREE YEARS EXPERIMENTS ON NITROGEN RATION.

In summarizing the results of the first three years of these tests, it must be kept in mind that the experiments are not yet complete and any tentative decisions drawn may be reversed by results of the experiments of 1925 or subsequent years. Also it must be remembered that only one of the three years was a normal tobacco year, viz., 1923. The season of 1922 was unusually wet while 1924 was abnormally dry. It is conceivable that the results in a normal year might be different.

[1] Ave. yield for 3 years.

*—Through a mistake which was not discovered until after the conclusion of these experiments plots N4 and N5 were treated with a low grade nitrate of potash (18% NH_3 and 12.76% K_2O) instead of a high grade (15% NH_3 and 43.4% K_2O) as was considered in working out the formula. The total amount of ammonia added to N4 was 275.6 lbs. and the potash was reduced to 106.5 lbs. per acre. Plot N5 likewise had the ammonia increased to 277.4 lbs. and the K_2O reduced to 70.4. It is quite certain this mistake also occurred in 1923. For this reason, the results obtained on these two plots in 1923 and 1924 are of doubtful significance.

Nevertheless with the preceding reservations in mind, let us see what tentative answer can be made to the questions proposed on page 4.

1. *Can all the nitrogen be supplied from mineral sources?* In answering this question it is best to disregard, for the reason previously stated, the plots on which nitrate of potash was used. Thus the question really is: Can all of the nitrogen be supplied from a mixture of nitrate of soda and sulfate of ammonia? This may be answered by comparing plots N1 (basal ration) with N3 (all nitrogen in sulfate of ammonia and nitrate of soda). The average yield of the N1 plots for the three years was 1,520 lbs. and for N3 was 1,573 lbs., showing thus a small increase in weight of cured leaves. In 1922 the quality of tobacco raised on N3 was rated poor as compared with N1 rated excellent. The sorting records for 1923 do not show that the N3 tobacco was inferior to N1. In 1924 the average price of the N1 tobacco was 2c. per pound higher than N3. When, however, this is balanced against the reduced cost of the fertilizer used on N3, the net return to the grower was only 90c. per acre less than where the more expensive fertilizer was used. However, since the quality was undoubtedly inferior during two out of the three years it would seem best for the grower to avoid the entire substitution of mineral sources of nitrogen and keep up the quality of the tobacco even though the immediate net return is no larger.

2. *Can one half of the nitrogen be supplied from sulfate of ammonia and nitrate of soda?* This question may be answered by comparing the records of the N1 plots with the N2 plots. The average yield on the N2 plots was 70 lbs. per acre less than the N1 plots for the three years. In 1922 the N2 tobacco was rated as "fair in quality" compared with N1 rated "excellent". On the other hand the sorting records of 1923 show somewhat better quality in N2 than in N1. The average price for the 1924 crop was practically the same for N1 and N2. The sorting records indicate about the same quality. The net return for the N2 tobacco was $5.56 per acre greater than for the N1 tobacco in 1924 because of the reduced price of the fertilizer. In answer to the question then we may say that the results during 3 years of tests indicate that mineral carriers of nitrogen may be used to advantage to supply one half of the ammonia.

3. *Can one half of the nitrogen be supplied to advantage in dry ground fish?* This may be answered by comparison of the records of the N1 and the N6 plots. The average yield of the N6 plots for the three years was 1,571 lbs. as compared with 1,520 lbs. for the N1 plots. In 1922 the quality of the two was rated the same. In 1923, N6 had more light wrappers, more seconds, fewer fillers and brokes and much longer fire-holding capacity than N1. In 1924 the average price of the N6 tobacco was about 1 cent less

than N1 and the net return per acre after deducting the cost of the fertilizer was $10.87 less for the fish plots than for the basal ration plots. Since the favorable results of the first two years are contradicted by the third year's results it would seem best to delay a decision until after further tests. At least we can say that the fish ration compared very favorably with the basal and it was superior during two of the three years.

4. *Can one half of the nitrogen be supplied in tankage?* The answer is obtained by comparing the records of plots N7 with N1 during the three years. The average annual yield per acre of the N7 plots was 1,543 as compared with 1,520 for the N1 plots. In quality N7 was rated "good" in 1922 as compared with "excellent" for the N1 plots. The sorting records of 1923 show a higher percentage of light wrappers and seconds, a smaller percentage of fillers and brokes and a better fire-holding capacity on the N7 tobacco than the N1 plots. The situation is just reversed in 1924 when the average price per pound for the tankage tobacco was 2.2 cents less than N1 tobacco and the net return per acre was $35.55 less than where the basal ration was used. Here again, the results of the three years are contradictory and final decision must be reserved until after further trials have been made. The case does not seem quite as favorable for tankage, however, as for the substitution of fish.

