Bulletin 364 September, 1934

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Agricultural Experiment Station
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TOBACCO CULTURE IN CONNECTICUT

P. J. ANDERSON

History failed to record the date, the residence and the name of the first white tobacco grower in Connecticut. He was probably one of the original settlers, for as early as 1640, seven years after the first settlement was made in the colony, it is recorded that tobacco was being raised at Windsor. From that time to the present, tobacco has been one of the important crops of Connecticut. In the early years most of the towns in the state grew some tobacco at one time or another. Eventually it was found that the best leaf could be grown in the valley of the Connecticut river and the industry gradually concentrated there. In periods of greater demand it has spread farther from the river only to recede again in times of low prices. About 1840 another center of concentration of acreage began in the Housatonic Valley. To-day the commercial production is confined to these two valleys.

Connecticut, however, owes its preëminence in the tobacco world to the cigar. The heyday of commercial expansion began when cigar smoking became popular. Although the Indians are known to have rolled leaves of the plant loosely together before smoking them, cigars such as we have now were hardly known in New England until about 1800.

In the first few years of the nineteenth century the farmers' wives began to roll cigars in their homes to be peddled in wagons from village to village. The most popular brands in those days were the "Long Nines" and "Windsor Particulars". In 1810 the first cigar factories were established, one in Suffield and one in East Windsor. Gradually the business of rolling cigars passed from the homes into small factories which grew up in all the towns. Then some of the manufacturers began to import tobacco from Cuba and Brazil for blending with the native leaf.

With the increase in cigar smoking it came to be recognized in other parts of the country that the soil and climate of the Connecticut Valley were adapted to growing the finest quality of cigar leaf. The outside demand, thus created, necessitated the establishment of warehouses where large quantities of tobacco could be packed and shipped to New York and other centers where cigars were being made in increasing numbers. Warehouse Point owes its name to the fact that the first tobacco warehouse in Connecticut was established there in 1825. The history of the tobacco industry from that date to the present was one of continuous expansion until 1921. Occasionally there were reverses for a few years, but these were followed by periods of growth and renewed prosperity. The last decade, however, has seen an irregular downward trend in acreage.

TYPES OR VARIETIES

Three varieties of tobacco are now grown in Connecticut. Two of these, Broadleaf and Havana Seed, are commonly called "out-door" or "sun grown" tobacco. The third one, Cuban, is known as "Shade tobacco" because it is grown in fields covered, or shaded, by tents of cotton cloth.

In early colonial days in America, all tobacco was alike. As new centers of production were established, however, it was found that tobacco grown in one part of the country had different qualities from that grown in another section. Some produced a kind which suited best the taste of the pipe smoker; others, a snuff type; and others again, plug types, etc. The three varieties grown in Connecticut are most suitable for cigars and the entire crop is used for this purpose except for a small amount of damaged or inferior leaf which, as a by-product, is used for scrap chewing.

In the manufacture of cigars, three kinds of tobacco are needed corresponding to the three parts of a cigar: the filler, binder and wrapper. The filler is the central portion of a cigar consisting of a bunch of leaves laid parallel together. For this, there is needed a heavy leaf which burns well and has a pleasant aroma and taste. It constitutes the larger part of the cigar. The filler is first covered and held in place by the binder, a leaf of a different type, not so heavy as the filler. This in turn is covered with a thinner leaf, the wrapper. The wrapper must burn well and be uniform and light in color. It must have very fine veins only, and a pleasing luster and finish that appeals to the eye of the smoker and sells the cigar. The wrapper is the smallest part of the cigar, but the most expensive per pound. Every different combination of filler, binder and wrapper produces a different taste or aroma. On the proper blending of these three parts depends the popularity and success of any brand.

More than a hundred years ago it was recognized that Connecticut tobacco excelled in the qualities that are desirable for wrappers and New England has become known as a wrapper section. It is also one of the two leading binder sections of America. Filler types of tobacco are not grown here although a small percentage of the top leaves is sometimes used for that purpose.

Of the three types of tobacco produced in Connecticut at present, Cuban Shade is grown for wrappers while the other two, Havanna Seed and Broadleaf, are used mostly as binders. There is still some demand, however, for the best grades of the latter two types for wrappers. Each kind has distinct characteristics and a distinct use in the manufacture of cigars. In the latter field they are not interchangeable.

Indians who grew tobacco here before the white man came used it only for smoking in pipes and probably were not particular about such things as shape of leaves, luster, and size of veins. The type they grew probably could be found nowhere to-day. Almost as scanty are the records in regard to types grown by the colonists for a hundred years or more. At the beginning of the nineteenth century, farmers were growing "shoe string" tobacco, a narrow-leaf type probably much like the present day Maryland Narrow-Leaf.

BROADLEAF (U. S. TYPE 51)

When fickle fashion started the vogue for cigar smoking a century and a quarter ago, there arose a demand for a wider leaf suitable for binders and wrappers. Consequently, Mr. B. P. Barbour of East Windsor imported seed from Maryland and began growing the Broadleaf variety in 1833. This new tobacco was so superior to the type previously grown that within a few years it entirely supplanted "shoe string". With its

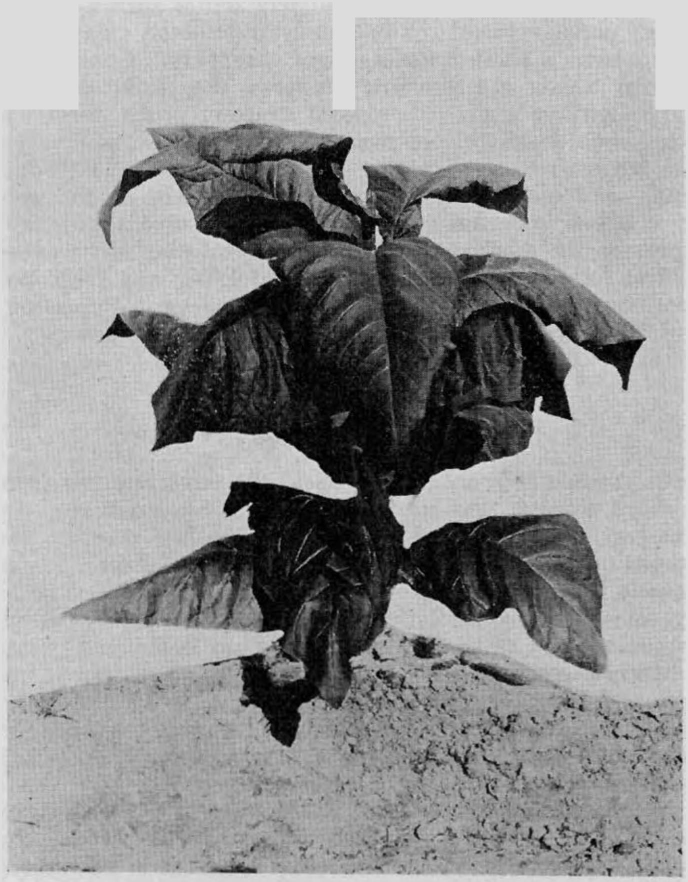

FIGURE 116. Broadleaf plant ready to harvest.

coming the tobacco growing business in New England entered a period of expansion and prosperity which continued for nearly a hundred years.

The Barbour variety of Broadleaf is still grown in some localities, but during the past century new kinds have developed either by mutation and acclimatizing of the original or through fresh importation of seed. As a result we have a number of more or less distinct varieties or subtypes of Broadleaf, for example: John Williams, Bantle, Frank Roberts and Hockanum.

The bulk of the Broadleaf is grown in Connecticut east of the Connecticut river in the towns of Glastonbury, East Hartford, Manchester, South Windsor and East Windsor. A scattering acreage is found in the Havana Seed sections of Connecticut and Massachusetts. The plant is principally characterized by the drooping habit of its leaves (Fig. 116). The leaves also are longer and wider than those of the other two dominant types in New England.

Broadleaf is used mostly for cigar binders and as such is found in many of the most popular brands of nationally distributed cigars. The better grades also have a limited use as cigar wrappers. Compared with the more popular Shade and Sumatra wrappers, they make the cigar appear dark and rough but many experienced smokers prefer them. Broadleaf top leaves, when thoroughly re-sweated and aged, also make a good cigar filler and are used to some extent for this purpose. Badly damaged or poor crops, and damaged and short bottom leaves of the good crops, are sold at a low price for "stemming". When mixed with other types, they appear on the market as scrap chewing tobacco. The average yield of Broadleaf for the past 12 years, 1922 to 1933, was 1,422 pounds per acre according to estimates of the New England Crop Reporting Service. Yields of 1,800 to 2,000 pounds are not uncommon, however, on good land.

HAVANA SEED (U. S. TYPE 52)

There is considerable uncertainty as to the circumstances under which Havana Seed tobacco was introduced into New England. Apparently the event was not considered worthy of published record. Its culture began sometime between 1870 and 1880 but the writer has found no report giving the name of the man who imported the seed or his object in doing so. Probably he hoped to duplicate in Connecticut the aroma or other qualities for which the tobacco of Cuba is famous. Although the seed evidently came from Cuba, to-day there is no district in that island which grows tobacco like it. However, as there is wide variation in leaf and habit of growth in the tobacco fields of Cuba, it is entirely possible that our seed was isolated from such a heterogeneous population. By generations of selection and acclimatization here, the size and shape of the leaf has so changed that we fail to recognize the Cuban ancestor. At any rate the culture of Havana Seed spread rapidly and has supplanted most of the Broadleaf west of the Connecticut river in this state, on both sides of the river in Massachusetts, and even up into southern New Hampshire and Vermont. It is the only type grown in the Housatonic Valley. Its acreage in New England in recent years has been about the same as the Broadleaf acreage.

The leaves are somewhat smaller and smoother than those of Broadleaf and they do not droop but stand upright from the stalk. The upright habit makes this type more suitable for machine culture. (Fig. 117).

Before shade tobacco became so popular, Havana Seed was widely used for cigar wrappers. Now only a very small percentage of the crop serves that purpose while the bulk of it goes for binders. The taste and flavor of cigars bound with Havana Seed differ from those bound with Broadleaf. It is not, therefore, a substitute for Broadleaf on the same brands of cigars. The principal competitor of Connecticut Havana Seed is Wisconsin binder, and the price which the Connecticut farmer receives for Havana Seed is influenced to some degree by the character of the crop grown in Wisconsin. Many nationally popular brands of cigars

FIGURE 117. Havana Seed plant ready to harvest

use Connecticut Valley Havana Seed binders. The stemming grades of this variety are used for scrap chewing tobacco just as those of Broadleaf are. Average yields for the 12 years, 1922-1933, were 1,404 pounds per acre according to the New England Crop Reporting Service. Yields of 1,800 to 2,000 pounds, however, are often obtained by skilful growers.

SHADE (CUBAN) (U. S. TYPE 61)

Growing of tobacco under cloth in Connecticut began in 1900 with an experimental half-acre in Poquonock under the direction of the Connecticut Agricultural Experiment Station. In the original tests, seed was imported from Sumatra. The experiment proved this variety unsuited to shade culture and seed from Cuba was tried. With a few years of

FIGURE 118. Mature Cuban Shade plant.

selection, the Cuban type became established and its culture spread until it reached about 9,000 acres. It is grown in the same sections as Havana Seed and Broadleaf on both sides of the Connecticut river from southern Vermont to Portland, Connecticut.

The variety is identical with the tobacco grown generally in Cuba to-day but has been more carefully selected for uniformity. The leaves are smaller and less pointed than are those of Broadleaf and Havana seed, and are set farther apart on the stalk. The plant as a whole is taller than the other types. (Fig. 118).

Shade tobacco is used primarily for wrappers, and appears as such on the most popular high-priced cigars in America. Its only competitor is the imported Sumatra wrapper. The leaves are light in color, smooth and glossy, with very small and inconspicuous veins. They make a cigar which appeals to the eye of the smoker. The top leaves and heavier grades are used to some extent as cigar binders. Connecticut Shade is

FIGURE 119. A field of Havana Seed Tobacco growing in Connecticut.

the highest priced tobacco grown in America. The price of Sumatra is somewhat higher but only because of the high import duty. According to records of the New England Crop Reporting Service, the average yield for the last twelve years, 1922 to 1933, was 987 pounds to the acre.

SOME LESS IMPORTANT VARIETIES

The three varieties which have been described are the dominant types and the only ones grown to any extent commercially in New England. Many attempts have been made to introduce other varieties without ultimate success. Some of these, however, should be mentioned.

Primed Havana is the same variety in the field as Havana Seed but in the trade it occupies a separate position. The difference comes from the method of harvesting and curing. Ordinary Havana Seed is harvested by cutting down the whole plant and curing it in the shed with all the leaves attached to the stalk. In the case of Primed Havana, the leaves are removed from the stalk (primed) in the field as they become mature, starting at the bottom of the stalk. They are sewed on lath, and cured like shade leaves. Primed Havana has the same uses as Shade but is not of such good quality. Its popularity began about the same time that Shade was introduced but it was gradually supplanted by Shade from Connecticut and Florida.

Halliday's hybrid: Many attempts have been made to produce an acceptable variety by crossing two other varieties. Such crossing usually results in a hybrid that is vigorous, high-yielding but lacking in quality. One of the first of these that became popular was the Halliday Hybrid

FIGURE 120. Field of Broadleaf tobacco showing the method of wilting the leaves. They are cut down and thrown on the ground.

which was grown rather extensively in the Havana Seed sections about the beginning of the present century. Unfortunately its lack of uniformity and some other objectionable characters doomed it to an early fate and caused considerable financial loss to some who had grown it too extensively.

Mongrel: This rather indefinite name has been applied to a hybrid variety produced by interbreeding of Havana Seed and Broadleaf. Just when or how often this nondescript cross has been made is not recorded but it has been grown rather extensively in some sections in the past and is still raised on a few acres. It is a rank grower and heavy yielder with leaf characters midway between the parents. There is little market for it because it is neither Broadleaf nor Havana Seed.

Roundtip: This variety was developed at the Connecticut Station by selection from a Sumatra-Broadleaf cross. It is a rank grower, with leaves of excellent shape, a high yielder, and resistant to rootrot. It was grown commercially first in 1920 and within a few years there were several hundred acres. However it did not meet with favor in the trade and is no longer grown commercially in Connecticut.

With the centralizing of cigar manufacture into a few large units has come a demand for large quantities of uniform leaf. Varieties or grades which can be supplied only in limited amount are not wanted. They do not fit into the scheme of wholesale production. This means less and less chance of introducing any new type or variety of tobacco. The opportunity of the future will be to improve by selection the types which we now have, rather than to introduce new ones.

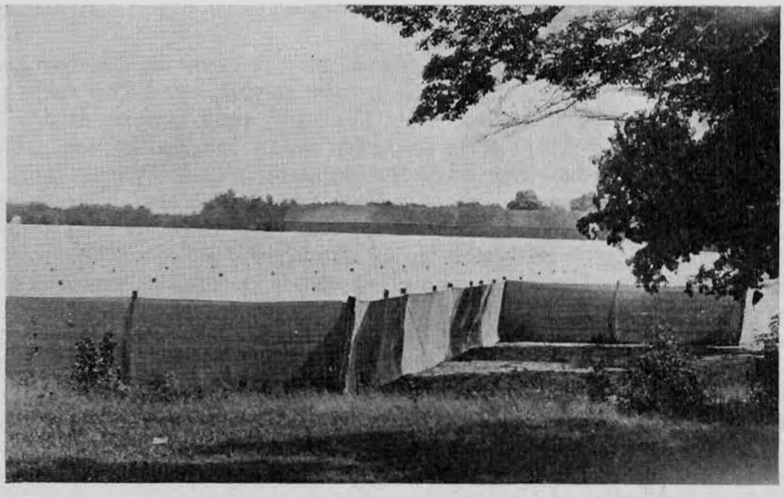

FIGURE 121. A tent in the Connecticut tobacco country under which Shade (Cuban) tobacco is grown.

ACREAGE AND DISTRIBUTION

For the first two centuries of tobacco growing in Connecticut there are no statistics to show how many acres were planted or how many pounds were raised annually in the state. Tobacco was grown at first mostly for home and local consumption. Yet the colonists apparently grew more than they could use, for early in the seventeenth century they were exporting it to the Dutch colony of New Amsterdam. During the next century tobacco was an important item of export in the West Indies' trade but no figures are on record by which we may judge the volume of this commerce. In 1753 the General Assembly made a law prohibiting the export from Connecticut of any tobacco that was not stamped and sealed by the official town packer. After that date, town packers were regularly elected at the annual meetings of the valley towns, indicating that export of tobacco was of some importance in these towns.

At the beginning of the nineteenth century the increasing popularity of cigars and the introduction of the Broadleaf tobacco induced a heavy expansion of acreage, but since no official statistics were kept, the extent of the increase cannot be stated. The first official figures which show the size of the industry in the state are in the Federal Census of 1840. According to this, there were 538,000 pounds of tobacco raised in New England in 1839. Assuming a yield of 1,413 pounds to the acre, which was the average annual yield of the first two decades for which we have acreage records, we may estimate that only about 380 acres were planted to tobacco in Connecticut and Massachusetts in 1839. In 1849 production had increased to 1,406,000 pounds. The next decade saw tremendous gain so that there was more than six times as much tobacco produced in 1859 as in 1849—about 6,500 acres. This wave of expansion continued until after the Civil War.

Beginning with 1862 there are official records showing the number of acres of tobacco cultivated, as well as the pounds produced each year. These figures are assembled in Table I[1]. They show a fairly steady production of 6,000 to 8,000 acres annually up to the end of the century. Then follows a gradual rise until the outbreak of the World War, and rapid expansion during and shortly after the war period, culminating in the peak of 31,000 acres in 1921. A violent drop came in 1925 followed by still further drastic reductions in 1932 and 1933.

Since 1920 there has been a slow but steady decline in consumption of cigars, largely due to the rising popularity of cigarette smoking. This was an important factor in reducing the acreage during the decade, 1920 to 1930. Another factor was the rapid substitution of cigar-making machines for hand work. In making a cigar a hand worker uses a double binder, while the machine uses only a single binder. Thus machine-made cigars require about half as many pounds of binders as hand-made cigars. During these years when the demand for binders was steadily declining, reduction of acreage lagged behind with the result that excessively large stocks of leaf accumulated, reaching a peak in about 1929. The ruinously low prices paid for tobacco after the economic depression set in resulted in reducing the acreage of outdoor types in 1933 to nearly the lowest point in the century.

The region of greatest concentration of tobacco acreage includes the towns on both banks of the Connecticut river northward from Glastonbury and Hartford to the Massachusetts line. The industry has been subject to wide fluctuations. In prosperous days tobacco growing has spread far to the east and to the west of the river towns, but in periods of lower price and depression, the acreage shrank first in the towns at the greatest distance from the river. But even disregarding these fluctuations the last hundred years has seen a steady tendency toward concentration of the industry in this part of the tobacco country. This is well illustrated by the maps of the state on page 727 which show the distribution in 1880 as compared with 1930. The distribution by towns in the state is shown in Table IV. (Appendix).

[1]For Tables I to IV see Appendix, page 801.

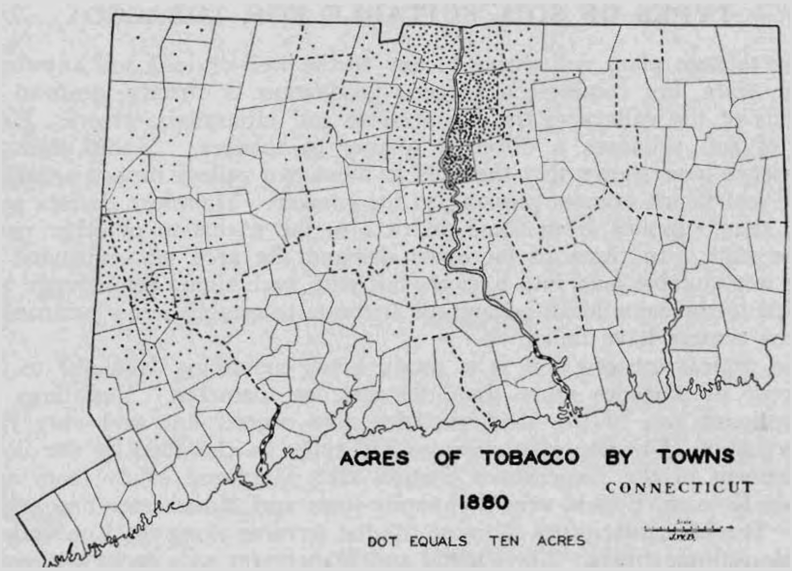

FIGURE 122. Map of the state showing acres of tobacco by towns in 1880. Each dot represents ten acres.

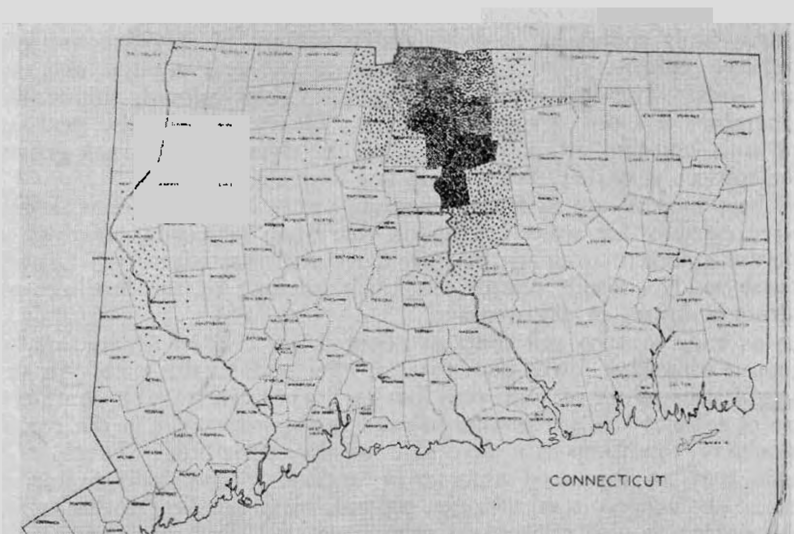

FIGURE 123. Acres of tobacco by towns in 1930. Each dot represents ten acres.

TYPES OF SOIL SUITABLE FOR TOBACCO

The tobacco plant will thrive in any fertile well-drained soil anywhere in the state, but commercial tobacco production is strictly localized in sections of the valleys of the Connecticut and Housatonic rivers. Each type of soil produces a different quality of tobacco. Many years of experience have shown that the soils in these two valleys impart a quality to the leaf which is most pleasing to the smoker. Therefore dealers purchase their supplies from these districts to the exclusion of other parts of the state. In times of increased demand the area has expanded to bring less suitable land into tobacco, but with each slump the acreage has receded to the same localities and all attempts to establish new permanent tobacco centers have failed.

The typical tobacco soil is a sandy loam containing from 60 to 80 per cent of particles more than .05 mm. in diameter. Variations in predominant size of the sand particles give coarse, fine and very fine sandy loams. The important tobacco soil types as classified by the Soils Department of the Experiment Station are: Merrimac sandy loam and fine sandy loam, Enfield very fine sandy loam and Manchester fine sandy loam. The Merrimac types compose the flat terraces along the Connecticut and Housatonic rivers. The Enfield and Manchester soils occur on gently rolling, somewhat higher, areas. To a smaller extent Wethersfield loam and Suffield clay loam are used but these two types are generally too heavy for best leaf quality.

The Merrimac coarse sandy loam is used for shade tobacco but is not so suitable for out-door types because it is susceptible to drought and leaching. Soils containing a considerable amount of clay are not good for tobacco culture. The plant prefers sandy, well aerated and well drained soils. The lighter soils produce a lighter-colored, thinner leaf and therefore a more desirable tobacco. Heavy black soils, peat and swamp soils, and the "meadow" soils along the river, produce rank growth, but the tobacco is darker, heavier and less desirable.