Phosphoric Acid Series.

This series was begun in 1922 with the object of determining how much phosphoric acid should be used on tobacco. There is considerable difference of opinion on this point among tobacco growers. The only experiments dealing with this point on Connecticut Valley tobacco are those recorded by Jenkins which were conducted in co-operation with the United States Department of Agriculture.* In experiments on shade tobacco they found that by increasing the acre application of phosphoric acid from 210 to 310 pounds, the yield was increased by 25 pounds when precipitated bone was used, 55 pounds with double superphosphate and 88 pounds with acid phosphate. The burn and quality was good on all but best where precipitated bone was used to supply the extra hundred pounds of phosphoric acid. In another test, on broadleaf, they increased the phosphoric acid from 176 to 276 pounds by addition on successive plots of (1) acid phosphate (2) Thomas slag (3) double superphosphate and (4) precipitated bone. The addition of acid phosphate did not increase the yield, slag increased it by 108 lbs. per acre, double superphosphate by 144 lbs. and precipitated bone by 408 lbs. The burn was freer on the plots without added phosphoric acid but the leaf grown on added double super-

* Jenkins, E. H., Studies on the tobacco crop of Connecticut. Conn. Agric. Expt. Station, Bulletin 180:28–30. 1914.

phosphate and on precipitated bone had better quality than the others. From these data one would expect that there would be a distinct advantage in raising the amount of phosphoric acid to about 300 lbs. per acre.

At the Windsor station during 1922, '23 and '24 four plots in triplicate received varying amounts of phosphoric acid according to the following formulas. The amount of ammonia and potash was the same in all. The plots were on the same field as the nitrogen series during these years and all treatment throughout the season after the application of the fertilizer was the same for all plots.

PLOT P1. BASAL RATION 225 LBS. P_2O_5. SAME AS N1.

PLOT P2. BASAL RATION BUT WITHOUT ACID PHOSPHATE OR PRECIPITATED BONE. 75 LBS. P_2O_5.

Carrier		Plant nutrients per acre		
Name	Pounds per acre	NH_3	P_2O_5	K_2O
Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	....	....
Sulf. potash.....	400	....	....	200.0
Total.....	3,500	264.2	75.0	239.5

PLOT P3. 190.5 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	.....	.....
Precipitated bone...	300	.....	115.5	.....
Sulfate potash.....	400	.....	.....	200.0
Total.....	3,800	264.2	190.5	239.5

PLOT P4. 306 LBS. P_2O_5 IN PRECIPITATED BONE, COTTONSEED MEAL AND CASTOR POMACE.

Cottonseed meal....	2,100	172.2	60.9	31.5
Castor pomace.....	800	54.4	14.1	8.0
Nitrate of soda.....	200	37.6	.....	.....
Precipitated bone...	600	.....	231.0	.....
Sulfate potash.....	400	.....	.....	200.0
Total.....	4,100	264.2	306.0	239.5

During 1922 the plots were carefully watched for any signs of earlier maturity. The triplicate plots, P4, almost from the start showed a marked tendency to early ripening and the buds appeared on the plots of this series fully a week before the others. This plot, P4, had received a very high application, 306 lbs., of phosphoric acid per acre. On none of the other plots of this experiment (on which phosphoric acid was applied in amounts ranging from 75–225 lbs. to the acre) was there noted any such tendency to

early maturity. All the tobacco was harvested at the same time in spite of the early maturity of the plants in plots P4. In the following table will be found the amounts of phosphoric acid applied per acre and the resulting yields with Chapman's notes as to quality.

TABLE VII. EFFECTS OF DIFFERENT AMOUNTS OF PHOSPHORIC ACID ON THE YIELD AND QUALITY OF PRIMED HAVANA—1922.

Plot No.	Pounds of P_2O_5 per acre	Yield of cured leaf lbs. per acre	General Quality
P1	225	1,419	Excellent
P2	75	1,425	Good—Greenish
P3	191	1,456	Excellent
P4	306	1,386	Poor—double colors

Within the limits of this experiment, varying the amounts of phosphoric acid had little effect on the yield. Only one treatment, P4 (with an excessively high application of phosphoric acid) showed any appreciable effect and this was on the quality rather than on the yield. The tobacco from P4 was inferior and showed many double colors, probably due to the fact that it was harvested over-ripe. The colors of P2 were inclined to be more green than the other plots but the tobacco was of fine quality otherwise.

In 1923 tests of plots P1–4 and replicates were conducted just as in 1922, the location of the plots and treatment being the same. The unfavorable effect of high application of P_2O_5 was apparently the same as in 1922 but the notes are scanty. The tobacco was primed. Records were taken from sample hands of leaves as in the case of the nitrogen series. Burn tests were made. Table VIII includes all records taken.

These data do not indicate that there has been a reduction in yield from omission of all mineral carriers of P_2O_5. The fire-holding capacity is strikingly best on the plot which received the least P_2O_5. In view of the fact that acid phosphate is believed to be detrimental to the burn of the leaf, it is puzzling to find that P1 which received acid phosphate had a longer fire-holding capacity than P3 or P4 which received no acid phosphate, and that P1 also had the highest yield.

During 1924 no wide differences in growth and maturity were observed. Plot P2 might possibly have been slower and Plot P4 more rapid in developing buds and flowers than the other plots of this series.

The tobacco was taken down, stripped, sorted and weighed at the same time as the nitrogen plots. The sorting results are given in Table IX.

TABLE VIII. SORTING DATA ON PHOSPHORIC ACID PLOTS FOR 1923.
Data taken by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves: Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	Fire-holding capacity (seconds)
P1	Basal ration, 225 lbs. P_2O_5.	1,919	544	1	30	....	....	50	50	53–61–49–60
				2	107	....	....	35	....	11– 9– 6– 7
				3	25	100	9	9	....	9– 6– 5– 7
				4	....	9	120	....	....	11–14–23–25
				Total	162	109	129	94	50	
				%	29.79	20.03	23.71	17.28	9.19	Av. 22 secs.
P2	Without acid phos. or ppt. bone. 75 lbs. P_2O_5	1,863	547	1	57	....	....	40	51	37–31–29–30
				2	95	....	....	40	....	65–51–67–11
				3	38	91	4	3	....	47–29– 8– 6
				4	....	8	120	....	....	21–16–14–20
				Total	190	99	124	83	51	
				%	34.66	18.15	22.68	15.18	9.33	Av. 30 secs.
P3	190½ lbs. P_2O_5, without acid phos.	1,826	550	1	93	....	....	32	30	40–20–41–33
				2	112	....	....	17	7	8– 5–15–11
				3	70	61	....	12	....	10– 8–13– 9
				4	....	30	85	1	....	16–13–11–14
				Total	275	91	85	62	37	
				%	50.00	16.55	15.46	11.27	6.72	Av. 17 secs.
P4	306 lbs. P_2O_5, without acid phos.	1,853	564	1	54	....	....	47	43	40–35–37–36
				2	116	....	....	28	....	12–20–17–20
				3	31	96	....	13	....	10– 9– 5– 7
				4	....	20	116	....	....	7–10–12–13
				Total	201	116	116	88	43	
				%	35.64	20.57	20.57	15.60	7.62	Av. 18 secs.

TABLE IX. SORTING RESULTS FOR 1924 CROP. PHOSPHORIC ACID PLOTS.

WEIGHT OF LEAVES IN EACH GRADE.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks: 18"	20"	22"	24"	Oz. of Light Seconds: 16"	18"	20"	22"	24"	Total
P1.....	43	113	66	12	40	92	38	0	13	24	21	2	464
P1*.....	32	114	82	18	32	42	13	2	12	25	24	3	399
P1**.....	26	95	38	17	48	64	2	2	13	34	12	0	351
P2.....	45	128	79	4	29	42	9	0	3	16	18	2	375
P2*.....	32	114	47	14	53	72	18	3	13	27	18	0	411
P2**.....	30	81	44	18	66	85	14	3	16	39	19	0	415
P3.....	35	113	56	7	32	76	23	2	8	24	37	5	418
P3*.....	35	103	47	8	39	62	17	2	12	30	23	2	380
P3**.....	42	87	38	21	66	64	11	3	14	30	14	0	390
P4.....	40	160	92	5	18	34	10	0	3	13	17	0	392
P4*.....	29	113	55	9	49	50	10	5	23	38	23	2	406
P4**.....	29	113	55	16	50	63	8	2	12	29	15	0	392

PERCENTAGE OF EACH GRADE AFTER SORTING

P1.....	9	24	14	3	9	20	8	0	3	5	5	0	100
P1*.....	8	28	21	5	8	10	3	1	3	6	6	1	100
P1**.....	7	27	11	5	14	18	1	1	4	9	3	0	100
Av. %...	8.0	26.3	15.4	4.3	10.3	16.0	4.0	.7	3.3	6.7	4.7	.3	100
P2.....	12	34	21	1	8	11	2	0	1	4	5	1	100
P2*.....	8	28	11	3	13	18	4	1	3	7	4	0	100
P2**.....	7	19	10	4	16	22	3	1	4	9	5	0	100
Av. %...	9.0	27.0	14.0	2.7	12.3	17.0	3.0	.7	2.7	6.6	4.7	.3	100
P3.....	8	27	13	2	8	18	5	1	2	6	9	1	100
P3*.....	9	27	13	2	10	16	4	1	3	8	6	1	100
P3**.....	11	22	10	5	17	16	3	1	3	8	3	0	100
Av. %...	9.3	25.3	12.0	3.0	11.8	16.8	4.0	1.0	2.8	7.3	6.0	.7	100
P4.....	10	41	23	2	5	9	2	0	1	3	4	0	100
P4*.....	7	28	14	2	12	12	3	1	6	9	6	0	100
P4**.....	7	29	14	4	13	16	2	1	3	7	4	0	100
Av. %...	8.0	32.7	17.0	2.7	10.0	12.3	2.3	.7	3.3	6.3	4.7	0.0	100

Averaging the results given in the above table, the following comparisons can be made as to the effects of P_2O_5 on quality.