The best subsoils are of fine or medium sandy loam texture with good retentive capacity for water. Clay or "hard-pan" subsoils, however, do not permit sufficient drainage and are not usually satisfactory. Gravelly or coarse sandy subsoils permit too much leaching of the fertilizer and also drought injury in dry weather.

The average tobacco soil contains about 3 per cent of organic matter, an amount somewhat lower than that in other soils in the state. In very sandy soils this figure may drop as low as 1.5 per cent. With continuous culture of tobacco this percentage has not decreased except in the coarser sands where conditions are favorable to decomposition. There is no evidence that an increased amount of organic matter is desirable for tobacco. The average total nitrogen content, corresponding to the organic matter content, is also relatively low as compared with other soils types, being about .15 per cent. This small amount becomes available very slowly, hence the necessity of heavy nitrogen fertilization.

The quantity of phosphoric acid on old tobacco soils, however, is very high, due to accumulation. New tobacco soils (less than five years in tobacco) have an average of some 1,500 pounds of phosphorus (3,450 pounds phosphoric acid) to the acre, while those that have had tobacco 15 or 20 years often show more than double that amount. The tobacco crop takes very little phosphoric acid (15 pounds per acre) from the soil. In the average fertilizer practice, 100 pounds or more are added every year. Practically none is leached away. Thus constant accumulation makes the old tobacco soils very rich in phosphorus. All "availability" tests also show that there is a corresponding increase in available phosphorus. Therefore the addition of special phosphoric fertilizer materials such as various bone compounds is quite unnecessary on old tobacco soils.

The tobacco soils of Connecticut contain a very large total quantity of potash, 25,000 to 50,000 pounds to the acre. Unfortunately, however, this exists mostly in the form of relatively insoluble minerals and becomes available only very slowly. Therefore annual applications of fertilizer potash are necessary.

Total calcium amounting to about 15,000 pounds to the acre, is lower than in the other types of soils in the state.

Magnesium at about 7,000 pounds to the acre is still lower and is usually too slowly available. Therefore it is advisable to add magnesia for optimum tobacco production.

Our tobacco soils are fairly acid, averaging about 5.2 pH. The optimum reaction is between 5.00 and 5.6 pH. Those above 6.0 pH favor the development of black rootrot and should be avoided. Below 4.5 pH, the crop often suffers from manganese poisoning due to formation of soluble manganese compounds at this degree of acidity. Such soils should be limed to make them less acid. The presence of manganese compounds in the leaf gives an objectionable reddish brown color—commonly called "muddy" or "bricky"—to the ash. The more acid the soil, the greater the absorption of manganese by the plants.

SEED BEDS

The seed is started during the first weeks of April in long, narrow beds covered with glass sash or with cloth (Fig. 124). The size of the ordinary glass sash is 3 by 6 feet, but many prefer a wider bed and therefore use 8-foot, or even 10-foot, sash. From the standpoint of convenience in operation, weeding, pulling plants, etc., the 6-foot width is preferable. The length of the bed varies according to acreage of plants required. The side boards on one side of the bed are higher (10 to 14 inches above ground) than on the other, thus giving a slope to the sash. This slope, which is usually toward the south or east, drains off the water better and may possibly make the beds somewhat warmer. The boards are 1 to 2 inches thick. Since the parts of the boards in contact with the soil decay in two or three seasons, some growers use timber specially treated to prevent decay. Creosote is not suitable for this treatment because its fumes injure the young plants.

Instead of glass a fine-mesh white cotton cloth may be used to cover the beds. It is a common but not universal practice first to treat this cloth with linseed oil. Such treatment is said to keep the beds warmer and to preserve the cloth.* The cloth is supported at the center over a raised pole which runs longitudinally above the middle of the entire length of the bed. The margins of the material are stretched over small headed nails driven into the outer face of the side boards. Plants grown under cloth are just as good as those grown under glass, but are ready for setting about 10 days later.

A protected spot which insures a maximum amount of sunshine and minimum of cold winds is commonly selected for the location of the beds. Such conditions make the plants grow more rapidly and at the same time are more comfortable for working during the early spring months. Locations protected by tobacco sheds or other buildings, or by woods on the north and west, south slopes, nooks in the woods, or hollows, are favorite places. Some growers build high protecting board fences around the beds or place shade tents around and over them. The soil should be sandy, well drained and aerated, and of one of the types described above as favorable for tobacco culture. A good water supply close at hand is also essential.

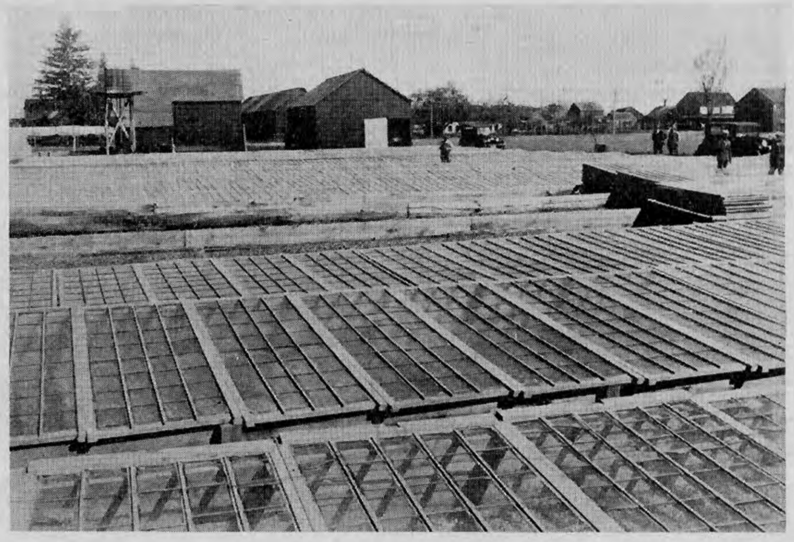

FIGURE 124. Seed beds used for starting tobacco in April.

The beds are made in the same place year after year without change of soil. As long as the measures suggested below are practiced for keeping up the fertility of the soil, such continuous use of the same spot is generally advantageous and attended by no ill effects. Sometimes the soil becomes infested with certain insects or disease organisms, angle

*Mr. W. S. Pinney of Suffield, who has used oiled cloth over his beds sucessfully for many years, gives the following directions for treating the cloth: In a tub, make a mixture of 1 part boiling water in 2 parts of linseed oil. Add a little paint drier. Dip the cloth in this mixture until it is thoroughly saturated. Then run it through a wringer to remove excess oil. It is now ready to spread over the beds. *Do not leave cloth in a roll* on account of danger of spontaneous combustion.

worms or unexplainable deterioration, especially when not sterilized yearly. Then the grower may find it best to replace the soil in the beds with new soil, or to select a new location.

TESTING THE SEED

Poor seed is very expensive and is often the cause of worry and disappointment. Before sowing, it is advisable to find out what percentage of the seed will grow. Every grower may do this for himself. The test requires two weeks time for certainty. Light seed and chaff should be blown out first. One hundred seeds should be counted out and put on a moist blotter in a covered dish in a warm place—not over 90° F. The number of seeds which sprout give the percentage sought. The blotter must be kept moist all the time, but the seeds should not be covered with water. An average of several tests is more accurate than one. Good seed should germinate more than 80 per cent and many samples run more than 95 per cent. Seed usually germinates somewhat better the second year than the first. It should be good for at least five years. The Experiment Station makes these germination tests and blows out the light seed for growers free of charge.

RATE OF SEEDING

If the plants grow too sparsely, there is a waste of bed space and also they develop too short and squat for best setting. If they are too thick and crowded in the bed, they become weak and spindling, have not enough roots and do not start so well when set out. Such thick stands are also more subject to bed rot diseases. The stand of plants is more likely to be too dense than too sparse.

It is therefore important that the proper quantity of seed be sowed to produce optimum stand. One ounce of seed to 900 square feet of bed space is sufficient. This is equivalent to one ounce to fifty 3 by 6 sash.

STERILIZING THE SEED

As a common practice, sterilizing the seed is not recommended, but if wildfire is known to have been present on the seed plants, it is safest to immerse the seed for fifteen minutes in a 1-1000 solution of silver nitrate. Then wash it in running water for fifteen minutes and spread in a thin layer to dry quickly.

STEAM STERILIZING THE SOIL

Steaming the soil not only kills any wildfire germs which may have been carried to the beds, but it is beneficial in destroying the fungi which cause rootrot and bed rot as well as various other germs and insects. Steam kills weed seeds. Many growers consider this latter benefit alone worth the cost of the operation. It also makes the plant nutrients in the soil more available and produces a more vigorous growth.

Soil may be sterilized either in late autumn or in spring. The advantage of fall sterilization is that it distributes the labor better by avoiding the spring rush. Spring sterilization may delay considerably the time of seeding, especially during late springs. The disadvantage of fall sterilization is that the soil may become infested with weed-seeds, insect pests and fungi to some extent during the winter. On this account, the operation should be delayed until as late in the season as possible.

Injury to the germinating seeds sometimes results when the bed is seeded immediately after steaming. For this reason it is best to wait a few days before the sowing—ten days is better if it does not delay the time of seeding too seriously.

Of the various methods for steaming soils, the only one used in Connecticut is the "inverted pan" method. A galvanized iron pan, rein-

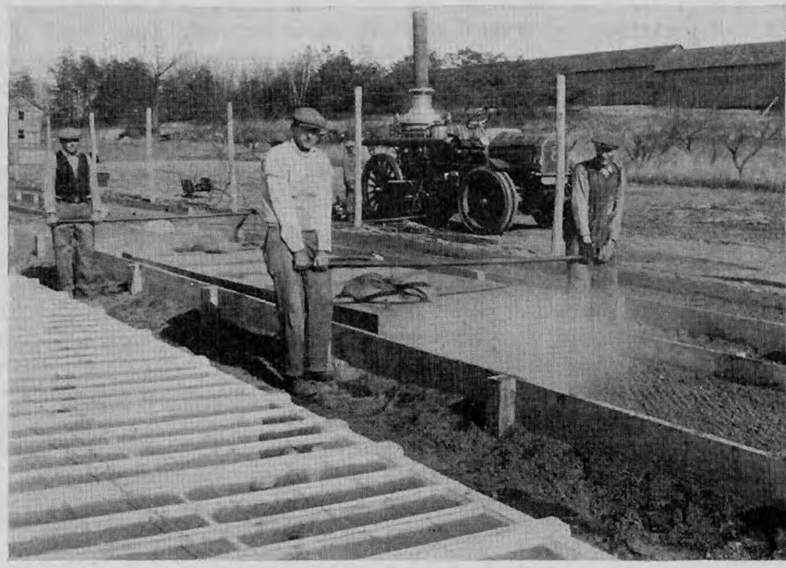

FIGURE 125. Sterilizing the beds by the steam pan method. The men are seen moving the pan forward. An old fire engine serves as a boiler.

forced with angle irons, about 10 inches deep, 12 to 16 feet long and just wide enough to fit inside the bed, is inverted over the soil and the sharp edges pressed a few inches into the loose earth (Fig. 125). Steam under high pressure from a steam boiler is forced through a pipe into the end of the pan and penetrates into and sterilizes the soil. The method is too well known to require further description except for the following precautions:

The soil should be well worked up and loose. Any manure or humus to be added should be applied before steaming. Commercial fertilizers may be added before or afterward. A moderately dry soil is more easily sterilized than one that is water-logged, because steam penetrates mud very slowly. Twenty to thirty minutes with a pressure of 75 to 125 pounds is usually sufficient. If, after removing the pan, the soil is so hot that you cannot hold your hand in it at a depth of five to six inches, the steaming is sufficient. Otherwise the length of steaming time should be prolonged. The soil should not be worked deeply after steaming because there is danger of turning up some of the unsterilized earth.

STERILIZING SOIL WITH FORMALDEHYDE OR ACETIC ACID

The soil may also be sterilized effectively with formaldehyde solution instead of steam, although this process does not kill all of the hard weed seeds. The solution should be made at the rate of 1 part to 50 of water and the soil soaked at the rate of one-half gallon to one square foot of soil if it is pretty damp. If the soil is dry, a more dilute solution of 1 to 100, and used at the rate of 1 gallon to 1 square foot, is advisable. Seed should not be sowed for ten days to two weeks after drenching, or until the odor of formaldehyde has disappeared. Stirring up the soil a few times may hasten escape of the fumes.

More recently it has been found that a 1 per cent solution of acetic acid is just as effective as formaldehyde and costs less. The solution is made by mixing 8 pounds of acetic acid (56 per cent) in 50 gallons of water and applying at the rate of one-half gallon to one square foot of soil. Otherwise the procedure is as with formaldehyde.

FERTILIZING THE BEDS

So many different systems of meeting the food requirements of the seedlings are employed by different successful growers that it is apparent that there is no single best method. The application of a complete commercial mixture at the time of sowing the seed—unless it be a very light application—is not recommended because there is danger of burning the first tender shoots and rootlets, and because the food requirements of the plants in the germination stage are light. Also the use of fresh organic materials such as cottonseed meal favors the growth of undesirable molds.

A safer practice is to make a heavy application of stable manure in the summer or autumn, work it into the ground and let it become thoroughly rotted during the winter. Cottonseed meal may also be applied in the fall; or a complete tobacco fertilizer may be added at that time. Any of these practices is good and eliminates the necessity of using fertilizer in the spring.

It is not advisable to force plants to grow too rapidly in the bed. Such plants become succulent, tender, have not enough roots for the size of the tops and do not live so well when set in the field. If, however, the growth is too slow in the bed or the plants begin to turn yellow after they have started, a top dressing may be applied to the soil. Nitrate of soda, nitrate of lime, or nitrate of potash may be dissolved in the water used for sprinkling the bed. The rate of dilution is about a tablespoonful to a sprinkler of water, or two pounds to a barrel. "Swiftsure", or dry ground fish, may be applied in a dry condition to the growing plants. The beds should be heavily watered immediately after application.

A heavy coating of peat or swamp soil composed mostly of decayed vegetable residues worked into the ground before seeding is used by some growers with good results. It increases the moisture-absorbing capacity of the soil and induces a better root system.

PRE-SPROUTING THE SEED

Seed may be sowed dry or may be sprouted before sowing in the bed. The sprouting process consists of keeping the seed moist and warm for several days previous to sowing. Then when the young white roots appear in four to eight days, the seed is ready for the beds. The object is to get the plants started more quickly. It is a common practice to mix the seed with damp, well rotted and pulverized wood (apple punk) or cocoa fibre or various other materials which will keep it moist. Some growers prefer to sprout the seed in bulk without any diluting material.

It is questionable whether any worthwhile advantage is derived from pre-sprouting. The majority of growers use unsprouted dry seed. Some growers mix sprouted and unsprouted seed in order to increase the length of the period during which the plants become successively ready for transplanting.

SOWING THE SEED

In preparation for sowing, the soil need not be worked very deeply but should be well pulverized and raked over until the surface is level. It may then be pressed down with a plank or rolled. Some times it is left loose at this time and rolled after seeding. The seed can be distributed better if first mixed with a diluting material like fine corn meal, coal ashes, fine sand, superphosphate, or land plaster. It is sowed by hand because no machine has yet been found which will distribute it in a satisfactory way. After spreading it over the soil, it may be raked over very lightly or it may be rolled in with a hand roller. An old method was to tramp the ground with the feet. The soil should then be thoroughly soaked with water using a fine gentle spray, gradually applied, so that no streams run over the surface.

The essential points are that it must not be buried deeply, if covered at all, and that the soil must be firm enough to be kept moist easily. Some growers of shade tobacco cover the ground with a layer or two of old shade cloth. This keeps the soil moist, prevents washing and has been very satisfactory in producing a uniform stand of plants.

WATERING

At the time when the seeds are just sprouting, it is extremely important that they be kept moist. No dry spots should be allowed to appear at this time, even though it may be necessary to sprinkle the beds twice a day. Uneven "stands" are usually traceable to neglect at this critical period.

When the plants have become established, however, the system of watering should be changed. Heavy watering at less frequent intervals is the best practice at this time. Too much water is objectionable, because it may start bed rot and because it makes the plants too tender and does not force them to develop a strong root system.

VENTILATION

Except in extremely severe weather, the beds should be ventilated for several hours every day by raising one end of the sash, or by removing the narrow boards sometimes placed between the sash. The temperature in the beds should never be allowed to rise above 100° F. The optimum temperature for germinating seed is 85° to 90° F.

SPRAYING

Since the advent of the wildfire disease in New England, about 1921, spraying or dusting of the plants in the seed beds has become a common practice. It not only prevents wildfire but also other diseases, repels flea beetles and is commonly recognized as a good practice in producing healthy plants.

The only sure way of preventing wildfire in the young plants is to keep the leaves covered with a copper fungicide continually. This may be applied as a dust or a liquid spray. Either method will prevent wildfire. The choice between them is largely a matter of personal preference, convenience and economy.

Our own preference is the ordinary 4-4-50 Bordeaux Mixture which is commonly used for spraying potatoes. It is the cheapest and safest material, and sticks to the leaves better than any other fungicide. Directions for making a convenient quantity for tobacco beds, are:

1. Slake 25 pounds of quick lime (granulated lime is perhaps best) in a barrel with just enough water to keep it boiling. Too much water at first will "drown" the lime, i. e., it will not heat. Stir the mixture continually until it is slaked. Afterward add water to fill the barrel up to 25 gallons. If hydrated lime is used the quantity should be increased to about 35 pounds.

2. Put 25 pounds of copper sulfate (blue-stone, blue vitriol) in a burlap bag (fertilizer or onion bag). Hang the bag in 25 gallons of water in a *wooden* barrel over night to dissolve the copper sulfate, or stir the compound about in the water until all of it is in solution.

The above are the "stock solutions" and may be kept all season. Keep them covered and stir well before using.

To make a barrel (50 gallons) of Bordeaux Mixture:

1. Pour four gallons of lime stock solution through cheesecloth stretched over the top of the mixing barrel. (The cloth may be held in place by a hoop slipped over the top). Much of the lime will be left on

the cloth. Wash as much of it as you can through with 25 to 30 gallons of water.

2. Pour four gallons of the copper stock solution through the same cheesecloth and add enough water to fill the barrel.

The solution is now ready for use. Stir each time before using. Don't mix together more than you need at one time. It will not keep until the next application.

Use one and one-half to two gallons of this solution per square rod of bed, depending on the size of the plants and fineness of the spray. Use a fine spray and high pressure.

Keep the leaves covered with the spray all the time after the second pair of leaves appears. This means spraying about every four or five days when the plants are growing rapidly.

Spray when the leaves are dry and then do not put the glass on again until the spray has dried. Don't spray at night, but earlier in the day when the spray will have time to dry.

If the mixture has been made and applied properly, the plants will appear blue when dry, and the spray will not wash off when the bed is watered.

Any kind of a spray pump that gives a fine spray and fairly high pressure is satisfactory for the work. The barrel pump or wheelbarrow type are convenient. The hose used in watering the beds may also be used for spraying.

COMMERCIAL BORDEAUX MIXTURES

Ready-made commercial products such as "Pyrox" may be purchased at hardware or farmers' supply stores. On the outside of each package there are directions for diluting the contents with water to make it equal to 4-4-50 Bordeaux. Follow the directions. A number of these products have been found to be satisfactory, and if a small bed is to be treated, they may be economical. None of them is as cheap or any better than the Bordeaux made at home.

COPPER LIME DUST

Copper lime dusts, such as Sanders' Dust, Niagara Dust, etc., are effective and in common use, being preferred by many good growers. They should be applied somewhat more frequently than Bordeaux, and they stick best if applied when the leaves are moist. The dusts are more expensive than Bordeaux but have the advantage of covering the underside of the leaves better than spray. It is not necessary that they should contain arsenicals if they are used only to control wildfire.

ERADICATION OF WILDFIRE SPOTS IN BEDS

Frequently wildfire appears only in isolated spots or areas in the beds. Whenever a spot infection is found, all the plants in the infected area, as well as those bordering on it for a foot or more, should be destroyed by drenching it with formaldehyde diluted at the rate of about one part in 25 parts of water. Glass should be removed from the bed during this operation to prevent the fumes from spreading and injuring other plants.

If the infected spots are numerous or the disease is spread generally throughout the bed, it is best to destroy the bed entirely by drenching with a 1 to 50 solution of formaldehyde on a hot day and leaving the glass on tight. Wildfire is contagious. Tools used in infected beds should be dipped in formaldehyde before being brought into contact with healthy plants.

Under no conditions should plants which show lesions of wildfire be set in the field. It is better not even to pull plants from a bed which shows any infection whatever. This, however, is not always practicable.

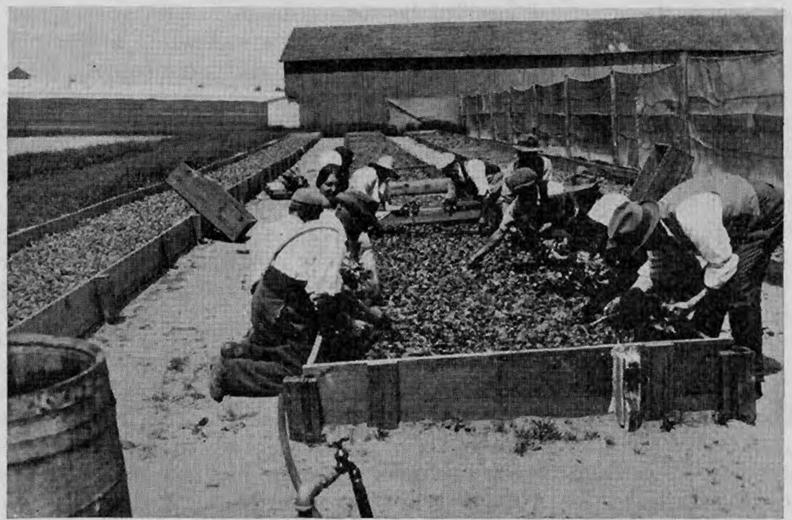

FIGURE 126. Pulling the plants. After thoroughly moistening the soil, the workers take the tips of the largest leaves in their fingers and pull one plant at a time.

Do not neglect to keep the plants sprayed or dusted all the time.

After the disease is in the leaf it cannot be eradicated by application of spray or dust but it can be prevented from spreading to other plants.

PULLING THE PLANTS

When the stalk of a plant is four to six inches long it is ready to be transplanted to the field. Previous to this move it is best to remove the glass from the beds and leave them open day and night for several days or a week. This hardens the plants and makes them better able to withstand the shock of transplanting. Plants are pulled out singly by taking hold of the tips of the larger leaves (Fig. 126). They should be heavily watered beforehand to make the ground soft and prevent unnecessary breakage of roots. If a leaf breaks when pulled, or a plant does not come out easily, more water is needed. As soon as the larger plants are removed, others grow up and the bed may be pulled every two or three days. In order to keep the plants growing straight, the glass should be replaced after pulling. If the plants stop growing or turn yellow before enough have been transplanted, they should be fertilized again as prescribed in the previous section.

FITTING AND FERTILIZING THE LAND

Since plants usually are set in the field about the first of June, the land should be prepared during May. Some growers prefer to plow in April, especially if there is sod land to be turned under. Others practice fall plowing but it is questionable whether this is worth while unless old sod is being plowed. In that case the sod has a longer time to rot. There is no advantage in plowing to a depth of more than seven to eight inches. After turning the land with a plow, it is thoroughly pulverized with a disk harrow and then with a spike tooth or spring tooth harrow. Just before setting, the surface is leveled with a drag or a plank behind the harrow.