TABLE X—SUMMARY OF TABLE IX.

Plots	Pounds P_2O_5 Per Acre	Part Mineral P_2O_5	Fillers Average %	Brokes Average %	Tops Average %	Darks Average %	Seconds Average %
P1	225	2/3	8.0	26.3	15.4	34.6	15.7
P2	75	none	9.0	27.0	14.0	35.0	15.0
P3	191	7/12	9.3	25.3	12.0	35.6	17.8
P4	306	3/4	8.0	32.7	17.0	27.3	15.0

TABLE XI. SCHEDULE OF PRICES PER POUND.

Plot	Price per pound on basis of pooling, using 1923 prices. Filr.	Tops	Brks	Darks			Seconds		
				16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
	¢	¢	¢	¢	¢	¢	¢	¢	¢
P1	10	15	18	17	27	42½	28	40	68
P1*	10	15	18	17	27	42½	28	40	68
P1**	10	15	18	17	27	42½	28	40	68
P2	10	15	20	17	27	42½	30	45	72
P2*	10	15	20	17	27	42½	30	45	72
P2**	10	15	20	17	27	42½	30	45	72
P3	10	15	18	17	27	42½	28	40	68
P3*	10	15	18	17	27	42½	28	40	68
P3**	10	15	20	17	27	42½	30	45	72
P4	10	15	16	17	27	42½	25	37½	65
P4*	10	15	16	17	27	42½	25	37½	65
P4**	10	15	16	17	27	42½	25	37½	65

The above schedule of prices is based on pool ratings by Mr. Walter Edwards and 1923 Pool prices. Average prices per pound of the tobacco grown on the different plots were computed on the same basis as the nitrogen plots. This is given in Table XII.

CONCLUSIONS FROM THREE YEARS DATA ON THE PHOSPHORIC ACID PLOTS

The most striking result of these experiments is the bad effect of increasing the phosphoric acid to 306 lbs. per acre. This is evidenced first by the reduced yield, the average being 31 pounds less than where no mineral phosphoric acid was used. In quality it was rated as "poor" in 1922 as compared with "excellent" for the P1 plot. The sorting data for 1923 show little difference in the tobacco taken from the different plots. In 1924, however, the quality was so poor that it was pooled at an average price of 4 cents per pound less than where no mineral phosphoric acid was added. The net return after deducting the cost of the fertilizer was $77.36 per acre less than where no mineral phosphoric acid was used.

TABLE XII. SUMMARY OF RESULTS FOR 1924 ON PHOSPHORIC ACID PLOTS.

Plot No.	Treatment	Yield per acre lbs. 1924	Yield per acre lbs. Ave. of 3 years	Net price per lb.[1]	Net value of tobacco per acre	Fert. cost	Net return
P1	225 lbs. P_2O_5 (⅔ mineral P_2O_5)	1,493	....	$19.16	$286.06	.....	.....
P1*		1,387	....	16.85	233.71	.....	.....
P1**		1,307	....	18.96	247.81	.....	.....
Ave.		1,396	1,610	18.32	255.86	$94.65	$161.21
P2	75 lbs. P_2O_5 (no mineral P_2O_5)	1,413	....	15.66	221.28	.....	.....
P2*		1,387	....	19.99	277.26	.....	.....
P2**		1,387	....	22.78	315.96	.....	.....
Ave.		1,396	1,561	19.48	271.50	85.15	186.35
P3	191 lbs P_2O_5 (7/12 mineral P_2O_5)	1,493	....	22.03	328.91	.....	.....
P3*		1,360	....	20.11	273.50	.....	.....
P3**		1,333	....	19.09	244.47	.....	.....
Ave.		1,395	1,559	20.41	282.29	92.65	189.64
P4	306 lbs. P_2O_5 (¾ mineral P_2O_5)	1,387	....	11.31	156.87	.....	.....
P4*		1,333	....	18.49	246.47	.....	.....
P4**		1,333	....	16.81	224.08	.....	.....
Ave.		1,351	1,530	15.54	209.14	100.15	108.99

[1] Net price per pound after deducting 11 cents for sorting, packing, sweating and overhead.

These results are not in accord with those presented by Jenkins as discussed above. No explanation of the contradictory results will be attempted until the tests have been carried further.

The highest average yield for the three years was obtained where 225 lbs. of phosphoric acid were supplied by addition of both acid phosphate and precipitated bone to the organic carriers (P1) but the best quality was obtained on P3 where the acid phosphate was omitted but the P_2O_5 brought up to 191 lbs. by addition of precipitated bone. The latter also gave the highest net return per acre of all the phosphoric acid plots in 1924. The effect of omitting all carriers of mineral phosphoric acid was noticeable only by a slight reduction in quality.

Potash Series.

This series of experiments was begun in 1923 and continued through 1924 with three treatments in duplicate on the same field as the nitrogen and phosphoric acid series. The object of the tests was to compare the effect of supplying one half or all of the potash in double sulfate of potash magnesia instead of supplying it all in high grade sulfate of potash. The occurrence of "sand drown" during 1922 in the other plots previously mentioned suggested the advisability of supplying magnesia in the fertilizer ration. Since the cheapest and most convenient carrier of magnesia is the double manure salt, it has been most frequently used as the source of this element in fertilizer mixtures. It seemed advisable therefore to find out what effect its use would have on the yield and quality of the leaf.

Goessman, in the experiments in Massachusetts previously referred to, after three years of testing, sums up his conclusions in regard to it: "Our results with potash magnesia sulfate as main potash sources of a tobacco fertilizer are not encouraging". In rating the ten fertilizer formulas which were tried he places the two which contained double manure salt at the foot.

Jenkins, in the five year experiment at Poquonock, found that the plot treated with double manure salt gave a higher yield than the plots treated with any other carrier of potash. The quality of leaf, however, was not so good and the fire-holding capacity was less than all the rest except high grade sulfate which stood at the foot of the list although the yield was good. Thus he ranks double sulfate above high grade sulfate while Goessman does just the reverse.

In the face of these contradictory experimental results there appeared to be need of further tests. It was decided to compare plots where double manure salt was the only source with those in which high grade sulfate was the source and also with plots where the ration contained a mixture of the two carriers. The fertilizer ration of each of the plots is as follows:

Plot K1. All K_2O in Sulphate.

Carrier	Lbs. Carrier Per Acre	NH3	P_2O_5	K_2O
Cottonseed meal	2,100	172.2	60.9	51.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	....	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Sulfate of potash	400	....	....	200.0
Total	4,000	264.2	224.9	239.5

Plot K2. All K_2O in Double Sulphate of Potash Magnesia.

Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	....	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Double sulfate	800	....	....	208.0
Total	4,400	264.2	224.9	247.5

Plot K3. K_2O Divided between Sulfate and Double Sulfate.

Cottonseed meal	2,100	172.2	60.9	31.5
Castor pomace	800	54.4	14.1	8.0
Nitrate of soda	200	37.6	....	....
Precipitated bone	300	....	115.5	....
Acid phosphate	200	....	34.4	....
Sulfate of potash	200	....	....	100.0
Double sulfate	400	....	....	104.0
Total	4.200	264.2	224.9	243.5

No differences in growth during the season of 1923 were noted. Sorting data on the primed leaves as taken by Slagg are recorded in Table XIII.

During the first year of this experiment no appreciable effects were seen on the yield and quality of the tobacco. The percentages of the two top grades of plots K1, K2 and K3 were 48%, 51.4% and 50.3%, respectively.

The experiment was conducted during 1924 in the same manner as in 1923. The tobacco on the K2 plot was somewhat taller than on the other plots. Otherwise no differences in growth were noticed.

The tobacco was harvested, stripped, and sorted at the same time as the nitrogen plots. Table XIV gives the sorting data on the plots.

TABLE XIII. SORTING DATA ON POTASH SERIES.

Experiments of 1923 by C. M. SLAGG.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fu. and Br.	
K1	All K_2O from H. G. sulfate 5.2 lbs. MgO per acre..	2,056	576	1	57	....	....	70	35	37–34–35–25
				2	74	....	....	74	....	7– 5– 6– 7
				3	38	94	....	....	....	5– 7– 4– 5
				4	....	14	120	....	....	7– 5– 7– 7
				Total	169	108	120	144	35	
				%	29.34	18.75	20.83	25.00	6.08	Av. 13 secs.
K2	All K_2O from Dbl. Sulf. 90.4 lbs. MgO per acre..	1,966	564	1	79	....	....	56	27	32–36–47–59
				2	76	....	....	61	....	19–30–11–24
				3	18	94	6	14	....	7– 9– 8–11
				4	....	13	110	....	....	
				Total	183	107	116	131	27	
				%	32.42	18.99	20.57	23.23	4.79	*Av. 25 secs.
K3	K_2O divided between the two. 45.2 lbs. MgO per acre.....	2,039	568	1	50	....	....	70	33	40–37–16–20
				2	97	....	....	43	....	5– 5– 6– 7
				3	12	107	16	....	....	4– 5– 3– 4
				4	....	20	120	....	....	4– 5– 7– 6
				Total	159	127	136	113	33	
				%	27.99	22.35	23.94	19.92	5.8	Av. 11 secs.