Fertilizer is spread broadcast on the field a week or two before setting and thoroughly mixed with the soil with the disk harrow. The ordinary fertilizer sower or lime spreader is used for applying fertilizer. Application in the row is not commonly practiced here.

SELECTION OF THE FERTILIZER

Until the middle of the last century, barnyard manure from the farms was the only fertilizer used on tobacco fields. But with increasing concentration of acreage and continuous growing of tobacco on the same land, the farm supply of manure became inadequate. Growers began to import manure from New York and other large cities, then to use more concentrated animal and plant residues such as fish scrap, Peruvian guano, tankage, and bone meal; and later, the vegetable meals, cottonseed meal, linseed meal and castor pomace. The earliest source of potash, wood ashes, was succeeded by cottonhull ashes. Then purely mineral compounds, cheaper and containing the plant nutrients in more concentrated form, supplanted the manures and organic materials to a greater extent each year. Manure is still used but the greater proportion of the plant food is now supplied in a mixture of mineral compounds and concentrated organic residues.

Under the conditions of continuous tobacco culture on our usual sandy soil types, it has been found best to use a larger proportion of organic material than is customary for other crops or for tobacco in other regions where it is grown in rotation with other crops. The plant makes most of its growth in six to eight weeks. During this short period it must have an abundant supply of plant food ever at hand in the soil in an easily available condition.

The actual quantity of each of the essential elements to be supplied varies somewhat with the character of the soil, but many experiments and long experience have led to the following general rules for rates and carrier materials:

Nitrogen should be supplied at the rate of about 200 pounds to the acre. On sandy places subject to rapid leaching, it is sometimes necessary to add more of the material later as a side dressing in seasons of heavy rainfall. In heavier, more retentive land, some growers reduce the amount to as little as 150 pounds without detriment. When the supply of nitrogen is too low, tobacco leaves become yellow in the field and, when cured, they are dead, yellow, and non-elastic. They are not only of inferior quality in general, but also the yield is reduced. When there is too much nitrogen, the cured leaves are dark and heavy, and the taste and aroma are not pleasant.

As for the materials in which the nitrogen should be furnished, there is wide diversity of opinion. The larger part of it should come from organic materials; some growers prefer to derive all of it from such sources. Cottonseed meal is used more than any other organic material. Nearly all formulas contain a considerable proportion of it. Linseed meal and castor pomace frequently are added to make up a part of it. Dry ground fish is also an excellent nitrogenous material which is used extensively because its nitrogen becomes available more quickly than that from other organics. It is a common belief that the mixture should contain several sources of nitrogen which will decompose at different rates and thus supplement each other in bringing their supply successively into an available state. Hoof and horn meal is another good organic source of nitrogen. Tankage and dried blood have a reputation for producing dark tobacco and are therefore rarely used here. Peruvian guano was a favorite source of nitrogen a generation ago but went off the market and only recently has become more plentiful.

Of the mineral sources of nitrogen, nitrate of soda has been used longest and most commonly. Recently nitrate of calcium has partly supplanted it. The latter nitrate is at least theoretically preferable because a good supply of calcium is essential for tobacco growing, while sodium is entirely useless. A five-year field test at the Windsor station where the two were compared on adjacent plots showed some advantage in favor of the calcium salt. Nitrate of potash is a third good nitrate form and furnishes the two most important plant foods in a single salt. Formerly very expensive, it has now become as cheap as any other nitrate material on account of its synthetic preparation from air nitrogen. Nitrogen in the nitrate form is ready to be taken into the roots immediately without further change and is therefore frequently used as "starter", and in side dressings for later application. It has the disadvantage, however, of leaching quickly from the soil—especially sandy soil—in seasons of heavy early rains. For this reason only a small part of the nitrogen—not more than one-fourth or one-fifth of the total—should be in this form.

Urea or calurea (a mixture of urea and nitrate of calcium) may be used as a substitute for a part of the organic materials. About one-half of the nitrogen in manure is in the urea form and in early days the crop received large doses. More recently urea has been synthesized from air nitrogen and is now supplied as pure chemical. It is usually a much cheaper source of nitrogen than the organic forms and is more quickly available. It does not leach seriously from the soil.

The ammonia forms of nitrogen are not recommended for tobacco mixtures. Field tests at the Windsor station showed that sulfate of ammonia produced dark tobacco of inferior quality and poor burn. Ammonium phosphate and ammonium nitrate have not been sufficiently tested. The objection to cyanamid is that it makes the soil too alkaline.

Potassium is the second important nutrient element. It is necessary for the proper growth of the plant and also a good supply of it insures a long fire-holding capacity of the leaf. It reduces wilting of the plants during hot days in the summer. Cured tobacco with a sufficient potash content also comes into "case" more readily in the shed and is more pliable and elastic on the bench. About 200 pounds of potash to the acre should be supplied. It does not leach away as rapidly as nitrogen and there is probably never a need of making additional applications during the summer. Yet it leaches slowly throughout the year. As a result there is no great accumulation of potash and it is necessary to apply about the same amount annually.

There is a considerable choice of materials in which potash may be furnished. Sulfate of potash has been used more than any other since the beginning of the present century. It falls short of being the ideal form in that it increases somewhat the percentage of sulfur in the leaf and thus reduces the fire-holding capacity. But this objection is usually not very serious because of the limited capacity of the tobacco plant to absorb sulfur. Sulfate of potash-magnesia (double manure salts) has been used to some extent and has the advantage of containing magnesia, an essential to the production of good burn. Its disadvantages are: First, that it contains only about one-half as much potash as the high grade sulfate; and second, it contains twice as much sulfate in proportion to the potash supplied. It is somewhat more expensive per unit of potash than the high grade sulfate.

Nitrate of potash is an excellent source of potash because it contains no residues that may be objectionable if accumulated in the soil or taken into the plant. It is now as cheap as other sources of potash when allowance is made for the nitrogen it contains. The amount which can be used in the formula is limited by the quantity of nitrate that one wishes to use.

Carbonate of potash was originally supplied in wood ashes. The use of large enough quantities of wood ashes to furnish the requisite amount of potash for tobacco is undesirable because it makes the soil alkaline. Wood ashes may be used in small amounts, however, Cottonhull ashes also contain potassium in the carbonate form and in much higher percentage than wood ashes. At the close of the last century this material was a favorite source of potash but later it disappeared from the market. In recent years the supply has been renewed and is now used with satisfactory results by many growers. The magnesia which it contains (about 5 per cent) increases its value. Pure carbonate of potash is also a good potash material which is used with success. It is now more expensive than carbonate in the form of cottonhull ash.

Tobacco stems are perhaps the ideal source of potash since it is safe to assume that they contain all the other elements which the growing plant needs as well. In a finely ground condition (residue from nicotine extraction) they may be mixed directly with the other ingredients of the formula. They are also much used in the unground condition (long stems) in which case they are spread directly on the soil with a pitch fork.

All of the organic materials mentioned above as sources of nitrogen also contain small percentages of potash which is readily available to the plant.

Muriate of potash is never used in Connecticut because the chlorine is greedily absorbed by the plant and injures the burn.

It is a good practice to get the potash from several carriers in the formula rather than from one.

Phosphorus is needed only in very small amounts by the tobacco plant. Less than seven pounds (15 pounds phosphoric acid) is taken up by an acre of tobacco. Since more than that amount is supplied in the nitrogenous organic materials (a ton of cottonseed meal contains 50-60 pounds) and since additional carriers of phosphorus are commonly added, such as various forms of bone, phosphorus accumulates in old tobacco soils. It does not leach away. Consequently fields which have had tobacco on them for five years or longer rarely respond to further application of phosphorus. Such applications only serve to build up the over-supply and represent wasted money. New lands may require phosphorus and it is advisable to add it. There are no very convincing experiments recorded to guide us in making recommendations in this case, but arbitrarily 100 pounds is assumed to be adequate. Otherwise it may be omitted entirely.

Magnesium is the fourth element which must be considered though it does not always have to be supplied on all lands. This is an essential constituent of chlorophyll and if the supply is inadequate, the leaves of the plant lose their green color, exhibiting the chlorotic symptoms known as "sand drown". Such tobacco is very poor in quality when cured. A second function of magnesium which is important in cigar leaf is to promote the burn. If the supply is poor, the cigar burns with a black or dark gray ash and the taste and aroma are unpleasant. With increase of magnesia the ash is correspondingly whiter and the taste and aroma are improved. However, care must be taken not to add too much magnesia else the ash will have an undesirable "flakiness".

With respect to the quantity of magnesia to be applied, the grower must be guided by the burn of the tobacco which is produced on a field. If the ash is satisfactory, it is not necessary to increase the magnesia supply. If it is inclined to be dark, however, magnesia must be added. About 75 pounds to the acre applied annually should keep the burn good. If the ash gets flaky the application may be omitted for a while or may be reduced. If it is too dark the dose may be increased.

Magnesian ground limestone, or hydrated lime, is perhaps the most economical and convenient material with which to meet the magnesium requirements. It should analyze as high in magnesia as can be obtained. Limestone with an Mg0 content up to 20 per cent and hydrated lime of 30 per cent are easily obtainable. If the material is to be mixed with the other ingredients, the ground limestone is better because of danger of liberating the ammonia from other materials when caustic lime is present.

Double manure salts have already been mentioned as a source of magnesia. Cottonhull ashes contain about 5 per cent. The percentages in other ingredients are given in Table V (page 810).

MIXING THE FERTILIZER

The grower may either purchase the materials and mix them at home or he may purchase ready mixed fertilizer. The principal argument in favor of home mixing is that it is less expensive. The amount saved varies with the kind and quantity of mixture and terms on which one is able to buy, but a saving of $10 to $25 an acre is not unusual. A second argument favoring home mixing is that it enables one to change his formula according to variations in his fields. Every grower learns by experience that different fields, or different parts of the same field, respond differently to the same fertilizer treatment. By mixing his own fertilizers he can easily adapt the mixture to his land. A third advantage is that he always knows just what goes into his mixture and on his soil.

The first argument against home mixing is the labor and time involved. Growers who have had long experience state that the labor does not cost over $1.00 a ton. Some find that it costs them nothing, because they mix it either in winter or on rainy days when the help would otherwise be idle. For the grower who raises only a small "patch" of tobacco, home mixing is not worth bothering about, but the larger grower can find no easier way of cutting down costs.

Another objection sometimes heard is that the farmer will not mix his fertilizer as thoroughly as does the machine. This may be literally true, but it has been demonstrated thoroughly on thousands of acres of good tobacco that the farmer can mix it well enough to suit the tobacco plant. Any farmer who can read and follow the directions given below can mix a fertilizer on which tobacco will grow as well as on machine-mixed products.

Many farmers hesitate to mix their own fertilizer because they do not know how to make up the formula. The following simple principles for making a formula, together with Table V, showing the percentage of plant food in each good material, will enable any grower to make his own.

Principles to be Followed in Making the Formula

1. Figure pounds of *plant food* per acre. Pounds of mixed fertilizer per acre mean nothing to the plant.
2. An acre of tobacco should receive 200 pounds of nitrogen and 200 pounds of potash. For new land, about 100 pounds of phosphoric acid should be used. For old tobacco land, phosphoric acid is not important.
3. About two-thirds of the nitrogen should be from natural organic carriers: Cottonseed meal, castor pomace, linseed meal, fish, etc. The other third may be taken from such sources as nitrate of potash, nitrate of soda, nitrate of lime, urea, or calurea.

4. It is better to derive each food element from several sources rather than from one.
5. Avoid all compounds containing more than 2 per cent of chlorine as far as possible.
6. The sulfur content should be kept as low as is practicable.
7. The mixture should contain a minimum of 25 to 30 pounds of magnesia per acre, and where a better ash is desired, as much as 75 pounds.
8. There is no one best formula. There are many good ones.

Method of Mixing

No special apparatus is necessary for mixing. A level floor of a barn or shed is convenient. Mix in one-acre batches. Spread the cottonseed meal, or other material of which there is the largest amount, in an even layer on the floor. On top of this, spread an even layer of each material in turn. Break up any large lumps. Now shovel the whole mixture into a high pile at one end of the floor taking each shovelful from the bottom of the pile and throwing it directly on top of the new pile. Then shovel this new pile to the other end into another pile. Next shovel it back through a sand-screen or other coarse-mesh screen. The screen removes lumps and at the same time makes the mixture more intimate. It should now be ready to bag, but if it does not appear uniform, it may be shovelled until it does.

Materials which may be used in tobacco mixtures with their approximate average analyses are listed in Table V (page 810).

As an example of how the formulas may be built:

I.

	Nitrogen	Phosphoric acid	Potash	Magnesia
1500 pounds cottonseed meal	102	45	30	10.5
500 pounds castor pomace	27	10	5	4.
100 pounds calurea	34			
300 pounds nitrate of potash	37		132	
100 pounds precipitated bone		38		
125 pounds double manure salts			33	14.
	200	93	200	28.5

Other examples:

II.

1200 pounds cottonseed meal
300 pounds linseed meal
400 pounds castor pomace
100 pounds fish
100 pounds urea
200 pounds nitrate of potash
200 pounds cottonhull ash
100 pounds bone meal
100 pounds sulfate of potash

III.

1500 pounds castor pomace
1000 pounds cottonseed meal
200 pounds nitrate of lime (or soda)
100 pounds nitrate of potash
150 pounds double manure salts
100 pounds ammophos
100 pounds precipitated bone
200 pounds sulfate of potash

These formulas assume that no other source of magnesia has been used. When heavy applications of stems or manure are made, it is not necessary to use such carriers of magnesia as double manure salts. This can also be supplied very cheaply in limestone. If analysis of the limestone, for example, showed it contained 20 per cent of magnesia, 200 pounds per acre would be sufficient.

Some growers prefer an all-organic mixture. For these, some such mixtures as the following are favored:

2500 pounds cottonseed meal
400 pounds fish scrap
600 pounds cottonhull ash

or

2000 pounds cottonseed meal
2000 pounds tobacco stems
300 pounds hoof and horn meal
200 pounds cottonhull ashes

Such formulas will grow excellent tobacco but are bulky and ordinarily more expensive than formulas in which a part of the nutrients is supplied in minerals.

FIGURE 127. Setting the plants in a shade field. This transplanter makes the furrow, drops about a pint of water where each plant should be placed and draws the earth up around the plants.

SETTING THE PLANTS

The best time to set the stalk-cut tobacco is from the first to the twentieth of June. Shade tobacco is usually set a little earlier, beginning about May 20. The usual distance between rows for Havana Seed and Shade is 40 inches, while Broadleaf is usually 42 to 44 inches. Sometimes Shade is set as close as 36 inches (10 rows between poles). In the row, Shade plants are set 12 to 14 inches apart, Havana Seed 17 to 19 inches, and Broadleaf 20 to 27 inches apart.

A transplanting machine (usually "Bemis" or "Tiger") drawn by two horses makes the furrow, deposits about one-half pint of water where each plant is placed and then draws up the soil around the plant (Fig. 127). By means of this machine, operated by one driver and two "droppers", two or three acres per day may be set. Two-row tractor-drawn setters are now used with satisfactory results by a few growers. The plants should be set into the ground as deeply as possible without covering the bud ("chit"). Plants set late in the afternoon start better because they do not suffer so severely from the wilting of the first day and have an opportunity to start new roots during the first night.

A small amount of nitrate of soda (about one to two pounds per barrel) is sometimes dissolved in the water of the setter barrel to give the plants a quick start. Under the usual conditions of heavy fertilization however, the value of this practice is questionable.

RESTOCKING

Even under the most favorable conditions for setting, some of the plants will die. It is essential that the grower go over his field within a few days after setting and replace all plants which have failed to establish themselves. If this is delayed too long the "stand" is uneven and the restocked plants do not mature as soon as the others. Since all are harvested at the same time, the restocked plants will be immature and when cured will not be of as good quality. It is therefore important that the field be restocked as soon as possible after setting in order to minimize such differences in the age of plants. This operation should be repeated every two or three days until there are no missing plants.

In restocking, a hole is dug with a hoe or with a dibble and the plant set in by hand with about a half-pint of water. If this can be done during rains, it is not necessary to add the water, but it is not wise to wait too long for rain.

Cutworms and wireworms kill many plants at setting time and shortly afterwards and are the principal causes of poor stands and considerable restocking.

Since cutworms may be expected every year, control measures should be adopted as one of the routine operations of each season. Directions for control are presented below. Wireworms, on the other hand, are of more local and occasional occurrence and are discussed under the chapter on insects (see page 794).

CONTROL OF CUTWORMS

Cutworms are rather easily controlled by the use of poison baits. The most commonly used poison is Paris Green. Arsenate of lead has been used to a less extent and is probably just as effective and less likely to cause burning of the leaves. The poison must be mixed with some carrier which will be attractive to the worms.

The poison mixture may be applied to the field several days before the plants are set and thus kill the worms before they have an opportunity to destroy the plants; or it may be applied after setting. The former method seems to be more logical but the latter is more commonly followed.

Poisons Used Before Setting

For application previous to setting, the following mixture has been used successfully:

Bran (1 bag)	100 pounds
Paris Green	3 to 5 pounds
Oranges or lemons	½ dozen
Cheap molasses	4 quarts
Water	about 15 gallons

The amount of water to be used must be determined by the condition of the mixture. Enough must be added to make the bran stick together in small lumps so that it can be broadcast by hand but not enough to puddle it. The bran and Paris Green are first mixed thoroughly in a dry condition by shovelling them over on a floor or in a box just as one mixes fertilizers. The oranges are squeezed and cut into small pieces and mixed with molasses and water. After thorough stirring, the sweetened water is sprinkled over the bran and poison mixture while it is being shovelled over so that it will mix thoroughly. Several days before setting the plants this mixture is scattered broadcast over the field at the rate of 25 to 50 pounds dry weight to the acre. This should be done late in the afternoon or in the evening in order that it may be in a moist condition during the night when the worms are out.

Recent experiments in other tobacco sections throw some doubt on the attractive value of such substances as molasses and oranges. In Farmers' Bulletin 1494, issued by the United States Department of Agriculture, the following mixture is recommended as being just as effective:

Bran	100 pounds
Paris Green	2 pounds
Water	enough to moisten

Method of mixing and application to the field late in the day, just the same as mentioned above, are recommended. Neither Lead Arsenate nor Calcium Arsenate is found as effective as Paris Green, according to this bulletin.

Poisons Used at Time of Setting

For application at time of setting or directly afterwards the following mixtures have been used successfully for years by good growers and are recommended:

(1) 100 pounds of cottonseed meal
2 pounds Paris Green
2 quarts molasses

Mix as described above and spread by hand directly over the row immediately after setting at the rate of about 75 pounds per acre. It is argued by the advocates of this method that the cottonseed meal is not wasted since it has a fertilizer value for the young plants.

(2) 100 pounds fine hominy
$1\frac{1}{2}$ pounds Paris Green

Mix thoroughly in a dry condition. Use no water or molasses. Apply beside the plants in the row (not on the leaves) by means of a tin can "shaker" (Fig. 128). Make holes in the bottom of a two-quart can and fasten the can to a stick about two feet long. One vigorous shake near each plant is sufficient. The mixture should be applied immediately after setting and if a later brood of worms emerges the measure should be repeated.

FIGURE 128. Control of cutworms. Application of poison bait in the rows with "shaker" cans.

3. Some growers prefer to use the same mixture as No. 2, but with less Paris Green, and shake it directly on the plants. If this method is to be used, it is safer to substitute two to three pounds of arsenate of lead for the Paris Green, or for a part of the Paris Green.

Paris Green Injury

When Paris Green comes in contact with the leaves accidentally or intentionally, it frequently produces irregular dead brown spots. This may at times be so serious that it kills the leaves. Since most of these first leaves die before the plants get started anyway, the loss is not important.

CULTIVATION

As soon as the plants have become established—a week or ten days after setting—the cultivator should be started. The field should be tilled about once a week as long as it is practicable to drive a horse between the rows without breaking the leaves. Various types of cultivators are used—one-horse (Fig. 129), two-horse, riding cultivators, etc.,—but the principles are the same. The first cultivation should be with narrow shovels—one and one-half to two inches—set deep, to loosen as much soil as possible, and the inside shovel should be set as close to the row as can be done without covering or dislodging the plant. When the roots begin to spread, after about the second cultivation, it is best not to dig so deeply near the plant but to practice more shallow cultivation and keep further away. Broader shovels ("sweeps") may now be used and the soil gradually worked up toward the rows. This "ridging" practice is used more

FIGURE 129. One horse cultivator used for working the fertilizer side dressing into the soil. During early growth tobacco should be cultivated once a week.

under cloth than in the open, and during wet years than during dry years. The additional soil thrown against the base of the stalks enables them to produce brace roots which help support the stalk and keep it from toppling over during storms.

The Prout hoe is used to good advantage for ridging and for shallow cultivation during the later operations.

The rows are hoed with hand hoes about twice during the season, once after the first cultivation and again two weeks later. The object is to break up the soil between the plants in the row and to destroy weeds.

FERTILIZER SIDE DRESSINGS

Should all the fertilizer be applied to the field before setting or should some of it be "held out" and applied as a side dressing between the rows while the crop is growing? On this question there is considerable diversity of opinion and of practice. During heavy rains, nitrogen—and other elements to a less extent—leaches out of the soil into the drainage water. Hence there is danger that tobacco plants may suffer and stop growing because there is not sufficient nitrogen. It is common knowledge that the best tobacco is produced when it grows continuously without any periods of checked development. The only reason for using later side dressings is to replace the plant food which has been lost. During dry years, or years of moderate rainfall, this loss does not occur. It is more pronounced

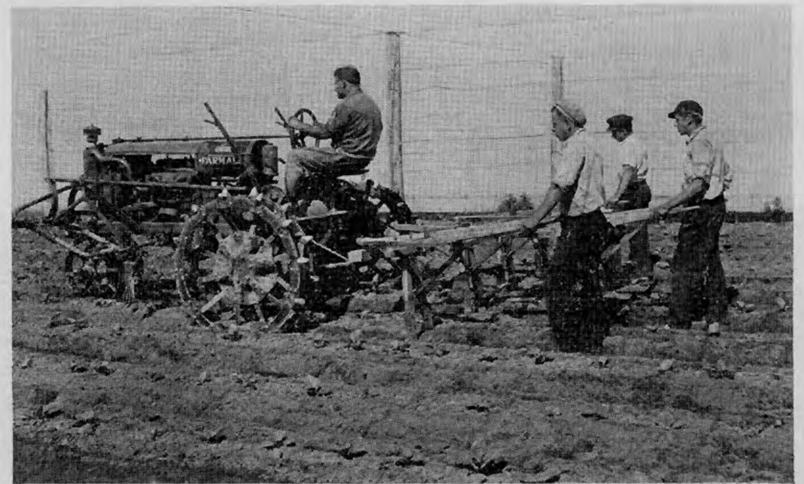

FIGURE 130. Cultivating in the shade tent with three Prout hoes drawn by a tractor.

on sandy soils, especially where the subsoil is of a sandy or gravelly porous nature. Obviously the benefit to be derived from later applications depends first, on the amount and distribution of the rainfall, and secondly, on the character of the soil. Therefore, it is not possible to lay down any rule of procedure which will apply in all cases. Different seasons and different soils call for different treatments.

At the Experiment Station farm, tests of five years failed to show that there was any advantage in later applications. But on the sixth year—the unusually wet year of 1928—the reverse was true and the benefit was evidenced by increased yield and better quality where side dressed.

Side dressings, however, may be detrimental to quality and should be practiced cautiously and only when there is little doubt of the necessity. When a new supply of nitrogen becomes available too late in the development of the plant, the tobacco enters another period of active vegetative growth at the time when it should be maturing. This results in green and dark leaves when cured.

Probably the best rule is: Broadcast all the fertilizer which should be needed by a normal crop in a normal year before setting. Then if the rainfall of the growing season becomes excessive, apply some quickly available nitrogen, especially to those fields or parts of fields which are known to be "leachy". For best results, it is essential to side dress immediately after the hard rain and *before* leaves show the yellow cast which indicates nitrogen starvation. If applied by hand, the fertilizer may be worked in between the plants with a hoe. Where the customary "wheel barrow" drill (Fig. 131) is used, it may be worked in with a cultivator.

Fish meal, nitrate of soda and cottonseed meal are most commonly used for this purpose. Nitrate of lime, calurea, or urea may also be used to

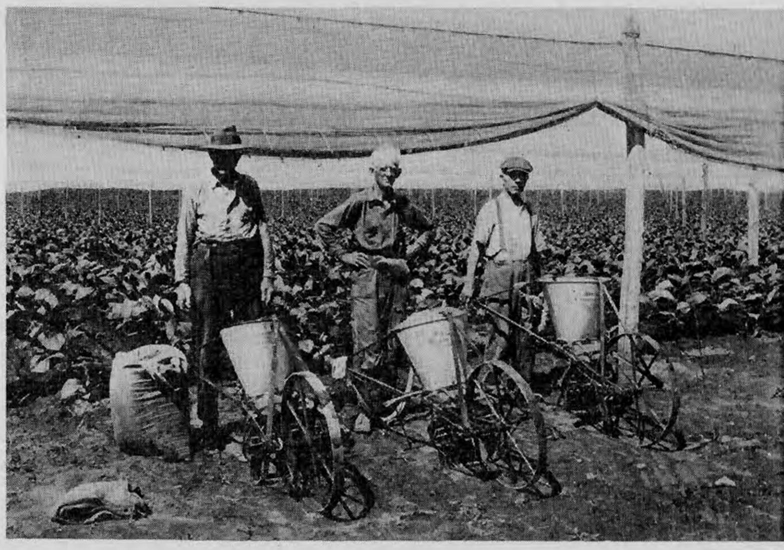

FIGURE 131. Wheelbarrow fertilizer sowers are used for the application of fertilizer between rows of growing plants.

good advantage. These more concentrated materials should be mixed with some other substance like cottonseed meal or linseed meal in order to get a better distribution in the wheelbarrow sower. The following mixtures are only a few of many good ones that may be used:

Material	Per Acre
Nitrate of lime	200 pounds
Cottonseed meal	300 pounds
Nitrate of soda	200 pounds
Linseed meal	300 pounds
Fish	400–500 pounds
Calurea	100 pounds
Cottonseed meal	300 pounds

Fish	100 pounds
Nitrate of lime	100 pounds
Cottonseed meal	300 pounds

The quantity per acre may be varied according to the grower's judgment of the needs of the crop.

TOPPING AND SUCKERING

With respect to these two operations, there is a marked distinction between shade tobacco and the out-door or stalk tobacco. The latter should be topped at about the time that the first blossoms open. There is considerable difference of opinion among growers as to the amount of

FIGURE 132. Wilting Havana Seed tobacco in the field.

top which should be removed. In tests at the Experiment Station the best results were obtained when the tops were removed to about three or four leaves before the first spike sucker, (the lowest sucker which has no leaves on it). The tops are broken off by hand with a sudden side twist. Ordinarily there is a period of about two or three weeks between topping and harvesting.

After removal of the tops, lateral shoots (suckers) grow out from the axils of the upper leaves. These must be removed once or twice before the harvest, the last suckering immediately before. If the period between topping and harvesting is long, and the suckers are removed only once, they become very large and tough and come off with difficulty at the risk of breaking leaves on the plant. It is better to remove the suckers twice even though it involves more labor and causes the second crop of suckers to grow lower on the stalk.

One of the immediate effects of topping is to make the stalk stiff and more resistant to blowing over during storms. In order to hasten this stiffening process by a few days, some growers prefer to remove the flower bud as soon as it appears and the full top later when the suckers begin to grow. This process is called "budding".

The usual practice under shade is to "bud", as described above, but to omit any further topping or suckering.

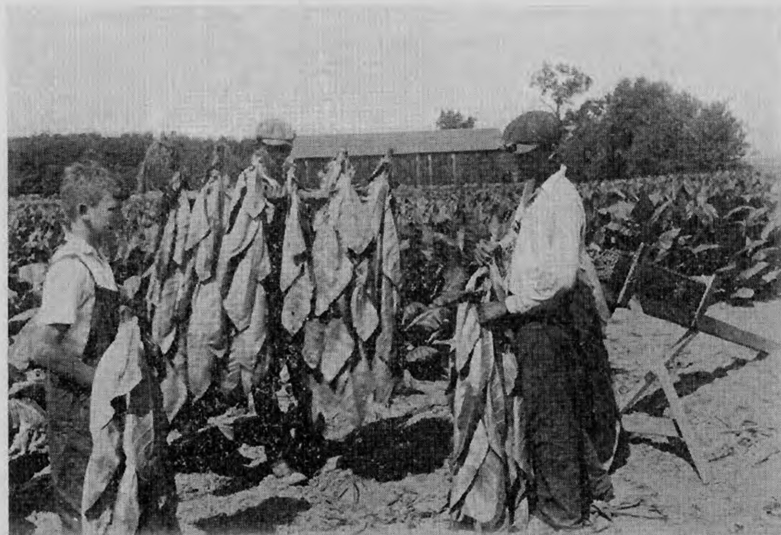

FIGURE 133. Spearing Havana Seed tobacco.

HARVESTING

The two methods of harvesting will be described separately.

STALK CUTTING

This method is used on all the Broadleaf and almost all of the Havana Seed plants and the operation is performed with a specially made tobacco hatchet. Holding the stalk with his left hand and pushing it over slightly, the workman severs it just at the surface of the soil with one clean slanting cut. The plants are then allowed to lie on the ground for an hour or two until the leaves are wilted and limp. During hot clear days one must be careful not to let the cut tobacco become "sunburned" or scorched. Such tobacco never cures out.

Next the plants are strung on four-foot lath by means of a steel spear head which slips loosely over the end of the lath (Fig. 133). The stalk is speared about six inches above the point where it was cut. Six plants on an average are hung on one lath. If they are large, five to a lath is better. When very small, more plants may be put on each lath. Since it requires a considerable "jerk" to force the spear through the stalk, the opposite end of the lath must be solidly supported. This may be done by setting the lath upright in the soil or more often, the opposite end of the lath is supported on a "stringing horse" (Fig. 133) which is specially constructed for this purpose and which the operator drags along with him. After removing the spear head, the lath of plants is transferred to a wagon rack (Fig. 134) where it is supported between two poles set about 44 inches apart and with the plants hanging upside down. A practice employed by many good growers is first to hang the lath of tobacco for a

FIGURE 134. Drawing Havana Seed tobacco to the curing shed.

few hours in the field on racks called "hurdles" (Fig. 135). This wilts the tobacco better and hastens and improves the cure. From the hurdles it is drawn on the wagon racks to the curing sheds.

The construction and dimensions of the curing shed vary. The usual type has a width of 32 feet, a length of some multiple of 16 feet, a height of about 16 feet at the eves and has a shingle ridge roof. The sheds are divided by the supporting posts into "bents", or sections, 16 feet square. Four of these squares furnish adequate space for hanging an acre of stalk tobacco. The size of the shed is designated by the number of bents on each side. For example, a shed 160 feet long is a 10-bent shed but actually contains 20 square bents. Such a shed is also commonly referred to as a five-acre shed. The sides of the sheds for stalk cut tobacco are made of vertical pine boards, an inch thick and 12 inches wide with each third board on hinges so that it may be opened wide for ventilation. Some growers prefer to hinge the boards at the top and let them swing out from the bottom. Most shade sheds have horizontal side boards which are hinged so that they swing upward and there is a ventilator board between each tier of leaves. (Fig. 136). The gables are also supplied with ventilator doors to allow air currents to blow lengthwise through the shed. Large swinging doors at both ends of the sheds permit the wagons to be driven through the length of the shed on either side. Raised ridges or metal ventilators of various types on the ridge are frequently added to allow upward currents of air during curing.

The poles on which the lath of tobacco are hung are 16 feet long and spaced 4 feet apart from center to center. There are usually three tiers of poles one above the other in the main body of the shed and one tier in the peak. Space between tiers is about five feet. The lath are placed on these poles about seven to eight inches apart depending on the size of the tobacco and the method of curing to be used. Larger tobacco should

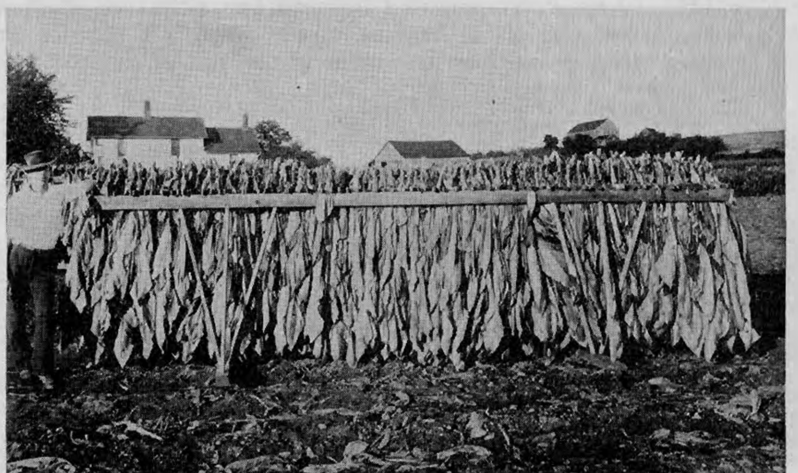

FIGURE 135. Havana Seed tobacco on a hurdle.

be hung farther apart. Closer setting of the lath may be practiced when the tobacco is to be cured by fire. For hanging shade leaves, the tiers are two and a half feet apart instead of five feet.

PRIMING

All shade tobacco is harvested by priming, i.e., picking the leaves from the stalks. A small percentage of Havana Seed is also harvested in the same way. Since the lower leaves mature first, they are picked off first.

About four leaves are picked at each priming and the process is repeated on an average of once a week but the interval between primings depends on the stage of maturity of the leaves as judged by the experienced grower. Boys pass between the rows, pick the leaves and deposit them in piles in the rows. Another set of boys draw large canvas baskets between the rows and collect the leaves which are then drawn to the curing sheds. Here they are "sewed" on four foot lath by girls and women. Each end of the lath has a saw notch about one-half inch deep. The string on which the leaves are to be sewed is fastened by drawing it into this notch and then winding it two or three times around the end of the lath. The leaves are placed in pairs—back to back—and the needle is passed through the midribs about an inch from the base. Twenty to twenty-two pairs of leaves are sewed on each lath. The lath are then hung on the poles just as in the case of stalk cut tobacco except that in the shade barn the tiers are only one-half as far apart and also the lath are crowded together closely on the poles.

FIGURE 136. Curing shed with partly harvested field of Broadleaf in foreground. The plants are cut down and laid on the ground to wilt.

CURING

During the time that the tobacco hangs in the shed, the color of the leaves changes from green to brown and there is a loss in weight of about 80 per cent, mostly in water. The drying—evaporation of water from the leaves—however, does not constitute curing; in fact it is merely incidental to the process. The essential part of the curing is a series of chemical changes in some of the compounds which make up the leaf, internal changes which transform raw, bitter, bad smelling leaves into mild, fragrant tobacco. For these processes to occur to the best advantage it is necessary that the cells remain alive for a considerable period and a certain amount of moisture be present. If the leaf is dried too rapidly ("hayed down"), the cells die, the leaf remains green, and curing does not take place.

Chlorophyll, the green coloring matter of the leaf, must be completely broken down, at which stage the leaf becomes yellow. Starch, which is abundant in the mature green leaf, is first transformed into sugar. Then the leaf, in an effort to prolong life as long as possible, burns up the sugar and respires the decomposition products as carbon dioxide and water. Next some of the nitrogenous compounds are broken down. Other chemical changes are taking place at the same time. Certain mineral salts must also have time to crystallize out as the small pebbles which constitute the grain of the leaf. If drying is too rapid, these crystals are not developed and combustion of the tobacco is adversely affected.

On the other hand, if the curing is prolonged for too long a time the leaf becomes darker in color and also is exposed for a longer period to the danger of pole rot and other curing troubles. There is then an optimum rate of cure, at which the above mentioned chemical changes take place to the best advantage and the fullest extent, and at which curing troubles are least dangerous.

Temperature and humidity of the air are the most important factors in determining the rate and character of the cure. Up to a certain point, we may say that the higher the temperature, the more rapid and the better the cure. According to experiments at the Windsor Station the optimum temperature lies between 85° and 95° F. But the temperature alone cannot be considered without reference to humidity of the air, which is of at least equal importance. A high temperature, with low humidity maintained for any considerable period of time, causes too rapid loss of water from the leaf with consequent "haying-down", i.e., the leaves become dry while still green. A low temperature with high humidity, or even a high temperature with too high humidity, causes slow cure, dark colors and danger of curing disorders. Johnson found that under Wisconsin conditions, the percentage of relative humidity should correspond roughly numerically to the temperature as expressed in degrees Fahrenheit. For example with temperatures of 75°, 85° or 95° F, one should have respectively relative humidities of 75, 85 or 95 per cent. In Connecticut, working with shade tobacco, Street has found that better colors and quality are produced by somewhat lower corresponding degrees of humidity. Numerically the humidity percentage should be about 10 points below the temperature, for example with a temperature of 90°, the humidity should be 80 per cent.

Under actual shed conditions where no effort is made to control temperature and humidity artificially, there are naturally wide fluctuations in both of these factors. In clear weather the temperature falls at night and the humidity rises, while the reverse is true during the day. Atmospheric changes follow those of the outside air but do not swing in quite as broad a range. The temperature at the top of the shed is usually higher and the humidity lower, which accounts for the fact that during dry seasons the tobacco in the peak "hays down", while in bad pole sweat years the best tobacco is from this section. During prolonged rains conditions are static and the humidity may remain at 95 to 100 per cent for a sufficiently long period to cause serious pole sweat, stem rot or other disorders.

During the process of curing, there are three stages which are distinguished by differences in color of the leaf: (1) the green stage, during which the leaf should wilt, (2) the yellow stage and (3) the brown or final stage. These are not sharply defined but in point of time they always follow in the order named. However, the leaves in a shed or on the same plant are not usually in the same stage at the same time. The lower leaves go through the stages more rapidly than the upper leaves, the tips more rapidly than the butts, and the more mature leaves before the less mature. Sometimes all three stages may be seen on the same leaf.

"Pole sweat" is the name commonly used in Connecticut to designate the various types of leaf rot which occur during curing. This disease is described more completely on page 784. "Stem rot" is the term used to designate a condition in which the midrib of the leaf becomes soft and rotten. This may progress to the point where the leaves actually fall from the stalks in the shed. Pole sweat appears during the late yellow stage and especially just when the leaf is turning from yellow to brown.

FIGURE 137. A row of curing sheds on a shade plantation.

At this critical stage moisture must be regulated to prevent pole sweat. The disease is especially favored by prolonged periods of high humidity, 95 to 100 per cent. At such times, water often collects in drops on the surface of the leaves, an ideal condition for infection.

The original method of curing was to hang the tobacco in the shed and trust all to the weather until time to take it down. This gave a successful cure during some seasons but was disastrous during others, especially when the weather was not so favorable. The weather outside cannot be changed but certain practices may be employed to modify the humidity and temperature inside the shed so that they may more nearly approach the desired optima.

Correct construction and manipulation of the sheds are of immense benefit here. The sheds should be tight but provided with ventilators which may be closed or opened as desired, as previously mentioned. During the curing of tobacco from one acre, about five tons of water must pass out of the shed into the air. The larger part of this goes out during the first ten days. With sufficient ventilation and air movement this can be accomplished easily in favorable weather. During rainy weather, however, the air is saturated with moisture and is less effective in evaporating moisture. Drops are likely to come to the surface and remain on the leaves. If this happens during the critical stages for pole sweat infection, some method of evaporating the water must be used. In good weather at this stage it is well to keep the ventilators open in daytime. On the other hand sometimes, especially in the later stages of the cure, the loss of water may be too rapid and it is better to open the ventilators during the night and close them during the day in order to keep up the humidity.

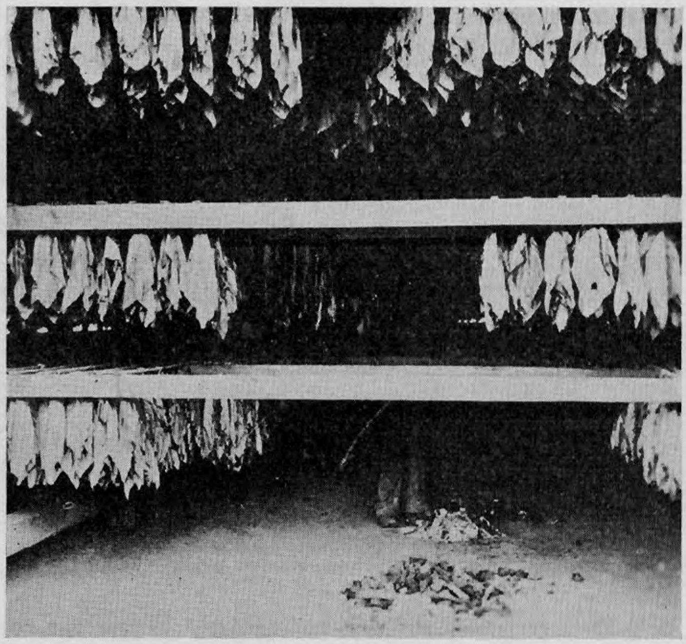

FIGURE 138. Curing shade tobacco. Note charcoal fires on the floor.

Nearly all growers of shade tobacco, and some growers of out-door tobacco, use charcoal fires to raise temperature and lower humidity. Thus they are able to approximate conditions that are optimum for wilting, for acceleration of chemical changes involved in curing and for prevention of pole sweat.

The fires are made in holes about 10 inches deep by 10 inches in diameter dug in the soil of the shed floor. From two to six fires to each bent of 16-foot square are used. Growers differ in their opinions as to the best number of fires. If a larger number is used the heat is better distributed. In this case more labor is required in tending the fires and each fire must necessarily be smaller to avoid raising the shed temperature too high. Thermometers are hung in the middle of the bents so that the operator may keep the temperature between 85° and 95° F. It is important that no tobacco be hung directly over the fires in the first tier. A good method of hanging the first tier is to leave out the second run from each side through the whole length of the shed. This allows room for the fires and free walking space for the operator. The fires may be started by pouring a little kerosene or denatured alcohol over the first charcoal before igniting. More charcoal is added as the temperature dictates.

In firing to wilt, the fires are started immediately, or within a day or two after the shed is filled with tobacco, and continued for 48 to 72 hours, or until the leaves are well wilted. The experienced operator regulates his firing by watching the condition of the leaves. If the tips become stiff while they are still green or yellow, firing has continued long enough and he lets the fires die out. After three or four days the leaves have become damp again and shade growers frequently fire a second time but for a shorter period.

Later firings are not necessary except to prevent pole sweat. If the weather stays damp for two or more days in the critical stage of curing,

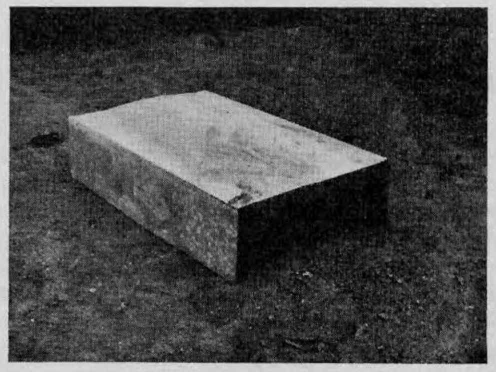

FIGURE 139. Metal fire cover, set over the fires in the curing sheds to distribute the heat.

and especially if there are drops of water standing on the leaves, the fires must be started again and continued until the surfaces of the leaves feel dry. Pole sweat first becomes evident by the "strutting" of the midribs and small brown spots on the leaves. One should not wait until these symptoms are present because it is then too late to prevent infection. If this has already occurred, however, it is best to fire at high temperature and low humidity until the leaves are entirely cured. Moderate firing at this time will only make conditions more favorable for development of the trouble.

Sometimes it is advisable to fire after the web of the leaf is cured but the midrib is still uncured. This is to prevent stem rot.

Metal spreaders are frequently used over the fires to disperse the heat and to keep the leaves directly above the fires from scorching. Spreaders are of various construction. A simple, cheap, but entirely adequate one is shown in Fig. 139. It is made from a piece of No. 22 galvanized sheet iron 32 by 30 inches in size. A 7-inch piece from each end is bent down at right angles.

The quantity of charcoal consumed varies naturally with the character of the season. If the grower has at hand 50 bushels to each acre, it should be sufficient.

Processed charcoal—such as Ford Briquets and Eastman Charkets—are used by some and certain advantages are claimed for them. Comparative tests with these are described in the annual reports of the Tobacco Substation for 1932 and 1933. They are more expensive than the ordinary charcoal. Coke has also been used successfully for this purpose (Report of Tobacco Substation for 1930). Coke requires a special burner.

It is generally agreed that alternate periods of drying and moistening are better than a continuous dry condition. This gives opportunity for the pigments to diffuse thus making the colors more uniform. Also chemical changes can continue to operate only when the leaves are damp.

TAKING DOWN, STRIPPING, BUNDLING

A month or more after harvesting, when the leaves are thoroughly cured and there are no more green midribs, they are taken down and put into bundles during a "damp". The leaves contain mineral salts and therefore absorb water when the air is saturated with moisture. After a few hours they become soft and pliable and may be handled without danger of breaking. The lath of tobacco may now be removed from the poles and piled on the ground in such a way that they will not dry out for several days even with the return of sunny weather. Primed or shade tobacco is laid so that only the lath themselves are on the outside, exposed to the air, while all the leaves are massed together inside so that they do not dry out quickly.

When stalk tobacco is removed from the poles, the lath are first laid in piles in the shape of wheels where the plants extend toward the center and overlap, while the wooden lath and stalk butts form the periphery. Next, the stalks of tobacco are stripped from the lath and laid in piles with the tops overlapping and the butts extending outward. This pile may be covered with burlap, stalks or other materials to prevent drying. The strippers may now work several days without danger of the tobacco becoming too dry. The tobacco should not be kept in piles too long however, else it will heat and become tender. For the same reason the piles should not be too high.

Holding the stalk in his left hand, the stripper pulls off the leaves, beginning at the base of the stalk, with his right, keeping the butts of the leaves even. When he can hold no more leaves in his hand he passes the handful of leaves to the man who does the bundling. Box presses with foot clamps specially constructed for this purpose are used. After placing four heavy strings in the box, it is lined with heavy Manila paper which will be used to wrap the bundle. The leaves are laid in two parallel piles on the paper with the tips overlapping and the butts to the outside (ends) of the bundle. Thirty to fifty pounds are thus packed into each bundle. The foot press is applied and finally the loose ends of the paper are folded over the top of the bundle and the strings are tied as tightly as possible.

The tobacco is now ready for market.

COVER CROPS

Tobacco is a fast growing crop, occupying the land for only two or three months out of the twelve. For several reasons the fields should not be left uncropped and bare during the other nine or ten months. During its season of development tobacco needs an abundance of food and the grower is lavish in his application of fertilizer. But when the crop is removed there remains a large unused surplus, part of which may be lost by leaching, washing or blowing of the soil or by reversion into difficultly soluble compounds within the soil. By sowing a cover crop immediately after the harvesting of tobacco, the greater part of this surplus will be used by the growing plants, and when the cover crop is turned under to decay the next year, the nutrients will be liberated in a form highly available for the next tobacco crop. The first benefit of the cover crop then is in the conservation of plant food. In lysimeter experiments at Windsor it was found that a cover crop of oats prevented the leaching of 56 pounds of nitrogen, 44 pounds of calcium, 24 pounds of potassium and 8 pounds of magnesium to the acre in one year.