* Data on fire-holding capacity of the fourth priming for some unexplained reason was omitted. If this were recorded it would reduce the average slightly.

TABLE XIV. SORTING RESULTS FOR 1924 CROP ON THE POTASH PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks				Oz. of Light Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
K1.....	37	67	25	7	33	70	48	0	8	26	28	3	353
K1*.....	29	60	39	13	43	88	46	3	7	27	31	2	388
K2.....	37	102	42	6	28	66	33	0	14	36	42	5	411
K2*.....	47	72	33	8	54	91	33	5	15	38	21	2	419
K3.....	37	55	24	9	56	97	45	4	21	50	34	5	437
K3*.....	45	71	38	18	58	63	15	4	17	36	20	3	388
PERCENTAGE OF EACH GRADE AFTER SORTING.													
K1.....	10	19	7	2	10	20	14	0	2	7	8	1	100
K1*.....	7	15	10	3	11	23	12	1	2	7	8	1	100
Av. %...	8.5	17.0	8.5	2.5	10.5	21.5	13.0	.5	2.0	7.0	8.0	1.0	100
K2.....	9	25	10	1	7	16	8	0	4	9	10	1	100
K2*.....	11	17	8	2	13	24	8	1	3	9	4	0	100
Av. %...	10.0	21.5	9.0	1.5	10.0	20.0	8.0	.5	3.5	9.0	7.0	.5	100
K3.....	8	13	6	2	13	22	10	1	5	11	8	1	100
K3*.....	12	18	10	5	15	16	4	1	4	9	5	1	100
Av. %...	10.0	15.5	8.0	3.5	14.0	19.0	7.0	1.0	4.5	10.0	6.5	1.0	100

No striking differences in quality were noted in the above plots. Samples were taken from these plots and graded in a manner similar to the other fertilizer plots. These pool ratings are given in Table XV.

TABLE XV. SCHEDULE OF PRICES PER POUND.

	Price per pound on basis of pooling and 1923 prices.								
				Darks			Seconds		
Plot	Filr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
K1	10	15	20	17	27	42½	30	45	72
K1*	10	15	20	17	27	42½	30	45	72
K2	10	15	20	17	27	42½	30	45	72
K2*	10	15	20	17	27	42½	30	45	72
K3	10	15	20	17	27	42½	30	45	72
K3*	10	15	20	17	27	42½	30	45	72

From the pooling data recorded in Table XV, it is apparent that there were no differences in quality between the different plots.

Regarding the percentage of the different grades as decimal parts of a pound and applying the corresponding pool prices, the average price per pound was figured for each plot, as given in Table XVI.

TABLE XVI. SUMMARY OF RESULTS FOR 1924 ON POTASH PLOTS.

Plot No.	Treatment	Yield per acre	Price per lb.[1]	Net value per acre	Fertilizer cost	Net return per acre
K1	Mineral potash	1333	$24.76	$330.00	....	....
K1*	all sulfate	1387	25.28	350.63	....	....
Ave.		1360	25.02	340.32	$94.65	$245.67
K2	Mineral potash	1413	24.86	351.27	....	....
K2*	all double sul-	1413	23.16	367.25	....	....
Ave.	fate.	1413	24.01	359.26	97.85	261.41
K3	Mineral potash	1467	27.70	406.36	....	....
K3*	½ sulfate, ½	1333	21.60	287.93	....	....
Ave.	dbl. sulfate.	1400	24.65	347.15	95.20	250.95

[1] Prices per pound after deducting 11 cents per pound for sorting, sweating, storage and overhead charges.

SUMMARY OF TWO YEARS' COMPARISON OF HIGH GRADE SULFATE WITH DOUBLE SULFATE OF POTASH.

During the two years of this experiment there has been no marked difference in the quality or quantity of the tobacco grown on the different plots. A somewhat larger yield in 1924 on the plots treated with double sulfate is offset by the smaller yield in 1923. Altogether there appears to be little choice between the three treatments. Apparently, if there were occasion to anticipate

that the crop was going to suffer from magnesia hunger the double manure salt could be used to prevent it without serious impairment of the quality or yield of the tobacco. Ordinarily, however, magnesia hunger is not found where reasonably large amounts of organic fertilizers such as cottonseed meal or castor pomace are used. In this case, there would seem to be no advantage in using sulfate of potash magnesia and it has the disadvantage of adding to the bulk of fertilizer and of doubling the quantity of sulphuric acid introduced into the soil. Any conclusions based on experiments of only two years must necessarily be tentative, however.