The turning under of a cover crop each year also maintains the humus content of the soil. Humus makes the soil more retentive of moisture and plant nutrients.

Cover crops prevent blowing of the soil. Most of the tobacco fields are sandy and loose. In dry, windy weather, if they are bare, as much as an inch of soil may be removed from the surface and deposited elsewhere like snowdrifts. There is necessarily a loss of some of the well fertilized soil which is not always re-deposited where it will be useful to the owner for the next crop. The large amount of dust in the air during windy periods is disagreeable and particularly irritating to the housewife who wishes to keep her house above reproach. Such blowing can be largely prevented by proper use of cover crops.

Cover crops prevent washing away (erosion) of the soil. When the fields are hilly, or even rolling, there may be considerable loss of plant nutrients and of the fertile soil itself through the washing out of gullies. The bare subsoil never produces as good tobacco. Furthermore additional time and labor is frequently necessary to level the land again in spring. The roots of the cover crop hold the earth in place and prevent such losses.

The maximum benefit from cover crops is obtained when they are sowed immediately after harvesting the tobacco. At that early period the soil is warm, the soluble nitrates are most abundant and therefore the danger of loss is greatest. Also the seed germinates more quickly and the plants make better fall growth.

A considerable number of species of plants may be used for cover crops. Theoretically, the legumes seem preferable because they not only conserve the plant food already in the soil but add nitrogen of the air. In practice, however, they are not commonly used. There are two objections to them. They start rather slowly and therefore do not make enough growth in the fall. Secondly, most of them are quite susceptible to winter killing when sowed at this time of the year. In experiments at Windsor, vetch has had a tendency to make the following crop of tobacco dark. On account of its growth habits alfalfa does not cover the ground so well and therefore does not prevent blowing.

In field tests at Windsor, oats gave the best results of any of ten crops used. Oats make a quick and heavy growth in the late summer and autumn and thus utilize the residual fertilizer to good advantage. They die down about the first of December but make a thick mat over the soil which prevents blowing and washing. Barley is very similar to oats in these respects.

Rye is preferred by many growers because it may be used for fall and spring pasture for stock. It is most popular on combination tobacco and dairy farms. In the 5-year field test at Windsor it stood next to oats in excellence. Rye grows rapidly in the spring and should be turned under before it gets too high. Otherwise it may make such a mat of loose material in the soil that during a dry early season, the ground will not retain sufficient moisture for best development of the young tobacco plants.

Timothy cover crops are used by some growers with good results, but it has been observed that brown rootrot of tobacco is worse after timothy on certain soils. It does not start as quickly or make as good a top growth as rye, but produces a luxuriant root growth. In tests at the Massachusetts Station red top has given better results than timothy. The growth habits of the two are quite similar.

TIME AND RATE OF SEEDING

The seed should be sowed just as soon as possible after the tobacco crop is removed. Seeding before removal of the tobacco has been tried but involves difficulties in management and is not advisable.

The following rates of seeding have been found satisfactory:

Oats, barley, rye or wheat ...	2 to 2½ bu. to the acre
Alfalfa, red top, timothy	20 pounds to the acre
Vetch	80 pounds to the acre

Unless vetch and alfalfa have been grown previously on the same land it is best to inoculate these seeds before planting.

Preparation of the land for seeding is easy at this time. It is not necessary to turn the soil with a plow although some growers prefer to use a plow to split the tobacco rows if the ridge has been made high. One harrowing with the disc is sufficient before sowing. For oats, wheat, rye, vetch or barley, the disc may also be used in covering the seed.

Smaller seeds, such as timothy, should not be planted so deeply, and a spike harrow, or another fine tool, will serve better than a disc.

DISEASES

In the following pages only those diseases of tobacco are described which are of fairly common occurrence in the state. There are an additional number which appear rarely or are of so little economic importance that they are not mentioned here. The discussion is devoted mainly to descriptions of the symptoms by which the diseases can be recognized, the damage they cause and the methods by which they may be controlled. They are arranged approximately in the order in which they occur: First the seed bed diseases, those which occur both in seed bed and field, then those which occur only in the field, and finally those which occur only in the curing shed.

The appended "Key to Diseases" may be helpful in preliminary identification of any disorder in which the reader may be interested. For final identification, however, he must depend on the more complete description given under the head of each disease.

KEY TO DISEASES

I. Diseases in the seed bed

1. Seedlings in two or four-leaf stage dropping over with lower part of stalk shrivelled, or devoid of roots. *Pythium Damping-off and Rootrot.*
2. Older plants affected with slimy brown rot of stalk which spreads later to other parts of the plants. *Bed rot.*
3. Patches of stunted yellow plants with rotted roots
   a. Some of the roots black *Black Rootrot.*
   b. Roots or part of them badly disintegrated but hardly discolored *Pythium Rootrot.*
   c. Roots brown *Brown Rootrot.*
4. "Halo" spots on leaves. May be accompanied by patches of wet-rot plants *Wildfire.*
5. Leaves "hobbly", with downward inrolled tips and margins, "rimbound", small yellow spots like premature ripening near margin *Potash hunger.*

II. In the field

1. Stalk diseases
   a. Sunken black canker at base of stalk *Sore Shin.*
   b. Wet-rot of pith finally making the stalk hollow *Hollow Stalk.*
2. Root diseases causing slow and stunted growth
   a. Roots brown *Brown Rootrot.*
   b. Some of the roots black *Black Rootrot.*
3. Leaf diseases
   a. Leaves irregularly mottled with alternating areas of light green and dark green. Leaves frequently distorted *Mosaic.*
   b. Leaves narrow, strap-shaped and in abnormally large numbers *Frenching.*
   c. Dead spots on leaves
      (1) Spots with definite broad yellow halo *Wildfire.*
      (2) Spots without halo *Physiological Spots.*

d. Lower leaves chlorotic between veins, thick, without inrolled margins *Magnesia Hunger.*

e. Leaf surface "hobbly", margins and tips of leaves inrolled downward *Potash hunger.*

f. Plants stunted, dark green. Leaves narrow, spatulate, pinched, with a bronze cast *Phosphorus starvation.*

III. In the curing shed

1. Scattered dark spots on leaves, coalescing later into irregular blotches. Under moist conditions parts of leaves become soft and rotten *Pole Sweat.*
2. A soft rot affecting the midribs of the leaves *Stem rot.*

PYTHIUM DAMPING OFF AND ROOTROT

This disease is confined to the seed bed. It is widespread and of long standing in the Connecticut Valley and is probably responsible for a considerable proportion of the poor "stands" of plants in the seed beds. On account of its inconspicuous symptoms, and the rapid disappearance of the affected seedlings, the disease has received scant attention and its ravages have been attributed largely to other agencies. For the same reason the extent of damage in the state can only be estimated, but it is safe to say that it is one of the very common seed bed troubles.

Symptoms: The symptom which the grower first notices is that the very young seedlings are disappearing shortly after germination. Every day the "stand" appears thinner. This may continue until there are not enough plants left to pay for further care and the bed is abandoned. More often, however, it results only in a reduced stand so that the grower has not sufficient plants to set his intended acreage and must purchase them elsewhere.

The stages of this mysterious disappearance of plants may be found by close observation of the beds in the germinating period. Some of the small two-leaved plants will be found prostrate on the ground with a part or all of the little stems (hypocotyls) dead and shrivelled to a mere thread. The shrivelled part is most often just at the surface of the soil. Other plants are prostrate, or entirely upside down, and are not attached to the ground at all. The hypocotyls are healthy but the roots are completely rotted away. Thus the disease may affect either the roots or the stem. After the plants topple over, they disappear very quickly. They may be covered by the splashing of soil while being sprinkled. Under dry conditions they disappear by shrivelling; under moist conditions, they rot and disintegrate quickly.

At about the time that the second pair of leaves appears, the stem becomes resistant to further attack but the roots remain susceptible for several weeks. This later rootrot causes the plants to become stunted and yellow in spots in the bed. Some of them die, but most of them linger for a long time with very little further growth. Such spots give the bed an uneven appearance. On careful examination the larger part of the roots are found to be soft, or completely disintegrated, except for a central thread-like strand which remains intact but may be pulled out of the rotted cortex easily.

Cause: The disease is caused by a parasitic fungus (*Pythium debaryanum* Hesse) which inhabits most fertile soils naturally. Here it may live indefinitely on dead organic matter and spread under and over the soil with extreme rapidity. When its branches come in contact with the young stem or root they bore through the epidermis and live parasitically on the interior cells of the tobacco plant causing them to collapse and die. Spores are produced in great abundance and may be carried about by water, wind, tools and other agencies, thus spreading the disease to new centers. Many other seedlings such as beets, tomatoes, cucumbers and pines are also attacked by the same fungus.

Effect of environmental conditions: The growth of the fungus is favored by a high temperature, high humidity of air or moisture of the soil. There is also a belief that a high percentage of vegetable matter in the soil fosters growth but this has not been demonstrated satisfactorily.

Control: Steaming the soil, the common practice in this state, has not controlled the disease. In 1933, when the disease was severe and widespread, the writer found many of the worst cases in steamed beds. In recent tests at the Experiment Station, in which numerous materials for sterilizing the soil or the seed were tried, the best control was obtained by treating the soil at the time of seeding with formaldehyde dust at the rate of one and one-half ounces of the dust to each square foot of soil. The dust was worked into the top two inches of soil, the soil heavily watered, and the seed sowed immediately. The dust is a mixture of 15 parts by weight of commercial formaldehyde and 85 parts of an absorbent dust. Finely ground charcoal, or a peat soil composed mostly of decayed organic matter, gave good results when used as the absorbent dust. Because the formaldehyde fumes are irritating to the nose and eyes, it is best to mix the dust in a closed container such as a barrel or drum which may be rolled about until the mixture is complete. The mixture should be made only shortly before using and should be kept enclosed in a tight container until needed.

Treatment of the seed with cuprous oxide or with Semesan gave some degree of control but was not found nearly so efficient as treatment with formaldehyde dust.

Spraying the plants with Bordeaux Mixture did not control the disease.

When the plants are larger, sprinkling diseased areas with a 1 to 1,000 solution of formaldehyde, followed immediately by a sprinkle with clear water to wash the formaldehyde from the leaves, has been used by some growers with apparent success. The writer has had no personal experience with this method.

BED ROT

Most writers on tobacco diseases have considered "damping-off" and "bed rot" as synonomous terms for the same disease although they recognized that two or more parasitic organisms might be involved. Since the first symptom of bed rot is a rotting of the base of the stem, it could properly be called damping-off. To avoid confusion, however, in this bulletin the name "damping-off" refers to the disease previously described as caused by Pythium.

Bed rot is common wherever tobacco is grown in Connecticut and has probably been here as long as tobacco has been started in beds. The symptoms are more clearly recognized and it has been more often described than damping-off but probably it is not of more general occurrence. It is one of the major diseases of the seed bed and may be carried from there into the field.

Symptoms: Bed rot appears in the beds at a later stage than damping-off. Beginning about when the plants have developed five or six leaves, it becomes increasingly prevalent until they are large enough for transplanting. It usually occurs in circular patches from a few inches to a foot or more in diameter. The stems are affected first with a brown wet-rot followed quickly by rotting and collapse of the leaves. In severe cases, every plant in the center of the patch is killed. If less moist conditions are then introduced, the leaves fall flat and form a parchment-like dry covering over the soil. For a considerable distance about the margins of these dead patches one finds most of the plants with brown lesions on the stems. Under moist conditions these enlarge and kill the plants, but under less humid conditions they dry out, seem to remain stationary and the affected plants do not die.

Cause: Bed rot is caused by the invasion of a parasitic fungus. This may not always be the same species of fungus however. In all instances where the writer has identified the fungus during the last ten years, it was found to be *Corticium vagum* Berk and Curt (*Rhizoctonia solani*) a common parasite which lives in most fertile soils here. Clinton earlier found instances in which a species of Sclerotinia was the parasite. Other species of fungi have been found in other tobacco sections. Under moist conditions the spider web-like threads (hyphae) of the first named fungus may be seen spreading over the surface of the ground and even through the air from one plant to another. Spores (basidiospores) are rarely produced, but the fungus is disseminated by the vegetative hyphae and also by hard black resting bodies (sclerotia) about the size of a pin head or sometimes larger, which may frequently be found on close examination on the surface of the soil in the infested patches.

Effect of environmental conditions: The disease develops only when humidity is high and the soil damp. Such conditions are ideal when the stand is thick and aeration about the stem base is poor. A relatively low temperature is more favorable for Rhizoctonia than a high temperature. Forced, succulent, rapidly growing plants are more susceptible than others.

Control: The first measure of control should be sterilization of the soil by steaming, acetic acid or formaldehyde. Soil sterilization, however, cannot be depended on always to give control, as can be seen from numerous severe cases which the writer has seen in sterilized beds. These exceptions are probably due to re-infection. Regulation of environmental conditions is the best method to prevent the trouble. Most cases are found in beds where the stand is too dense, in beds that are not sufficiently aired, or where the plants are kept too constantly moist or are forced too much. If such faults are avoided, there is little danger of bed rot. Watering should be thorough but not too frequent. Plants should not be forced by too generous applications of nitrogenous top dressings. There should be constant aeration by raising the sash except in most severe weather.

If there are only a few patches in the bed they should be destroyed with formaldehyde in the same manner recommended for eliminating wildfire patches (page 736).

Keeping the beds constantly sprayed with Bordeaux Mixture as recommended against wildfire is also effective against bed rot.

"GREEN MOLD" OR "MOSS" IN THE SEED BEDS

In the early seed bed period, while the soil must be kept constantly moist to insure good germination, growers often are troubled by appearances of a bright green scum over the surface which has received the popular name of "moss" or "green mold". Both of these names are unfortunate because this is neither a moss nor a mold but consists of a dense surface growth of one or more species of green algae. None of these algae is parasitic on tobacco seedlings but their dense growth may smother the sprouting seeds. There is considerable difference of opinion as to the extent of the damage but at least such a condition is not desirable.

Control: It is a common practice to sprinkle a thin coat of sharp dry sand over the ground to check the green algae. The benefit derived from this treatment, however, is probably more imagined than real. Applications of Bordeaux Mixture at intervals of two or three days give much better control, but there may be some detriment to the germinating seeds if this treatment is started before the cotyledons appear.

"Green mold" is usually eliminated by treating the soil at the time of seeding with formaldehyde dust as previously described for control of Pythium Damping-off.

These algae thrive only under high moisture conditions of soil and air. They can be checked by removing the sash during bright days and thus drying out the surface of the soil. However, this should not be attempted when the seeds are just germinating.

SORE SHIN

This disease, which is also called stem canker, stem rot, collar rot, or black leg, is of common occurrence in Connecticut tobacco fields. It is rarely of major importance because the number of affected plants is usually small, and the total loss is not heavy. Sometimes, however, under favorable conditions, it may take a serious toll and even necessitate replanting of entire fields. Growers have been familiar with it for many years but it has not been carefully investigated here and very little has been written about it.

Symptoms: The characteristic symptom most commonly observed is a brown or black, sunken, rotted canker at the base of the stalk when the plants in the field are half grown or larger. The canker may be only on one side or may entirely girdle the stalk at, or just below, the surface of the soil. Or it may extend several inches up the side of the stalk sometimes involving the lower leaves which drop off after the bases of the midribs become rotten. The canker reduces transfer of water and nutrients through the stalk so that the whole plant becomes sickly, yellow, and smaller than neighboring healthy plants. During strong winds many of these plants are broken off at the canker and fall over. In older plants the rotted portion extends inward to the woody part of the stalk. In younger plants it may go clear through, thus causing them to wilt and die. Although the grower sees the disease more often on plants after they are well grown, the most serious loss is among the younger ones. These die during the first weeks after setting which necessitates repeated restocking and sometimes replanting of the whole field.

Cause: Various fungi and bacteria, believed to be the causal agents, have been found in the diseased tissues by different investigators. The one most commonly found by the writer in this state is *Corticium vagum* Berk and Curt, which has been mentioned previously as causing bed rot (page 766).

Clinton also reported Pythium and Sclerotinia as causal fungi. It has been observed frequently that the most severe cases of sore shin were in fields set from beds known to be affected with bed rot. Sore shin, therefore, may be regarded for the most part as a later development of bed rot. It is not at all improbable however that some infection of previously healthy plants may occur directly in fields. Injuries to the stalk by tools or insects probably facilitate field infection.

Influence of environmental conditions: Heavy wet soils and periods of continuous rainfall favor development of sore shin. Under dry conditions the canker stops spreading and dry inactive scars which are apparently harmless may be observed on the stalk. With the return of moist conditions, however, activity of the parasite is renewed and the canker continues to spread.

Control: Since the seed bed is the focus of infection, all measures previously recommended (page 766) for controlling bed rot should be practiced. This offers the best means of preventing sore shin. If it is practicable, plants from beds which have bed rot should not be used. If this is impossible, the plants should be carefully inspected when pulled and all which show the smallest brown stem lesions should be discarded. Even under these conditions, all diseased plants will probably not be eliminated. Frequent restocking shortly after setting is advisable but late restocking is hardly worth while. Heavy wet soils and fields known to produce sore shin should be avoided.

WILDFIRE

Wildfire appeared first in Connecticut in 1919 having been brought from the southern states. It increased rapidly, became serious locally in 1920, and was widespread and very destructive throughout the Connecticut tobacco districts in 1921 and 1922. For a few years it was the most serious tobacco disease in the state. The damage varies from season to season but in general, during recent years, it has become less and less evident so that it is now regarded as one of the minor ailments. Whether this indicates a decline of virulence of the wildfire organism, or is due to a succession of years unfavorable to its spread, or to a more thorough adoption of remedial measures by the growers, cannot be definitely stated. There is no demonstrated reason why, under favorable conditions, it should not become as prevalent as it was in the early Twenties, and certainly precautionary measures against it should not be relaxed.

Symptoms: This is essentially a disease of the leaves but the lesions may appear on any green part of the plant above ground. It occurs both in the seed bed and in the field but does not spread on tobacco in the shed. The main damage is caused by the spots on the leaves, thus destroying or reducing their value as wrappers or binders. In early stages of development, spots caused by wildfire can be distinguished from all others by the presence of a broad chlorotic marginal band called the "halo" (Fig. 140). In the center of the spot there is

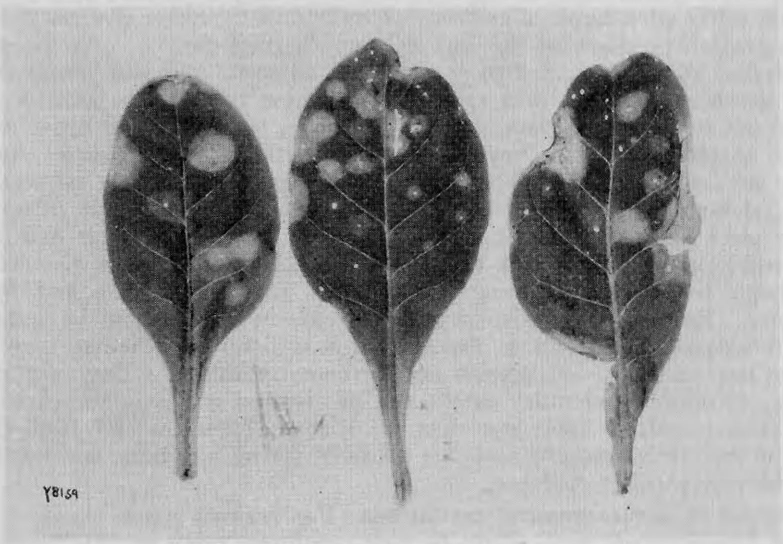

FIGURE 140. Wildfire. Young leaves from the seed bed showing halo spots.

a small, dry dead point, at first no larger than a pin head, surrounded by the yellow "halo" of living tissue, from an eighth to a quarter of an inch broad. The spots are circular—or semi-circular if on the leaf margin—with regular smooth outlines. They may run together, however, and produce large lesions of irregular shape. When the leaf is attacked before it is completely unfolded it becomes distorted. Severe infection in the bud causes all leaves which unfold from it later to be yellow, dwarfed and misshapen.

As the disease progresses the central dead part enlarges and in dry weather the entire chlorotic area may become dry, brittle and white, leaving no marginal yellow band. In this stage the spot is not easy to distinguish from various other kinds of leaf spots. Under moist conditions, however, the halo continues to develop in advance of the dry center. After the spots are dry and dead they often crack or fall out, leaving the leaf ragged. Badly diseased tobacco can be sold only for stemming.

In the seed bed, where the plants are thick and conditions more humid, the disease often takes the form of a wet-rot in which all the leaves in areas which may be a foot or more in diameter are reduced to a water-soaked, slimy pulp. This may occur at any time after the leaves are as large as the finger nail. It may be distinguished from bed rot, which it resembles, in two ways: First there is the presence of the regular halo spots on some of the leaves; and second, in this disease, the leaves are principally affected, while in the case of bed rot, the stalks are attacked first.

Cause: Wildfire is caused by the presence within the leaf tissues of enormous numbers of parasitic bacteria (*Bacterium tabacum* Wolf and Foster). A single bacterium is microscopically small and short-lived but it multiplies with extreme rapidity and a lesion is produced by the combined effect of a mass of millions of individuals. These live on the decomposition products of the leaf cells which they destroy. At the same time they secrete a toxin that spreads into adjacent cells and breaks down the green chlorophyll, thus creating the yellow halo. The bacteria then ooze out to the leaf surface and are carried by splashing rain drops or by wind to other leaves. They may also be carried by tools, horses, workmen and other agents. The surface of a healthy leaf must be wet for several hours at least after contact to permit infection. While infections take place most easily through wounds in the leaf, for example hail holes or wind rips, it is probable that a considerable proportion in the field is through the natural openings of the leaf surface, stomata and hydathodes. Bacteria may exist for a few weeks in the soil and be splashed or otherwise carried up to leaves, but it is doubtful whether they live over the winter to any extent under these conditions. They are more likely to winter under dry conditions, in diseased leaves in the sheds, or on sash, boards or tools stored in the sheds. Their transfer from these to the seed beds probably accounts for most spring infections and the start of the new season's epidemic.

Effect of environmental conditions: For reasons stated above, a wet year, characterized particularly by long continued rainy periods when the water stands a long time on the leaves, is particularly favorable to wildfire. Hailstorms and rains accompanied by high winds furnish excellent conditions for spreading the disease. Rapidly growing plants are more susceptible than slow growing ones. Variations in temperature are not known to have any influence.

Control: Practically all wildfire in the field starts from plants which came from diseased seed beds. Control measures are therefore directed mostly toward keeping the beds free from disease. The most effective method is to keep the seedlings constantly covered with Bordeaux Mixture or a copper lime dust. Since this is now generally considered one of the routine operations of seed bed management, it is discussed fully under the section on that subject (see page 735). If wildfire was prevalent on the farm during the preceding year, precautions should be taken against transferring any infected material from the sheds to the beds. If wildfire was in the beds, it is well to drench the sash and boards with formaldehyde diluted at the rate of 1 part in 25 parts of water. Directions for destroying isolated infected patches in the beds are given on page 736. If it is at all practicable, it is best not to pull any plants from beds in which wildfire is present.

Control measures taken after the disease is in the field are not dependable for the most part. If only a few diseased plants are found when the plants are quite young, they may be removed and carried from the field. If the infection is more general, this method is questionable because healthy plants, set where the diseased ones have been pulled, commonly become infected from bacteria left in the soil. Removal of diseased leaves generally has not been successful in stopping the disease when weather conditions favor its spread. Thorough spraying of the young plants in the field may reduce spread somewhat but this is not practicable or efficient when the plants are large. Plowing under a diseased stand and setting the field with healthy plants will eliminate wildfire only when following weather conditions are unfavorable for spreading it.

When there is any wildfire in the field, cultural operations should be carefully avoided while the leaves are wet.

MOSAIC OR CALICO

"Calico", "mongrel", "brindle", "mottle", and "grey top" are the most common names applied by growers to this malady which the pathologist calls mosaic. It can be found on almost every tobacco farm in the state but is usually not much feared because the percentage of plants affected is small. In some seasons, however, it becomes unusually severe in certain sections or in certain fields of the state. During such epidemics the writer has seen fields in which 98 per cent of the plants were affected. Under these conditions the loss is heavy and mosaic becomes a disease of major importance.

How long mosaic has existed here is not known. The first published account of it by the Experiment Station was in 1898 at which time it was apparently a common disease.

Symptoms: Although mosaic is said to originate in the seed bed, the symptoms are rarely seen there. In the field the disease can be recognized easily even at a considerable distance. Affected leaves have a mottled appearance due to irregularly shaped and alternating areas of light yellowish green and normal dark green giving the effect of a mosaic. All parts are commonly affected without any relation to position except that sometimes the darker areas follow the veins. On young, rapidly growing leaves, the darker spots are often puckered or puffed out (Fig. 141). Frequently they are otherwise distorted or narrower than normal leaves. In the field, mosaic is more prevalent on the top leaves and suckers than on lower leaves. The suckers which grow from the stumps after harvest frequently are affected severely. Plants which become infected at an early age remain smaller than normal plants. Calico leaves are less resistant to sun scorch than normal ones. As a result, during hot, dry days the sun kills irregular spots, particularly on the top leaves. Large areas thus killed turn a reddish brown color and account for the term "red dust" which growers apply to this stage of calico. When cured, such leaves are worthless for wrappers or binders.

Cause: The cause of calico is not definitely known. No parasitic organism has been found to have any connection with it. The disease, however, is highly infectious and is easily carried by various agents from diseased to healthy plants through a virus which exists in the plant juice. This virus permeates all parts of the plant although the symptoms appear only on those leaves which unfold after infection has occurred. Fortunately seeds do not contain the virus and healthy plants can be grown from the seed of those badly diseased. Neither does mosaic winter over in the soil of tobacco fields. Other plants, particularly those of the same family such as tomato, pepper and ground cherry, may contract the disease also, and it is possible that some of the wintering may be accounted

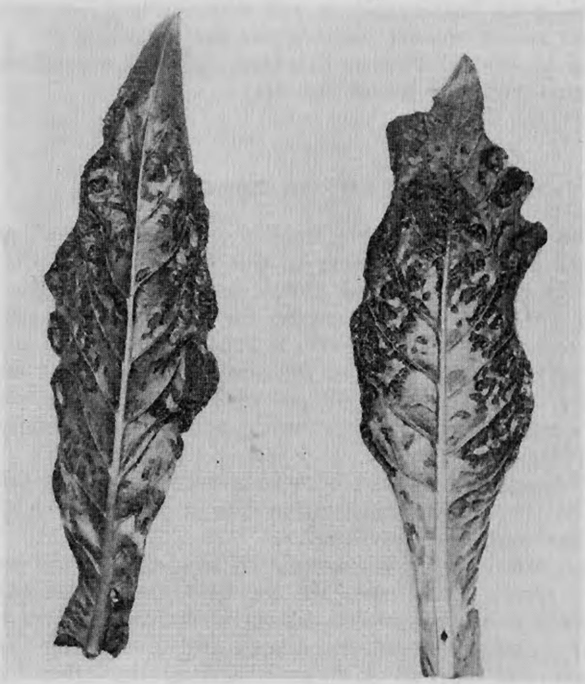

FIGURE 141. Virulent type of mosaic on Broadleaf, showing narrow distorted leaves with dark green puffed-out blisters between the veins.

for by perennial weed hosts. The virus does live for several years in dry, cured tobacco and such material probably accounts for most of the wintering over. Fragments of diseased leaves or other parts may carry the virus from sheds or shops to the beds where conditions for its spread are favorable and from which it is carried to the field. There it is spread on hands and tools of workmen during cultural operations and probably also by some insects, particularly plant lice. When a plant is once infected, regardless of its age, it never outgrows the disease.

Effect of environmental conditions: Variations in temperature, moisture or weather conditions are not known to have any influence on the occurrence or spread of mosaic. The nature of the soil in which the plant grows, and the kind of fertilizer or manure applied, are also without influence. Cultural operations have no effect except when they furnish opportunity for workmen to transfer the virus from one plant to another by contact.

Control: Since there is no known cure for the disease, all control measures must be precautionary rather than remedial. The most important measures come under the head of seed bed sanitation. The larger part of the field infection starts with plants which were diseased when they were taken from the seed bed. Steam sterilization for the purpose of controlling other troubles is also helpful here because it destroys any virus which may be in old leaves or other parts of the tobacco plant, or in weed plants. Every precaution should be taken against bringing into the bed any dry fragments of leaves or stems from the preceding crop. Trash raked up from the floor of the curing sheds should never be put on or near the beds. Tobacco stems should not be used as fertilizers for the beds.

In Kentucky it has been proved that seed bed infection may come from workmen spitting tobacco juice, or from handling the plants after handling infected chewing tobacco or smoking tobacco. There is a chance that cigar stubs and cigarette butts thrown into the bed may start infection. Although symptoms of mosaic are seldom seen in the beds, they should be carefully watched for. If they are found, it is not safe to pull plants from that bed because there are undoubtedly many more diseased ones than can be seen. When a workman gets the juice from an affected plant on his hands, he may spread the virus easily to hundreds of others. During the first few weeks after the plants are set in the field regular inspections should be made and any diseased plants found should be put in a basket and carried from the field. In doing this the workmen should not be allowed to touch any healthy plant. Also in later operations, up to the time of topping, diseased plants should not be touched by workmen. In topping and suckering, this precaution is not necessary because leaves which are to be marketed are developed before that time.

FRENCHING

Frenching is a rare disease in Connecticut. Not a dozen cases have been observed by the writer during the past ten years. Although a severely affected plant is a total loss, the disease does not usually mean a serious loss to a grower. Only a small percentage of plants in the field are likely to be affected and these are confined to certain definite areas and are not scattered promiscuously over the field. If the disease occurs during succeeding years, the location in the field is likely to be the same. Often it disappears entirely after one season. Frenching is a disease of long standing here, but the date of its first appearance is not recorded.

Symptoms: The earliest symptom is chlorosis, or fading of the bud to pale yellow. The most characteristic symptom comes somewhat later. The leaves become thick, brittle, narrow and strap- or sword-shaped, with wavy, scalloped or crinkled margins. They may or may not be mottled in a manner resembling mosaic. The leaf margins have a tendency to curl downward. In severe cases all the leaves on a plant are affected; in less severe cases, the lower leaves are normal, or nearly so, showing that the attack occurred after the plants were partly grown.

FIGURE 142. Frenching. A single plant showing branched stalk and numerous strap leaves.

The stem does not elongate naturally and the number of leaves is multiplied so that the whole plant appears as a bush of dagger like leaves in unusually large number set very close together (Fig. 142). This appearance may be intensified by abnormal branching of the stalk.

Cause: The cause of Frenching is not definitely known. It is not associated with any fungus, bacterium, insect or other foreign organism. It cannot be transmitted from a diseased to a healthy plant (non-infectious). It is probably a trouble caused by malnutrition. Opinions expressed by several investigators that it is caused by shortage of nitrogen, of potash or of phosphorus, or by excessive fertilization, however, are not supported by adequate experimental evidence. There is considerable observational and some experimental evidence to indicate that it is associated with poor aeration or excessive moisture in the soil. Such conditions may be due to poor drainage or heavy soils that pack easily. It occurs only on land of a high reaction (pH 6.0 or above). There is some recent evidence* that a toxic substance in such soils is the direct agent.

Control: No method of control is known. The elimination of unfavorable soil conditions before setting, mentioned above, should be helpful. Growing of tobacco on fields where the disease is wont to occur should be avoided.

BLACK ROOTROT

In extent of loss occasioned, black rootrot has probably been the most serious of all tobacco diseases in Connecticut during the last thirty years. Although first identified and investigated by the Experiment Station in 1906, it probably caused trouble before that date but the damage was attributed to other agencies. It occurs sometimes in the seed bed but is more serious as a field disease.

Symptoms: The first symptom of the disease that the grower notices in the field is that the tobacco doesn't grow. The plants are stunted, with narrow, thick, tough leaves that are either a starved yellow color or, where the nitrogen supply is high, a very dark green color commonly called "black" by the tobacco man. On hot days the leaves wilt or "flag" more quickly than on healthy tobacco. The dwarfed plants "top out" prematurely. Only rarely is a field equally affected in all parts. Usually there are "patches", from a square rod to several acres in extent, where the tobacco is short, while in other parts of the field growth is normal. In the diseased places the plants are frequently very uneven in development.

From the above ground symptoms, however, it is not possible for even an expert to be sure that this is black rootrot. Other troubles, such as brown rootrot, lack of fertilizer, or water-logged soil, may produce the same appearance. One must dig the plants and wash the soil from the roots to see the lesions which are unmistakable signs of black rootrot. Normal young roots are white, but on a diseased plant many are black (brown at first), either throughout their length or only in segments, with other segments appearing normal (Fig. 143). Most of the ends of the small roots are black, indicating that in digging the plants, the roots broke at this point and the decayed ends were left in the soil. The tissue of the smaller roots is rotted through, but on the large roots there occur enlarged, rough, scurfy lesions which may or may not kill the interior

*Shear, G. M. Field and laboratory studies on Frenching of tobacco. Va. Agr. Exp. Stat. Tech. Bul. 49. 1933.

tissues. Frequently the tap root is entirely rotted off at the bottom and there is an increased number of laterals. This results in a brush-work of intermingled brown, black and white small roots just above the blackened end of the main root. The character which distinguishes this disease from all other tobacco ailments is the coal black color of parts of the roots. The reduced root system is unable to secure sufficient water and soil nutrients for normal growth of the above ground parts of the plant. Hence the dwarfed growth and "flagging" on hot days.

Black rootrot may also occur in the seed beds where it exhibits the same symptoms: Slow growth, yellow or "black" color of leaves, "flagging", and black rotted roots. Many of the plants also die. The beds look very uneven.

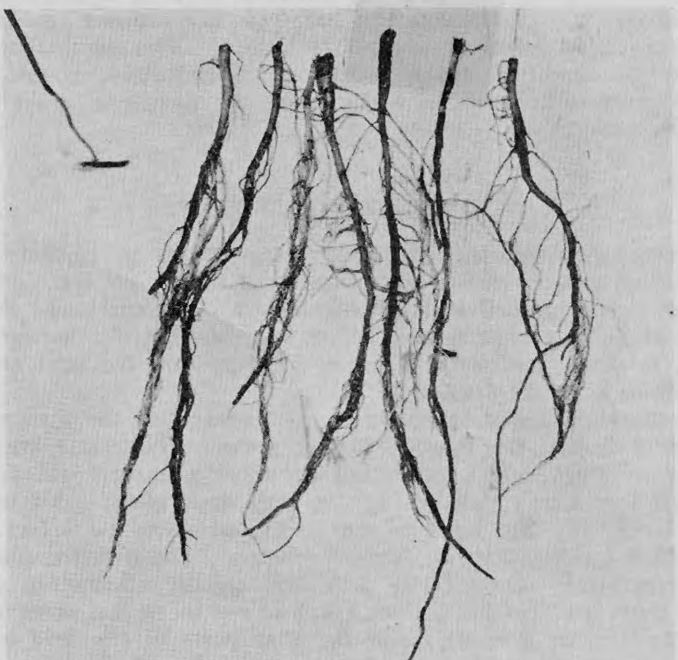

FIGURE 143. Black rootrot shows in the lesions (black portions) of these roots.

Cause: The disease is caused by a parasitic fungus (*Thielavia basicola* Berk and Br Zopf)* which is present in most, if not all, tobacco fields living in the soil indefinitely on dead vegetable matter. It becomes parasitic on the tobacco roots when the environmental conditions mentioned below are favorable. Three kinds of spores are produced in the diseased

*McCormick (Conn. Agr. Exp. Sta. Bul. 269. 1925) presents evidence to show that there are really two fungi in constant association and that *Thielaviopsis basicola* (Berk) Ferraris is the parasite.

roots. The black color of the affected roots is due to the great abundance of one type of spores (chlamydospores).

Effect of environmental conditions: Although the disease cannot occur in absence of the causal parasite, the extent of injury is much more dependent on the environmental conditions under which the tobacco grows than on the fungus.

The reaction (degree of acidity in the soil) is important. It is never serious in the more acid soils. Those testing above 6.0 pH, on the other hand, are favorable to the disease. A low temperature increases the disease and explains the variation in severity of black rootrot from year to year. For the same reason it is usually most injurious in the spring and early summer. Crops badly stunted in the cool early part of the growing season often make rapid recovery and almost normal growth with the advent of hot weather later. Poorly aerated, compact soils are more conducive to rootrot than soils which are loose and do not pack so easily. Wet seasons increase rootrot probably by keeping the soil at a lower temperature and more compact. Heavy applications of manure also increase rootrot.

Control: In the seed beds the disease is satisfactorily controlled by sterilizing the soil with steam, acetic acid or formaldehyde as described on page 731.

The most successful method of control in the field has been through regulation of the soil reaction. Connecticut Valley tobacco soils are for the most part rather acid, 5.2 pH or lower. It was only after this natural acidity had been neutralized by large applications of lime, wood ashes, or alkaline fertilizers that rootrot became serious. When such treatments are omitted for several years the soil gradually returns toward its original reaction. Avoidance of too much alkaline material on the land thus offers the most logical means of control. It has been found that black rootrot is rarely if ever serious on soils testing below 5.6 pH. Only those soils testing below 5.0 pH should be limed and then sparingly (not over 500 pounds to the acre at any one time except in extreme cases). Stable manure, wood ashes, or alkaline fertilizers should be avoided on soils testing near or above the danger point of 5.6.

A very successful method of combatting the disease in other tobacco sections has been through substitution of rootrot resistant varieties of tobacco. In Connecticut this method has not been generally used because the known resistant varieties have not been acceptable to the trade from a quality standpoint. A resistant shade variety, however, the 4R strain, was developed by the Experiment Station and is otherwise not distinguishable from ordinary Cuban Shade. It has been raised to some extent in the Valley with satisfactory results. There are also a number of Havana Seed strains under test at the Experiment Station which are quite resistant and of excellent quality, but they have not yet been raised in sufficient quantity for commercial test. No satisfactory resistant strains of Connecticut Broadleaf have yet been developed, but since Broadleaf withstands rootrot better than our other two types, there is less occasion to find a resistant variety.

Regular rotation of tobacco with other crops is a method of control which has been successful in certain sections of the country. This is not practicable in Connecticut where continuous cropping of tobacco year after year on the same land is considered better practice than rotation.

BROWN ROOTROT

This is a trouble of long standing in Connecticut. However, on account of its obscure nature and cause, it has only received recognition as a distinct disease within the last fifteen years. Under favorable conditions it may become serious and cause heavy losses, but over the Valley as a whole it is neither so general, nor so injurious, as black rootrot.

Symptoms: The above ground symptoms are indistinguishable from those of black rootrot and need no separate description. It is only by an examination of the roots that the two diseases can be distinguished. Here there are no black lesions or scurfy enlargements of the roots. The roots are brown, and many of them are rotten, so that the outer cortex slips easily away from the central strand when they are pulled. Death of the lateral roots induces new growth of successive crops of laterals from the main root, or bottom of the stalk, with the result that a veritable brown broom of roots appears when the disease is severe. When there are only a few brown roots diagnosis of the disease is attended with considerable uncertainty because roots killed by almost any agency turn brown.

Cause: The only diagnostic symptom of this disease is the presence of dead brown roots in smaller or larger number. Since a root naturally turns brown when it dies, regardless of the killing agent, and since no one species of fungus or bacterium has been found constantly associated with the malady, it is not at all certain that brown rootrot is a single disease always produced by the same agent. Some investigators believe that the cause is a parasitic organism which has not yet been isolated. Others are sure that it is a malnutrition trouble produced by such factors as lack of nitrates, lack of calcium, or excess of ammonia. Regardless of the direct cause, it has been demonstrated that the common type of brown rootrot found in the Connecticut Valley is an after effect of a preceding crop. Thus it often occurs when there was a crop of timothy, corn, clover, alfalfa or rye on the land the preceding year. It is rarely serious after a potato crop, and least of all when tobacco is grown continuously.

Control: For this type of brown rootrot, which is clearly linked with the previous cropping system, the obvious remedy lies in avoiding a rotation which will bring tobacco immediately after a hay or cereal crop. As a general rule there seems to be no advantage in rotating tobacco with other crops in Connecticut. The best tobacco is produced by growing the crop continuously on the same land. Under this condition, brown rootrot rarely is found.

For various reasons, however, a grower sometimes wishes to raise tobacco on a new field which has been in timothy or one of the other injurious crops mentioned above. If he goes directly from this to tobacco, he may have trouble from brown rootrot, or he may not. There is an inexplainable difference in fields in this regard. Some growers raise a crop of potatoes for the first year after timothy, and follow this the next year with tobacco, thus avoiding the danger of severe after effects. When tobacco is grown after hay or forage, the after effect may occasionally continue through two or three years but becomes less pronounced each season.

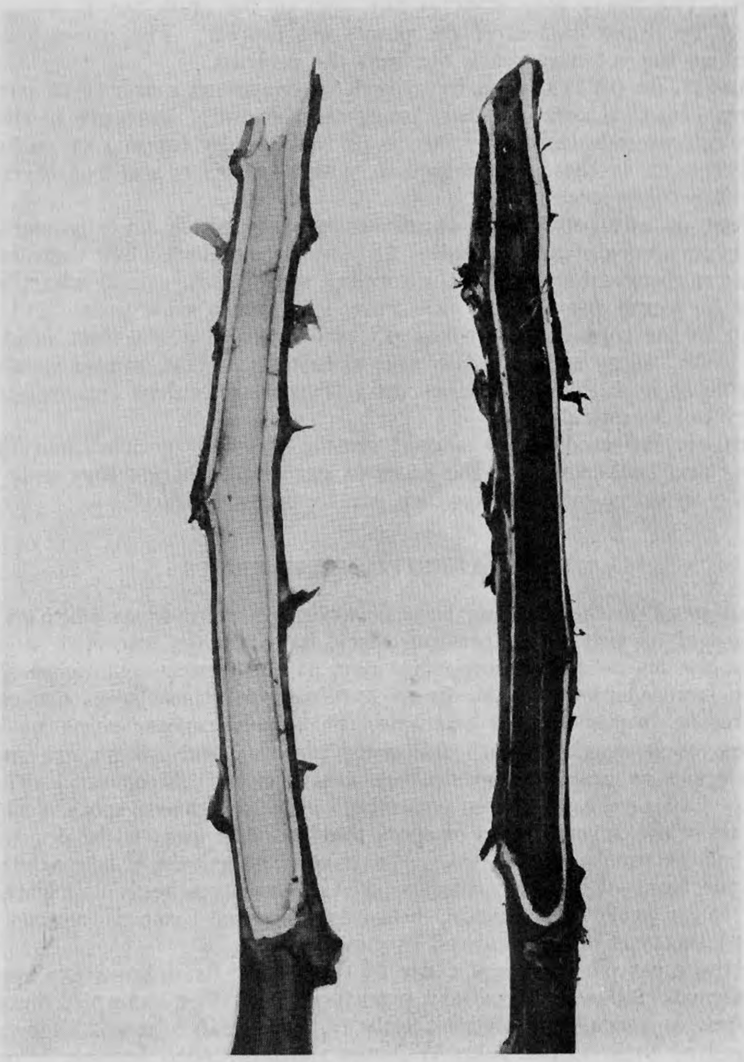

FIGURE 144. These sections show a normal tobacco stalk (left) compared with one affected by Hollow Stalk (right).

HOLLOW STALK

This is a rather common disease in sun grown tobacco some years but rarely affects enough plants to cause much loss. It is an old disease in this state.

Symptoms: Hollow stalk affects only plants which are mature or nearly so. The characteristic symptom is decay of the pith. With collapse of the succulent pith, the stalk becomes hollow through a part or all of its length. The decay may start in any part of the stalk but is most often seen in the upper part after the plants are topped. The leaves wilt and sometimes the rot may reach out into the midribs.

Cause: The rot is caused by growth of enormous numbers of parasitic bacteria (*Bacillus carotovorous,* Jones) in the pith. Entrance to the pith is through wounds caused by insects or tools, or by topping or suckering. The pathogen is the same organism which causes a soft rot of carrots and many other vegetables.

Effect of environmental conditions: Moisture is an important element in incidence of hollow stalk. It is most prevalent when there is continuous rainy weather during the topping season. In a field where it can hardly be found previous to this time, it becomes widespread and quite evident in the tops of the broken off stalks within a few days after topping. Wet, soggy soils are also said to foster it. Hot, humid weather is favorable to it in that this makes the pith more succulent and wounds do not dry out so quickly.

Control: Affected plants should not be touched by workmen during topping and suckering. If the bacteria get on the hands they may start infection in dozens of plants which are topped afterward.

NON-PARASITIC LEAF SPOTS

Dead spots on the growing leaves, varying in color from white to dark brown, and of various shapes and sizes, have always attracted attention because the leaf is the all important part of the tobacco plant and should be free from blemishes. We know that some of these spots are caused by parasitic organisms, for example, the wildfire spots; some by virus diseases, such as the "rust" following mosaic; and others are malnutrition spots as described in the previous section. Mechanical injuries, such as hail or Paris Green poisoning, may also leave spots. Besides these, there are several types of spots that do not appear to be due to any of the above mentioned causes. We have grouped these last arbitrarily under the name of non-parasitic spots. Growers commonly call leaf spots "rust". To prevent confusion, however, it seems best to restrict that name to the type of spot caused by mosaic.

For the most part the real cause of these spots is unknown. Some of them seem to follow a hereditary predisposition. For example, there are two types of spots characteristic only of Broadleaf tobacco. The more restricted of these is the John Williams spot, so called because it occurs only on this kind of Broadleaf. Just when the leaves are ripening, suddenly they become thickly peppered with small, round white spots, an eighth to a quarter of an inch in diameter. The presence of these spots is not considered a fault by tobacco handlers. On the contrary buyers like to see this development because it is a sign that the plant is the true John Williams type and that it is ripe tobacco.

The other kind of Broadleaf spot has sometimes been called the "star and crescent spot" because it frequently has a small central portion partly surrounded, beyond an intervening band of green tissue, by a circular, white, narrow band of dead tissue. This marking suggests the Turkish star and crescent. Sometimes the circle is complete; sometimes there are two or more concentric circles or parts of circles. There are numerous modifications but the whole appearance is quite different from other types of spots. They occur only on Broadleaf, or hybrids which have been derived by crossing with Broadleaf.

FIGURE 145. The white spots peppering this leaf are peculiar to John Williams Broadleaf tobacco.

On Cuban Shade tobacco there occur at times numerous small, round, deep brown spots of less than a quarter of an inch in diameter. Somewhat similar but larger spots appear also on Havana Seed tobacco. It has never been definitely proved that a parasite causes these spots although various fungi may be found on them as they become older.