FRACTIONAL APPLICATION SERIES.

This series was started in 1923 and continued during 1924. There was a double object of the tests (1) to see whether there was any increase in yield or quality above that obtained by the single broadcast application when some of the fertilizer was applied later during the growth of the plants and (2) to see whether a smaller amount applied fractionally would produce as good results as a larger amount applied all at once.

The basal mixture as in N1 was used on all plots, the only variation being in the amount and time of application. The treatments were as follows:

Plots H and H*. Total application 3,000 pounds; 1,400 broadcast, 400 in drill at time of setting, 400 after plants started, 400 at second hoeing, and 400 at later cultivation.

Plots I and I*. Total application 2,000 pounds. None of it broadcast, 400 in drill, 800 at first hoeing, 400 at second hoeing, 400 at later cultivation.

Plot J. 3,000 pounds broadcast. This to serve as a check on the above plots and on other plots where 4,000 pounds per acre was applied.

Between 500 and 600 leaves were taken from each plot when harvested and sorted by Slagg in 1923. Data are recorded in Table XVII.

These data show little difference in quality from the three treatments. Three thousand broadcast yielded over 100 pounds more leaf than 3,000 applied fractionally and about 150 lbs. more than 2,000 applied fractionally. There does not appear therefore to be any gain from fractional application as compared with the same amount broadcast and it is questionable whether the reduction in the cost of 2,000 lbs. of fertilizer as compared with 3,000 lbs. would counter-balance the 150 lbs. reduction in yield and the additional cost of labor for later applications.

During the growing season of 1924 it was noted that the growth was not quite so good on the I plots which received only one ton of fertilizer. The tobacco was topped, harvested, stripped and sorted at the same time as that on the nitrogen plots. The sorting records are presented in Table XVIII.

TABLE XVII—FRACTIONAL APPLICATION SERIES OF 1923.

Plot No.	Treatment of Plot	Av. lbs. per acre	Total No. leaves sorted	No. of priming	Number of leaves					Fire-holding capacity (seconds)
					Lt. Wr.	Med. Wr.	Dark Wr.	Secs.	Fil. and Br.	
H, H*	3,000 lbs. fractional.....	1,866	531	1	13	....	....	14	84	20–25–10– 5
				2	57	....	....	84	....	5– 6– 9– 7
				3	11	123	....	10	....	3– 4– 5– 4
				4	....	10	125	....	....	4– 5–10– 7
				Total	81	133	125	108	84	
				%	15.26	25.04	23.54	20.34	15.82	Av. 8 secs.
I, I*	2,000 lbs. fractional.....	1,827	588	1	21	....	....	60	78	30–25–26–35
				2	90	....	....	51	....	10–16– 6– 5
				3	38	107	....	....	....	4–13– 5– 6
				4	....	18	125	....	....	5– 7– 6–10
				Total	149	125	125	111	78	
				%	25.34	21.26	21.26	18.88	13.26	Av. 13 secs.
J	3,000 lbs. broadcast.....	1,974	570	1	10	....	....	78	56	20–23–10–15
				2	100	....	....	34	....	5–10–28–10
				3	....	121	16	10	....	4– 6– 5– 7
				4	....	5	140	....	....	5– 6–11– 5
				Total	110	126	156	122	56	
				%	19.30	22.27	27.36	21.30	9.77	Av. 10 secs.

TABLE XVIII. SORTING RESULTS FOR 1924 CROP. FRACTIONAL APPLICATION PLOTS.

WEIGHT OF THE GRADES.

Plot No.	Fillers Oz.	Brokes Oz.	Tops Oz.	Oz. of Darks				Oz. of Light Seconds					Total
				18"	20"	22"	24"	16"	18"	20"	22"	24"	
H.....	32	84	29	25	66	53	6	0	15	24	4	0	338
H*.....	30	98	36	23	69	65	10	0	18	25	7	0	381
I.....	39	122	83	40	60	19	0	3	15	18	2	0	401
I*.....	48	56	49	31	34	6	0	1	7	11	1	0	244
J.....	27	70	30	26	60	64	10	3	16	27	14	0	347
PERCENTAGE OF EACH GRADE AFTER SORTING.													
H.....	10	25	9	7	19	16	2	0	4	7	1	0	100
H*.....	8	26	9	6	18	17	3	0	5	6	2	0	100
Av. %...	9	25.5	9	6.5	18.5	16.5	2.5	0	4.5	6.7	1.5	0	100
I.....	10	30	20	10	15	5	0	1	4	4	1	0	100
I.....	20	23	20	13	14	3	0	0	3	4	0	0	100
Av. %...	15	26.5	20	11.5	14.5	4	0	.5	3.5	4	.5	0	100
J.....	8	19	9	8	17	18	3	1	5	8	4	0	100

The samples selected during sorting were judged by Mr. Walter Edwards and on the basis of his pooling and prices for 1923 the following schedule of prices per pound for the different grades was fixed.