The writer has frequently noticed that all these kinds of non-parasitic spots are prone to break out suddenly a few days after hard rains. On the whole, they do not cause very serious injury to the tobacco crop and no method of preventing them is known.

MALNUTRITION DISORDERS

There are eight food elements which the tobacco plant absorbs from the soil: Nitrogen, potash, phosphorus, magnesium, calcium, iron, sulfur and boron. If there is an inadequate supply of any one of these, the plant becomes abnormal (diseased). The disease symptoms produced by a shortage of any one of them differ from those produced by deficiencies of any other, with the possible exception of sulfur. Three of the eight elements—iron, sulfur and boron—are always present in the soils of Connecticut in sufficient quantity. Therefore disease produced by shortage of any of these three is never seen in the field. Calcium also never occurs in such small amount as to produce starvation symptoms although it may occur in too small quantity for best growth and quality of leaf. There are also certain elements which are not nutrients but which may be taken into the plant from the soil under certain conditions in sufficient quantity to produce abnormal symptoms. Examples of these are manganese and aluminum.

All these disturbances are called malnutrition diseases. The most common of them are described below. Possibly brown rootrot and Frenching should also be included in this group.

Magnesia hunger or sand drown is seen perhaps most frequently because, until recent years, no effort was made to include a supply of this element in the fertilizer mixture and some sandy soils do not contain an amount that becomes available fast enough for the needs of the plant. The trouble is most often seen during wet years because magnesia is easily leached from the soil.

The characteristic symptom is chlorosis, or blanching of the leaves, beginning with the tips and margins of those on the lower stem and progressing inward and upward. The chlorosis is principally between the veins. It may continue until the leaf is almost white except for the network of veins which remain green. The leaves are somewhat thicker than normal and remain flat and stiff without puckering or rolling down on the margins. Dead spots are not ordinarily produced and the leaves do not die abnormally early. Cured leaves show uneven colors and burn with a black ash.

The remedy lies in keeping a sufficient supply of magnesia in the soil. Materials best suited for supplying magnesia are discussed on page 741 of this bulletin.

Potash deficiency produces characteristic symptoms which are readily distinguished after a little experience. The most severe cases that the writer has seen in this state were in seed beds, but mild cases have been found in the field also. Under the Connecticut Valley practice of heavy potash fertilization, however, they are not common.

In the earliest stages the potassium-starved leaves are mottled with yellow near the margins and tips, resembling somewhat the early stages of ripening. Soon the surface of the leaf becomes rough and puckered, "hobbly". Meanwhile the centers of the mottled areas have died and the margins and tips of the leaves are speckled with numerous small white spots. As conditions grow worse, margins of the leaves turn downward, giving them a rim-bound appearance. In severe cases the dead portions may coalesce and fall out or break and make the leaf appear ragged. On large leaves in the field, when potassium deficiency is not great, we have found the only symptoms to be a yellowing and sharp downward recurving of the leaf tips.

Unlike magnesia hunger, the symptoms of potash hunger do not always appear first on the lower leaves. These may be quite normal and the worst symptoms occur on the middle leaves. In severe cases plants are dwarfed, but we have not seen such a case in the fields of the Connecticut Valley. Stunting of growth is apparently not uncommon in tobacco districts farther south.

Plants with low potash supply are the first to wilt during dry weather or on hot days. The cured leaves do not come into "case" in the shed so quickly as those which have more potash. They are dry, harsh, non-elastic and have poor fire-holding capacity.

When this disorder occurs in the beds, the plants should be sprinkled with a solution of nitrate of potash made by adding two pounds of this material to a barrel of water. After the spray has been applied, it should be washed from the leaves with clear water. Even when the plants are severely affected in the beds they may be set in the field safely since they recover rapidly there. The remedy in the field consists in supplying any of the potash materials as described on page 740 of this bulletin. The trouble in the field, however, is rarely observed until it is too late to undertake remedial measures for the current year.

Nitrogen starvation causes the entire plant to turn pale and in severe cases to remain smaller and produce narrower leaves than normal plants. This trouble is well known by tobacco growers and is remedied by nitrate applications in the bed, as mentioned on page 733, or by side dressings in the field, as described on page 749.

Phosphorus deficiency is evidenced by slow, "pinched" or stunted growth, and narrow, dark leaves. The narrowing is particularly evident at the heel of the leaves, giving them a somewhat spatulate shape. They do not become pale or yellow but, when viewed at an oblique angle, have a bronze cast. On old tobacco fields this trouble is rarely seen but sometimes may be found in new fields during the first year or two of tobacco culture.

Manganese poisoning: All tobacco leaves normally contain a small amount of manganese—usually less than one-quarter of 1 per cent of Mn_3O_4—although this element is not a nutrient and perfectly normal plants can be grown in complete absence of it. The more acid the soil, the higher the percentage of manganese in solution in the soil water and consequently in the plant. At a somewhat increased concentration it becomes toxic to the plant and produces symptoms of poisoning. Affected leaves grow pale and may be distorted. The yellow color develops between the minute ramifications of the veins. In later stages the leaf is dotted with small, irregular, brown dead spots. The plants remain stunted throughout the affected part of the field. Cured leaves are yellow, non-elastic and of inferior quality.

The remedy is to apply lime to correct the extreme acidity of the soil. The disease has been observed only on fields testing below 4.5 pH. Sufficient lime should be applied to bring this reaction up to 5.0 pH or somewhat above.

POLE SWEAT

After harvest the leaves must be dried out slowly. During the entire process, lasting from two to six weeks, they must not dry too rapidly, because they are worthless if they "hay down" quickly in a green state. The humidity and temperature must be kept high enough so that the leaves remain soft for a long time. In such condition they undergo those internal chemical changes at a proper speed to insure the desired color, elasticity, grain, texture and other characters which good cured cigar leaf must have.

During the curing process, while the cells of the leaf are slowly dying, although still soft and containing considerable moisture, they do not have the resistance of normal living cells and are favorable subjects for attack by decay organisms. The higher the humidity of the surrounding air, the greater the danger of damage from rot-producing organisms. Since the cells can no longer be considered normal living cells, attacking organisms should be called saprophytes rather than parasites. The injury produced by growth of these organisms in the leaves has received a variety of names in different parts of the country but is commonly called pole-sweat, pole rot, shed burn or just "sweat".

Symptoms: In the shed there is no danger of pole sweat while the leaves are in the green state or in the transition stage from green to yellow. It may be detected when the leaf is turning from yellow to brown. The first symptom is usually the appearance of numerous small dark spots, at first not over an eighth of an inch in diameter. If moisture conditions are favorable, these soon enlarge and run together to form large irregular blotches on the leaves. They occur mostly where the leaves overlap one another or are against the stalks where moisture collects. At times drops of water may be observed on the surface of the leaves. In the worst cases, the rot may continue until the affected parts are soft and slimy. "Strutting" of the midribs (the midribs stand out at right angles from the stalk instead of wilting down normally) is also a symptom.

The symptoms after the tobacco is cured are more familiar to growers. On the sorting bench, the affected parts of the leaf are found to be variously discolored, dry and brittle. It is difficult to get them into "case" for handling but when they are moistened they are "tender". They have no elasticity or tenacity and when leaves are opened for examination they tear apart between the hands. Sometimes the rot has gone so far that they fall apart when they are shaken out from the bundle. Such leaves are worthless for cigar purposes.

Cause: Various species of fungi and bacteria have been found in the affected tissues and declared to be the cause of the trouble. Probably no one of these is constantly the primary causal agent. It is more likely that any one of a number of species (Botrytis, Alternaria, Aspergillus and others) may invade the moribund tissues and make trouble. In Wisconsin, Johnson's investigations indicate that *Alternaria tenius* is the primary cause.

Effect of environmental conditions: As previously indicated, a high humidity in the shed is especially favorable to pole sweat. High temperatures are also favorable. Prolonged periods of fog or of rainy weather, since they give no opportunity for the leaf surface to become dry, are particularly conducive to sweat. Hanging tobacco too closely prevents proper air drafts between the leaves and is thus favorable to sweat.

Control: Since there is no known method of disinfecting the leaves or destroying the fungi, the logical method of control is to regulate the rate of cure properly. Keep the temperature and humidity in such a balance that the conditions are unfavorable for infection and spread of the disease, but favorable for curing. Methods of doing this are discussed under curing on page 735.

INSECT PESTS

All species of insects which have been reported as injurious to tobacco in Connecticut are discussed in this chapter. Some of them, like wireworms, cutworms and flea beetles, are of major importance and occur every year. Others, such as thrips and springtails, come only during certain seasons, but at these times may do serious injury, while such regular perennials as hornworms and grasshoppers rarely make trouble. Among those that appear infrequently in Connecticut and are relatively harmless are the stalk borer, corn root webworm, budworm, cranefly maggot and the tarnished plant bug. Various other insects may be found on tobacco at times, but since they do little or no damage, they are not listed here.

Insect pests may also be divided into groups according to the part of the plant they attack. The stalk borer, wireworm, seed corn maggot, cranefly maggot, etc., work only on the stalk. A much larger number—among them the flea beetles, hornworms and grasshoppers—damage the leaves. Cutworms injure both stalk and leaves, while budworms sometimes eat the seed pods. No insects are known to cause serious injury to the roots of tobacco.

The following key to insect injuries is included in the hope that it may facilitate identification of the insects through the type of injury produced.

KEY TO INSECT INJURIES

I. Small seedlings in beds in two or four-leaf stage defoliated. Tiny purple insects just visible to naked eye. *Springtail.*

II. Buds attacked before leaves unfold

1. Unfolding leaves distorted and curly but not with large holes. Brown mottled bug one-quarter inch long *Tarnished Plant Bug.*
2. Unfolding leaves ragged and misshapen with irregular large holes. Green slender worms with pale longitudinal stripes, up to one and one-half inches long *Budworm.*

III. Mature leaves in the field damaged

1. Main veins silvery above and peppered with minute black specks. Tiny, brown, slender, sucking insects one twenty-fifth inch long *Thrips.*
2. Numerous little "shot holes" eaten by small, black, active, jumping beetles, one-sixteenth inch long *Flea Beetle.*
3. Large rounded holes between the veins eaten by large, variously colored (never black) hoppers with prominent hind legs *Grasshoppers.*
4. Holes much as in 3, above, but eaten by dirty gray or brown, fat caterpillars *Climbing Cutworm.*
5. Large holes, or extensive areas without regard to veins, eaten away by large green caterpillars up to four inches long, with prominent horn-like appendage at rear *Hornworm.*

IV. Young plants cut off near surface of ground by plump gray or brown caterpillars, up to two inches long, which eat at night and curl up in the soil during the day *Cutworms.*

V. Inside of stalk of young plants tunnelled out, causing them to wilt and die.

1. Hard, brown, shiny, slender worms up to one and one-half inches long in tunnels or in surrounding soil *Wireworms.*
2. Soft little white maggots one-quarter inch long in stalk *Seed Corn Maggot.*
3. Single large, soft, grayish-brown caterpillar, up to one and one-half inches long, with longitudinal stripes on back and sides, in the tunnel *Stalk Borer.*

VI. Holes or notches eaten into sides of young stalks

1. Tough leathery gray maggots, one inch long, with four protuberances on head *Cranefly Maggot.*
2. Dirty yellow or brown worm one-half inch long accompanied by webwork. Girdles plant and tunnels to some extent *Corn Root Webworm.*

THE GARDEN SPRINGTAIL*

This species sometimes causes injury in the seed beds by eating off the leaves of the young plants in the very early stages. Shortly after the seed has germinated, and only the two cotyledons or the first pair of true leaves have appeared, the plants begin to disappear. Close examination of the beds at this time shows many naked stalks (hypocotyls) standing up without any leaves or with only remnants of partly eaten leaves. Large areas in the beds are entirely denuded of plants.

The insects which are responsible are so small and inconspicuous that they can be seen only by careful search at close range. When the sun is shining, however, they may be found on the plants, or on the surface of the ground or on the side boards. They are only about one-twenty-fifth of an inch in length, dark purple, spotted with yellow. When disturbed, they jump like fleas so that it is almost impossible to catch them. Each has a globular shaped body with a rather large head and slender neck. From beneath the body extends a forked tail-like appendage by means of which the insect is able to throw itself.

Remedy: The springtail can be controlled by spraying the beds on bright sunny days with nicotine sulfate diluted at the rate of one pint in 50 gallons of water. The glass sash should be kept tightly closed on the the beds just after spraying. It may be necessary to repeat this treatment

**Sminthurus hortensis* Fitch.

at intervals of two or three days. Two pounds of laundry soap may be added as a spreader.

TARNISHED PLANT BUG*

Although this insect is of common occurrence in Connecticut, the amount of damage caused is not large. It pierces the young growing buds in the field and sucks the juice. As a result of its feeding, the newly unfolding leaves become twisted and curly. The adult bug is about one-quarter of an inch long and less than half as broad. It is flat, oval in outline and brown, but mottled with irregular splotches of white, yellow, and black. Along the side of the body at the posterior third is a clear yellow triangle tipped with a small, round, intensely black spot. Apparently this bug does not breed on the tobacco plants but comes there only to feed. It winters under leaves, trash, bark of trees and in similar concealed places, and appears early in spring on weeds and grass. When disturbed it flies rapidly away.

Remedy: No method of controlling the tarnished plant bug is known.

TOBACCO BUDWORM**

Budworms are not often serious in Connecticut although in southern tobacco districts they are major tobacco insect pests. During certain years, however, they have been known to cause considerable damage here. They appear in the field when the tobacco is partly grown. Tiny, pale green, striped caterpillars[1] burrow through the young leaves which are still folded together in the bud. As the leaves unfold and become larger, the insect holes also become larger and the leaves ragged, distorted and worthless. As the caterpillars grow they feed on the more mature leaves. At the end of two or three weeks they are about one and one-half inches long, pale green and marked with longitudinal stripes. At maturity they leave the plants and burrow beneath the soil where they winter as mahogany-colored, hard-shelled, spindled-shaped pupae about three-quarters of an inch long. In the spring the moths emerge and deposit eggs singly on the underside of the leaves. The moths have a wing spread of about one and one-half inches. Front wings are light green crossed by oblique lighter bands. There are probably two broods of these moths in Connecticut yearly. Later in the season the larvae may be found boring holes into the seed pods.

Remedies: If these pests do not become more numerous than they are now in Connecticut, the most economical method of control probably will be careful hand picking.

In sections where they are more common, a pinch of a mixture of one pound of arsenate of lead in 75 pounds of corn meal is applied by hand, or by means of a sifter can, to the bud of each plant before the larvae get into it. During severe infestations it is necessary to do this twice a week.

**Lygus pratensis* Linn.
***Chloridea virescens* Fabr.
[1] Rusty brown when first hatched, change to pale, green striped when one-half inch long.

TOBACCO THRIPS*

Thrips are not usually considered serious insect pests of tobacco in Connecticut. It is only during dry growing seasons that they are noticed. All types of tobacco are affected but the injury to shade tobacco

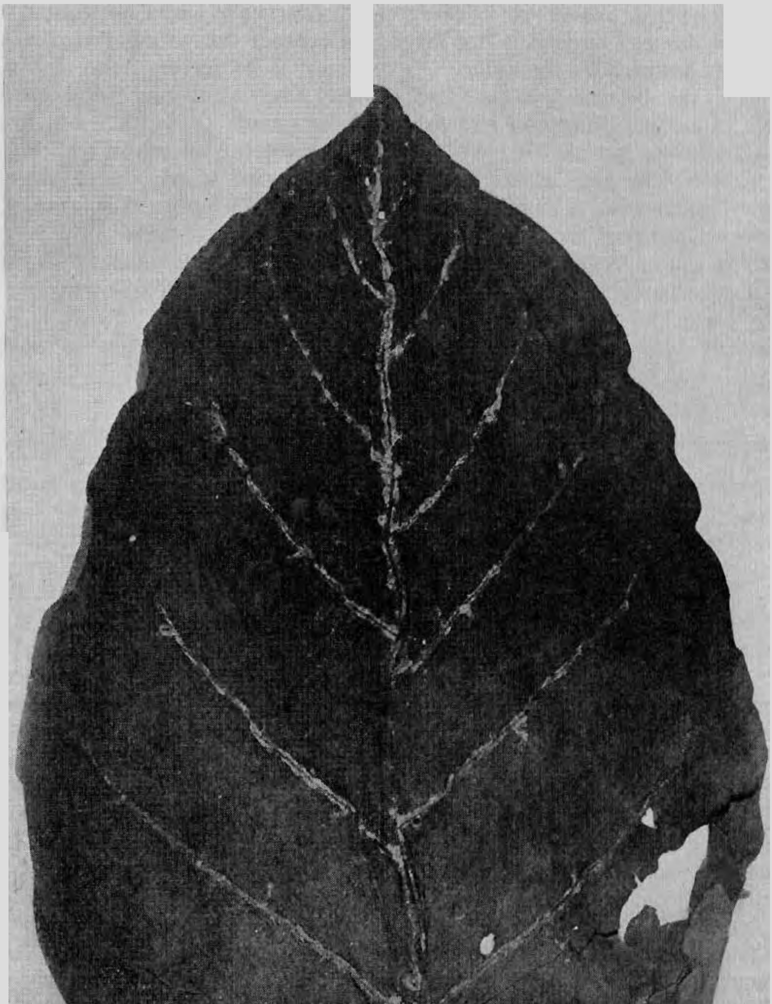

FIGURE 146. Thrips damage. The white veins seen on these cured leaves are caused by feeding of thrips while the leaf is growing.

is most serious because of the higher value of the leaves. Symptoms of infestation appear first on the lowest leaves and then work upward toward the center of the plant. As seen in the field, the principal veins of the

Frankliniella fusca Hinds.

affected leaves have a silvery appearance which makes them stand out from the remaining green tissue. The symptoms are seen only along the main veins of the upper leaf surface. Close examination shows the silver lines peppered over with tiny black specks. Badly affected leaves may sometimes turn yellow and die prematurely. The insects themselves are not so often seen as is their work. They are slender, yellow in the larval and brown in adult stage, and about one twenty-fifth of an inch long. When disturbed the adults fly suddenly and disappear like fleas.

In the cured leaves, affected veins are more conspicuous than in the green leaves, because they now appear white against a brown background. (Fig. 146). They may be distinguished from the ordinary "white vein", which comes during curing, by the irregular outlines of the white strips and the presence of tiny black specks in them. The commercial value of the leaves is seriously impaired because there is no demand for cigar wrappers with white veins.

Remedies: Methods of controlling thrips are not as thoroughly tested as those against other tobacco insects. Experiments with a number of dusts and liquid sprays at the Experiment Station show that none of the dusts are effective. Of the sprays, "Cubor" diluted in water at the rate of 1 part to 200, or nicotine sulfate diluted at the rate of 1 part to 400 and containing soap or penetrol as a "spreader", or Pyrethrol at the rate of 1 to 200, all give fairly good control. These should be applied at weekly intervals beginning when the work of the thrips is first seen.

FLEA BEETLES

The potato flea beetle* causes serious damage to all types of tobacco here and appears to have increased in abundance during recent years, probably due to increased potato acreage in the tobacco region.

The adult beetles are black, oval in outline, and about one-sixteenth of an inch in length. When disturbed they jump and disappear suddenly. They can fly and are very active. They eat numerous small, rounded "shot holes" into or through the leaves, mostly from the under side (Fig. 147). It takes only a few such holes to make a leaf unfit for wrapper purposes; if the holes are more numerous the leaves are also unsuitable for binders. The amount of damage varies from year to year. During years of severe infestation, the flea beetle is the most destructive of all tobacco insects.

Depredations of these insects are usually noticed first in the seed beds at about the time that the plants are becoming large enough to set in the field. Numerous holes weaken the plants so that they are less able to withstand the shock of transplanting and many die shortly after being set out. The insects propagate rapidly and eat voraciously. It has been estimated that a flea beetle eats ten times its own weight each day.

After the infestation in seed beds and at transplanting time, the injury becomes less evident for a while. Then a second brood, returning in July,

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**Epitrix cucumeris* Harris. The tobacco flea beetle, *Epitrix parvula* Fabr., which is the common species in southern tobacco districts, has been reported on tobacco only once in Connecticut and is probably of little importance here.

causes damage to the large leaves that is of much greater significance than the early injury.

The adult beetles hibernate in large numbers under grass, weeds, or trash around the fields or beds. Those which appear first in the seed beds are the over-wintered adults. They lay eggs on the surface of the soil under the plants. These hatch out in a week or less and the slender white larvae burrow into the soil and feed on the fibrous tobacco roots. They become full grown in about two weeks. Then after four or five days in the pupal stage they emerge as adult beetles.*

This same species attacks other plants of the tobacco family, the commonest members of which are potato, tomato, night shade, pepper, egg plant, Jimson weed and ground cherry. It is a common observation that flea beetle infestations are worst on edges of tobacco fields adjacent to

FIGURE 147. Flea beetles caused this damage. Note the numerous small holes in the cured leaf.

potato or tomato fields. When the potato vines die in midsummer, the beetles migrate in great numbers to the adjacent tobacco and cause extensive damage.

Remedies: In the seed beds, Bordeaux Mixture applied as recommended for control of wildfire is also effective in repelling flea beetles.

In the field, dusting the plants with barium fluosilicate at the rate of four or five pounds to the acre is the best method of control found to date. Since it is difficult to distribute evenly so small a quantity of material on

*Lacroix was unable to find any young stages (eggs, larvae, pupae) in the soil of tobacco fields. They are common in soil of adjacent potato fields, however, and this suggests that they may not breed in tobacco fields but that the adults migrate to the tobacco plants from elsewhere.

an acre, this substance is usually diluted with some light dust. Finely ground tobacco dust mixed at the rate of one part of barium fluosilicate to five or six parts of the dust gives excellent control and the color of the mixture leaves no objectionable deposit. This treatment should be applied as soon as beetles begin working and ought to be repeated at intervals of a week until they disappear. The application should be made during a calm part of the day. It is not necessary, however, that it be applied when the dew is on the leaves because the glandular hairs on the surface secrete a viscid substance that holds the dust.

This same treatment may also be used on seed beds.

GRASSHOPPERS

Grasshoppers of several species* feed upon the leaves of tobacco, leaving large, rounded, smooth-edged holes an inch or two in diameter

FIGURE 148. Grasshopper holes in shade tobacco leaf. The regular rounded margins of holes are characteristic. Such a leaf is worthless for cigar wrappers.

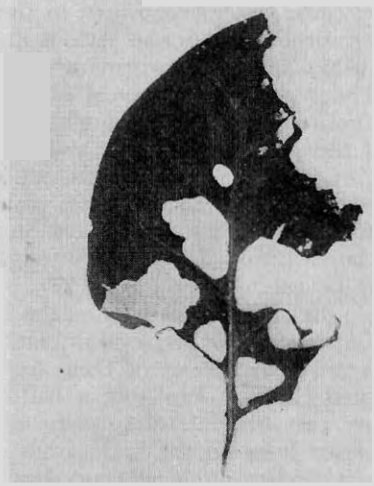

FIGURE 149. A climbing cutworm injured this leaf.

mostly between the veins (Fig. 148). Damage is usually worst around the edges of the field, especially when adjacent to grass or hay fields. Sometimes serious infestations occur, however, in the interior of fields, especially in new fields which were in grass the previous year.

*The red legged grasshopper, *Melanoplus femur-rubrum* DeG., is most common but frequently accompanied by the Carolina grasshopper, *Dissosteira carolina* Linn. A number of other species, particularly the green grasshoppers or Locustidae, are responsible for considerable damage.