TABLE XIX. SCHEDULE OF PRICES PER POUND. FRACTIONAL APPLICATION PLOTS.

	Price per pound on basis of pooling and 1923 prices.								
				Darks			Seconds		
Plot	Filr.	Tops	Brks	16-18"	18-20"	20-30"	14-16"	16-18"	18-30"
H	10	15	20	17	27	42½	30	45	72
H*	10	15	20	17	27	42½	30	45	72
I	10	12	20	15	20	35	30	45	72
I*	10	15	16	17	27	42½	25	37½	65
J	10	12	20	15	20	35	30	45	72

The average price per pound for each plot based on the above and the net return per acre are given in Table XX.

TABLE XX. SUMMARY OF RESULTS FOR 1924 ON FRACTIONAL APPLICATION PLOTS.

No. Plot	Treatment	1923 yield per acre	Price per lb.*	Net value per acre	Fertilizer cost	Net return per acre
H	3,000 lbs. basal formula applied fractionally.	1253	$17.88	$224.04		
H*		1333	18.74	249.80		
Ave.		1293	18.31	236.92	$71.00	$165.92
I	2,000 lbs. basal formula applied fractionally.	1200	10.36	124.32		
I*		1227	8.68	106.50		
Ave.		1213	9.52	115.41	47.33	68.08
J	3,000 lbs. applied broadcast before setting.	1307	17.82	232.91	71.00	161.91

*Based on sorting percentages, grading by Mr. Walter Edwards, and pool prices for 1923 after deducting 11 cents per pound for sorting, packing, storage, etc.

SUMMARY OF FRACTIONAL APPLICATION SERIES.

The results of two years' tests show that when 3,000 lbs. of fertilizer are applied to the acre, there is no advantage either in quality or yield of the tobacco when the total amount is divided between a number of applications. When the quantity of fertilizer applied was reduced, there was a reduction in yield and quality which more than counter-balanced the saving in the cost of fertilizer.

In order to see whether there was any profit in reducing the acre application from 4,000 to 3,000 lbs. per acre, we may compare Plot J with plots N1, P1 and K1 all of which received the same mixture as J but 1,000 more pounds of it. After deducting the cost of fertilizer we find that plot J netted a return of $161.91 to the grower in 1924, while plots N1 netted $174.17, plots P1, $161.21 and Plots K2, $245.67. From these figures it is apparent then that there was no gain from cutting down the fertilizer ration, but a strong probability of a loss. In this connection however, it should be kept in mind that the season of 1924 was very dry. A season characterized by more rainfall might show benefit from fractional application.

MANURE SERIES.

Concerning the value of stable manure for tobacco there is a wide difference of opinion among growers and dealers. Many would not use it even if it cost nothing. Probably the majority of farmers believe in using it, however, and would use more if it could be obtained. The ever increasing price of good manure makes it rather essential that we should find out experimentally just what its value is.

In the Massachusetts experiments previously mentioned, Goessman included plots in which manure at the rate of 10 tons per acre was the only fertilizer applied during two years. In his summary he concluded that the results were "encouraging but not sufficient in number to advise detailed discussion". In the Poquonock experiments, Jenkins treated one plot with 10-12 cords of manure per acre for four years and during two of the years added 500 lbs. of Swift-Sure Superphosphate. Although the yield was much below the average he attributed it to lack of a quickly available source of nitrogen and states that "the use of stable manure as an amendment as well as a fertilizer is necessary to get the best results".

An experiment was begun at the Windsor station in 1923 to test the value of manure as a supplement to commercial fertilizers and to compare cow manure with horse manure. Duplicate plots of one fourth of an acre were treated as follows:

M1—Two tons per acre of the basal ration.
M2—Ten tons of horse manure (New York) in addition to two tons of commercial.
M3—Ten tons of cow manure in addition to two tons of commercial.

The tobacco was stalk cut and one row of each plot weighed and sorted to get the data recorded in Table XXI.

TABLE XXI. MANURE SERIES OF 1923.

Plot	Treatment	Yield per acre	Percentage of grades				
			Light Wrapper	Medium Wrapper	Dark Wrapper	Seconds	Fillers and Brokes
M1	Com. Fertilizer	1540	35.05	9.11	19.76	25.77	10.31
M2	Horse Manure	1514	33.99	1.09	21.70	30.20	13.02
M3	Cow Manure	1928	33.04	12.98	27.85	19.21	6.92

These experiments are on too small a scale and preliminary in nature to warrant any conclusions as to the value of the different treatments.