Remedies: Grasshoppers may be controlled by scattering a poison bran bait between the rows as for cutworms (see page 745). This should not be allowed to fall on the leaves because it will poison them and cause large dead spots. Another formula successfully used in Wisconsin is made up as follows:

Sawdust	100 pounds
Sodium arsenite	1 quart
Molasses	1 gallon
Salt	5 pounds
Water	7-10 gallons

This bait is spread on the ground 10 to 20 pounds to the acre. It is usually necessary to treat only the edges of the fields.

CUTWORMS

Cutworms cause considerable injury to young plants in the field every year. The amount of damage varies from season to season. Occasionally they cause extensive injury in the seed beds. The only reason the cutworm problem is not so serious as the wireworm problem is that effective remedies against cutworms are well known.

The type of injury most often observed is produced when the worms eat entirely or nearly through the stalk, just at the surface of the ground, and the plant drops over and dies. Frequently only the tender bud is cut off and the plant sends out several suckers from below, producing a many-stalked and worthless plant. Some kinds of cutworms climb the stem and eat holes in the leaves much like those produced by grasshoppers or hornworms. In severe infestations, the greater part of the leaf web may be eaten away (Fig. 149). Others sever the petioles of the leaves. Even the stalk eaters feed on the leaves also.

Cutworms are the larval or caterpillar stage of Noctuid moths. Twenty-two different species of them feed on tobacco in the eastern part of the United States. Probably a half-dozen species occur in New England.* They are soft, fat, dirty gray to brown, variously marked with darker spots or lines on the back, from one to two inches in length and curled into a perfect circle when resting in the soil. Most of the species have one generation annually in this section. The eggs are laid on grass or weeds in the late summer, and the larvae hatching from them feed upon the smaller weeds, grass and other vegetation of the field. They are about half grown on the approach of cold weather when they go into the ground or under rubbish for protection during the winter. With the return of warm weather and green vegetation in the spring, they emerge from winter quarters and resume feeding. When, in plowing, all the weed growth is turned under, they have difficulty in finding sufficient food. Therefore they are very hungry when the young tobacco plants are set in the field and they attack them voraciously. Some species pass the winter in the pupal stage and the moths emerge in the spring.

**Agrotis ypsilon* Rott, the black cutworm, and *A. c-nigrum* L., the spotted cutworm, are found perhaps most frequently.

Cutworms do their feeding at night and hide during the day. They are usually found curled up just under the surface of the soil around the base of the injured plants. The adult moths range from grayish to brown or black and have a wing spread of about two inches. They fly and lay their eggs at night and rest during the day in protected places on fences, trees, sheds, etc.

Remedies: Application of insecticides for control of cutworms is one of the routine operations in the growing of tobacco and is therefore discussed under the chapter on setting the plants (page 745).

The poisoned bran bait described for field use may also be used to control the worms in the seed bed. A dosage of 4 pounds (dry weight) to 100 square yards of bed is recommended. This may cause some burning of the leaves.

HORNWORMS*

Hornworms are commonly called "tobacco worms" because their large size and striking appearance makes them the best known of the tobacco insects. They are bright green with white diagonal stripes on the side, plump, about the size of one's finger and three or four inches long when full grown. A slender, curved, soft horn-shaped protuberance on the back near the posterior end is responsible for the popular name of hornworm. They first appear in late June or early July and increase in number until harvest. They continue to eat the leaves, even in the sheds, as long as the foliage is green. It is not definitely known whether there is more than one brood during a season but worms of all sizes may be found at the same time in the latter part of the summer. The small worms eat holes between the veins but larger worms devour great areas of the leaf, avoiding nothing but the largest veins. In severe infestations many plants are rendered quite worthless. These worms vary greatly in abundance from year to year. During some seasons hardly one can be found; at other times they are everywhere. On the whole, however, they cause a comparatively small amount of injury in Connecticut, much less than in the southern states, and cannot be regarded as presenting a major insect problem here.

Hornworms are the larval or caterpillar stage of sphinx moths, also called hawk or humming bird moths. The moths are colored various shades of gray, have large heavy bodies and long narrow wings. Just at dusk, frequently, they may be seen poised like humming birds before deep throated flowers from which they sip the nectar by means of long tongues. At other times the tongues are coiled up like watch springs under the head. The moths lay their eggs singly on tobacco leaves. The larvae which hatch from the eggs feed three or four weeks on the leaves, growing rapidly, and then burrow under the ground. Here they transform into mahogany-brown, hard-shelled, spindle-shaped pupae, about two inches long, with slender tongue cases projecting from the front and bent forward on the body like jug handles. They pass the winter in this stage and emerge as moths about the first of June.

*There are two species in Connecticut, the northern tobacco worm, *Phlegethontius quinquemaculata* Haw., and the southern tobacco worm, *Phlegethontius sexta* Johan. The former is more common here.

Remedies: These worms would probably be much more numerous and destructive if they were not kept in check by natural enemies. It is not unusual to find numerous cylindrical white cocoons of a wasp-like parasite on the backs of some of the worms. Worms thus parasitized never recover but the parasites emerge and lay their eggs on other hornworms. When such parasitized worms are found they should not be killed because they serve to propagate parasites.

Dusting with arsenate of lead powder at the rate of 5 pounds to the acre, or spraying with the same material in water at the rate of 1-1/2 to 2 pounds to 50 gallons of water, is a method used in southern states to control hornworms. No doubt this could be used successfully here in severe infestations.

As a rule, however, the larvae are not so numerous but that they may be most economically picked off by hand and destroyed. Also during all cultural operations, workmen should be instructed to find and kill the worm every time they see an eaten leaf.

WIREWORMS*

The knottiest insect problem which confronts the Connecticut tobacco growers is the control of wireworms. These worms are the grubs or larvae of click beetles (Elateridae). They are slender, shiny, hard, about an inch in length, and colored from yellow to chestnut brown. They cause the greatest damage just after the plants are set in the field. Entering the stems below the surface of the ground, one or several of the worms eat out the interior and make tunnels up through the stalk. In severe infestations a dozen or more of them may be found in the soil close around one plant. The riddled plants usually wilt and die quickly; in fact many of them are attacked so soon after setting that they never recover from the initial wilt following transplanting. Some plants not too severely injured, however, recover and make normal but belated growth.

The infestation rarely affects a whole field with equal severity. Usually there are patches from a few square rods to several acres in size, where the worms are most abundant, while other parts of the field may be free from them. Such patches frequently persist in the same location through two or more seasons. This is probably due to the fact that the insect lives more than one year in the larval stage. The severity of infestation, however, varies from year to year. During some seasons they can hardly be found at all; during others they are widespread and destructive. Also they have a habit of disappearing very suddenly from a field, usually in the first half of June when the soil becomes hot and dry. They leave the plants and burrow deeper into the ground. During this same period the adults—flat, elongated, narrow, black or dark brown beetles, about an inch long—emerge and may be found in large numbers on the cloth of the tents of shade plantations. They appear especially on the side walls.

If the infestation is not too severe, the grower attempts to keep his "stand" by frequent restocking. Such a practice results in uneven stands

***Pheletes ectypus* Say, the Eastern field wireworm. *Limonius plebejus* Say has also been found in tobacco and there may be others.

in which the plants are in different stages of maturity at the time of harvesting, so that some leaves will be too green or others too ripe. This undesirable condition is more serious in shade tobacco than in outdoor types. When the number of affected plants is as high as 30 per cent, it is better to harrow up all of them and set the field again. Sometimes this measure must be repeated.

Remedies: No entirely satisfactory remedy for wireworms has been found. Often they may be escaped by delaying the setting of the field until the middle of June. There are some disadvantages, however, from other standpoints, in late setting. Many growers, especially growers of shade tobacco, do not like to delay setting so long. Moreover, during some years, the worms are still present even at that late date. Yet as a general principle, it is worth while to set those fields, or parts of fields, last which were found to be infested during the previous year.

A great many repellent or toxic materials dissolved in the water of the setter barrel and thus deposited in the soil around each plant have been tried. Among these are camphor, turpentine, naphthalene, carbon disulfide, sulfonaphthol, pyrethrol, Red Arrow, rotenone and various proprietary repellents. None of them has given sufficient control to pay for the cost of the material.

The most promising results up to the present have come from using the cyanogas method. This consists in attracting worms to a bait crop and then poisoning them with cyanogas (calcium cyanide). Rows of corn, beans, peas, or cereals are planted in the infested soil in early May or perhaps the last of April. All the worms in the soil will be attracted and will congregate in and around the germinating seeds. Then the cyanogas, which is of about the consistency of gun powder and flows easily from a spout, is drilled into the row, three or four inches below the surface, by means of a fertilizer drill or seed drill. The gas diffuses out into the soil and kills all the worms within several inches. The plants are also killed. About 100 pounds of cyanogas to the acre is the recommended dose.

A more practical method for tobacco growers is to use tobacco plants themselves as the bait crop. The field is set with tobacco in the usual way. If it should happen to be a year when wireworm infestation is absent or very light, there is no need of further worry. If, however, the infestation of the field or parts of the field is severe, the cyanogas may be applied in the rows and the worms destroyed. After four to seven days the majority of the worms will be dead and the field may then be harrowed and reset with tobacco in the regular way.

The cost of material—about \$20 to \$25 an acre—is the main objection to this method.

SEED CORN MAGGOT*

The ravages of this insect are not often seen in Connecticut but during some years it has assumed destructive proportions locally. It is likely that the injury caused by seed corn maggots has often been attributed to wireworms because the tunnels of both are much alike. The plants are attacked shortly after they are set in the field. The insects enter the stalk just below the surface of the soil and eat tunnels up through the interior. When the stalks are cut open, one or more soft, yellowish white maggots, about one-quarter inch long, with sharp pointed heads will be found in the tunnels. As a result the plants either wilt and die, or they remain sickly for a while and then make a belated growth. Such a condition necessitates restocking and often the whole field must be harrowed over and reset with fresh plants. The period of infestation is usually short and the insects disappear suddenly. The maggots are the larval stage of a two-winged fly which lays eggs in the spring in soil where there is an abundance of decaying vegetable matter. The most serious cases that the writer has seen were on fields where clover had been plowed under in the spring, or where a heavy application of manure had been made.

Remedy: The infestation lasts only a few days. By daily examinations of the plants, the grower may determine the date of disappearance of the maggots and it is then safe to set the field with fresh plants. This method has been successful in eliminating further trouble in all cases which have come to our attention.

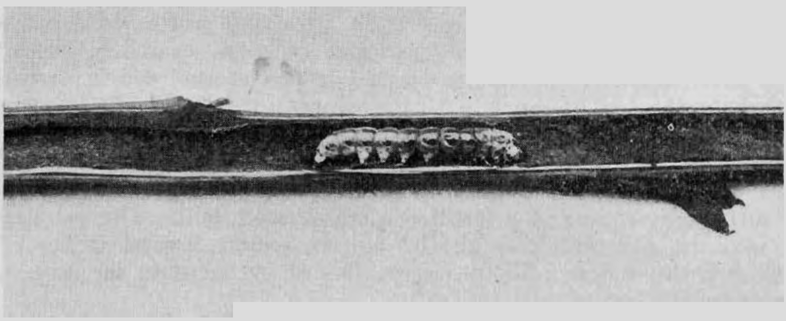

FIGURE 150. Stalk borer in tunnel. This stalk has been cut longitudinally to show the tunnel and insect.

STALK BORER

The stalk borer cannot be considered a serious insect pest of tobacco. Occasionally scattered plants, especially along the margins of the field near weed borders, are attacked. Their work is not noticed until the plants suddenly wilt. When the stalk is cut open longitudinally, the pith will be found entirely bored out and a single larva somewhere in the tunnel (Fig. 150). The mature worm is about one and one-half inches long, grayish brown, with one white longitudinal stripe along the back, paralleled by two white stripes on each side. Dark lateral stripes extend forward upon the sides of the head. A dark band or girdle encircles the third thoracic and first three abdominal segments. This borer is the larval stage of a moth.

Remedy: The insect has never been found sufficiently numerous in this state to warrant special efforts to control it.

CRANEFLY MAGGOT*

Damage to tobacco from this insect has been reported only once and it is probably of minor importance. Shortly after the plants were set in the field, holes or notches were eaten in the sides of the stalks just below or at the surface of the soil. This caused many of them to die while others were stunted so that it was necessary to harrow up and reset the whole field. The maggots are tough and leathery in texture, gray, about an inch long, with four horn-like protuberances at the head. They pupate in the soil and emerge as two-winged flies with extremely long legs, hence called "crane" flies.

Remedy: No method of control can be recommended.

CORN ROOT WEBWORM OR STALK GIRDLER**

Only one infestation of this sod webworm has been reported in Connecticut. However, it is known to cause damage in other tobacco sections, and since it is possible that it has caused other injuries here which were mistakenly ascribed to wireworms, it may be of more common occurrence than suspected. The following description is given by Lacroix who reported it in 1931.

"This worm, living beneath the soil, girdles the stalk of newly set plants just below the soil surface, and eventually enters the stalk and tunnels upward. It is a small active worm about one-half inch long, dirty yellow to light brown and always accompanied by a lot of web and silk strands. At first sight, a field infested with this insect looks much as though wireworms were at work, but an examination of the plant stems shows a girdling as well as a tunnelling.

"Pupation takes place in an earthen cell made up of silk webbing and loose soil. These tough cells are pear shaped and from one-half to three-fourths of an inch in length. They were found from one to three inches below the surface of the soil. The adult is a small light brown moth about half an inch long, of nervous temperament, flying with rapid zig-zag movements, and always darting to cover when disturbed.

"The insect belongs to a large group of stem girdlers that ordinarily feed on grass and weeds, and this fact probably explains how it happened to occur on tobacco. The plantation was in sod the year before tobacco was planted, which was ideal for the development of the girdler. On plowing and planting to tobacco, the natural food was not available, so the larvae attacked the crop present."

**Nephrotoma ferruginia* Fabr.
***Crambus caliginosellus* Clem.

APPENDIX

CONSTRUCTION OF A SHADE TENT

The object of growing tobacco under cheese cloth is to produce thinner, smoother leaves with smaller veins, thus more suitable for fine cigar wrappers. These changes in leaf characteristics are induced not alone by the shade effect of the tent but equally by the increased humidity, the reduced evaporation and wind velocity. Conditions in such a tent approach those of a moist tropical climate. The tent also affords some protection against hail, wind whipping and possibly some insects.

In the first tents constructed at the beginning of the present century the cloth was supported on cross beams of wood but these were soon

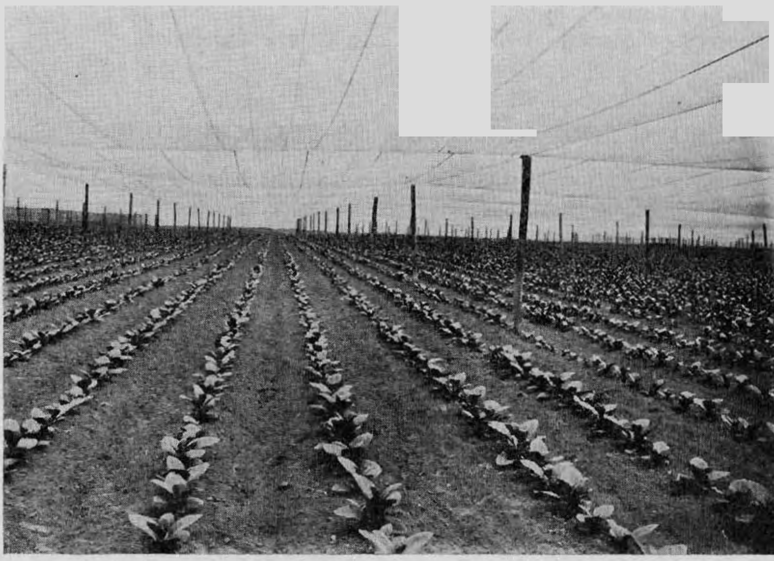

FIGURE 151. Scene under the shade tent in June.

supplanted by wires. All tents in the valley are almost uniform in pattern now. The wires over which the cloth is stretched are stapled to chestnut posts which are set 33 feet apart each way. These posts are in straight, exact rows, in either direction, the cross rows being exactly at right angles with the long rows. Peeled chestnut poles of a length of 12 feet, and a minimum top diameter of four or five inches, are now in use. These posts last five to ten years and when once set are not changed except when the grower wishes to abandon growing shade tobacco on a field. The poles are set three to three and a half feet in the ground and the wires are stapled to the sides of the post 6 to 12 inches from the top. The wires are commonly kept on the same side of all the posts, but some growers prefer to have the wires run alternately on opposite sides of the posts in a row, believing that this is a stronger construction. Wire is spliced with a hand tool called a "wire splicer" such as is used by telephone linemen. Before the tent cloth is laid over these splices, they are wound and covered thoroughly with some extra pieces of material to prevent the top cloth from being torn.

Wire and staples are galvanized to avoid rust which would wear through and tear holes in the cloth. The staples are common, galvanized, one and a half inch fence staples. Two sizes of wire are used; number six gauge, a pound of which makes about 10.28 feet, and number eight, at about 14.37 feet to the pound. Number six is stronger and some growers prefer to use this size only. The more common practice, however, is to use number six the long way of the field—the cloth is thus sewed to the large wires—and the smaller number eight gauge for cross wires. Using number six wire alone would require about 260 pounds to the acre without any allowance for the bottom wires and anchor wires, while number eight alone would require about 185 pounds. The amount required for ground wires and anchor wires depends on the shape and size of the field.

All outside posts are anchored to "dead men", pieces of post about three feet long, laid horizontally three feet under ground at a distance of about four feet directly opposite and outside the post. The anchor wire is cut to a length of about 16 feet, wound around the top of the post and then around the center of the dead man at such a distance that when the dead man is dropped into place the wire will be taut. It is then firmly buried. When the top wires are stretched, the anchor wires become tighter. Many shade growers prefer to use double anchor wires. Larger timbers are used for corner posts and they are anchored in both directions.

The bottom of the side cloth is attached to a ground wire stretched along the outside base of the poles. Since it is necessary to open the ends of the tent for cultivating and other cultural operations, the ground wires along the ends are attached by loops or rings to taut, vertical wires on the corner posts, in such a way that they may be slipped readily up and down. The ground wires along the sides of the tent, however, are stapled fast like the top wires. An additional wire about half way between the top and ground wires is stapled on the sides. A wire in this position cannot be used on the ends of the tent but some growers place a wire within about a foot of the top wire for supporting the cloth when it is rolled up to open the ends for cultivation. The ground wire along the ends is kept in position by hooks at the bottom of the posts.

It is necessary that all wires be tightly stretched. First, the wires are securely attached to the posts at one end by wrapping them around the top and winding the loose end around the wire just inside the post. Then they are attached loosely to every second pole across the field by driving the staple only half way in. After the wire is stretched, by means of a double pulley block and tackle at opposite ends of the field, the staples are driven securely into every pole. Winches and various other wire stretching equipment are used by different growers.

The cloth, which is used to cover the tent and form the side walls, is a specially prepared cotton cloth sewed in strips just 400 inches wide and 125 feet long. It is purchased in bales of 400 to 450 pounds, four strips in a bale. One bale will cover about one and one-eighth acres. Two different weights of cloth are in use: A lighter cloth in which there are eight threads to the inch each way, and a stronger cloth in which there are eight one way and ten the other. Groups of re-inforcing closer strands are spaced about 18 inches apart the long way, and 14 inches the short way. The advantage of the heavier but somewhat more expensive cloth is that it will not be so easily torn by high winds or hail. The cloth is used only one year on the top of the tent but a part of the top cloth is commonly doubled and used as side wall the second year.

DIRECTIONS FOR ATTACHING THE CLOTH

Select a calm day. Do not attempt to sew the cloth to the wires in a strong wind.

Place the side wall cloth on the ground around the outside of the frame.

Place the first piece of top cloth on top of the wires lengthwise of the field, between the first and second rows of poles.

Begin at the outside wire on either end by tying one end of the top cloth to the corner post, allowing about one yard over-hang—enough so that you will have plenty of material to sew to the top wires at the end of the field.

Now, take one edge of the sidewall cloth and the edge of the top cloth. Place both together and roll around the side wire from the underside, pinning it into place by using ten penny wire nails. Place the pins about 16 inches apart.

The cloth should be pinned along the wire about 10 feet before sewing is begun. Always have cloth pinned to wires about 10 feet ahead of the sewer. Be sure to sew the cloth the full length of the field to the outside wire before starting to sew the cloth to the second wire.

When pinning the cloth to the wires, do not stretch it too tightly lengthwise of the field.

Begin sewing by starting as close as possible to the end post. Use 12-ply cotton twine doubled—with about 9 feet of string on the needle—and first wind the string around the wire and cloth two or three times and tie fast. You are now ready to sew. Use the lock stitch, spacing about four inches apart, and sew down the full length of the field.

Place the second piece of top cloth on top of the wires lengthwise of the field between the second and third rows of poles. Fasten the corner to the outside post in the second row, allowing one yard to overlap, and pin into position on the wires, following the same pinning process as that used on the first outside wire. Placing the two pieces of cloth together at the selvage, pin both to the second wire and sew.

When the cloth is stretched and pinned to the second wire, be sure to keep the cross re-enforcement threads at right angles to the wires. Otherwise the cloth will not be wide enough to reach from wire to wire at the end of the field. Keep the sheet straight.

Sew the top cloth to the ends of the frame by rolling all surplus cloth around the top wire, first fastening with pins.

Don't sew the side wall cloth on the ends until all the top cloth is in position. Stretch the side wall down tight, rolling any surplus around the wire, and sew it to the ground wire.

TABLE 1. COMBINED PRODUCTION OF ALL TYPES OF TOBACCO IN CONNECTICUT. 1862–1933

Year	Acres	Yield per acre	Total pounds	Price per pound	Value
1839	.....	....	537,649*	....	....
1849	.....	....	1,405,920*	....	....
1859	.....	....	9,266,448*	....	....
1862	5,769	1300	7,500,166	14.0	$ 1,050,023
1863	6,000	1250	7,500,166	25.0	1,775,041
1864	6,828	1450	9,900,218	25.0	2,475,054
1865	6,050	1350	8,167,681	30.0	2,450,304
1866	6,534	1200	7,840,974	13.6	1,063,275
1867	5,263	1266	6,664,000	16.5	1,097,937
1868	4,871	1450	7,063,000	18.6	1,313,802
1869	4,482	1450	6,500,000	21.4	1,390,650
1870	5,996	1250	7,495,000	20.3	1,520,530
1871	4,761	1700	8,094,000	22.5	1,819,694
1872	5,052	1650	8,336,000	26.6	2,215,058
1873	5,220	1647	8,600,000	21.2	1,821,363
1874	7,224	1250	9,030,000	28.9	2,605,591
1875	6,600	1500	9,900,000	19.2	1,898,867
1876	6,203	1220	7,568,000	8.3	631,245
1877	.....	....	....	....	....
1878	5,800	1400	8,120,000	11.0	891,417
1879	6,900	1400	9,660,000	12.0	1,159,200
1880	10,070	1538	15,487,660	15.0	2,323,149
1881	8,753	1572	13,763,759	16.0	2,202,201
1882	8,665	1128	9,772,269	13.0	1,270,396
1883	8,145	1176	9,576,824	13.5	1,292,871
1884	8,064	1176	9,481,000	12.4	1,175,644
1885	7,661	1575	12,066,000	12.4	1,496,193
1886	7,292	1600	11,667,000	14.0	1,633,380
1887	6,198	1480	9,173,000	14.3	1,311,745
1888	6,136	1565	9,603,000	13.0	1,248,369
1889	6,331	1402	8,874,924	12.5	1,009,366
1890	6,394	1600	10,230,400	16.0	1,636,864
1891	6,458	1620	10,461,960	19.5	2,040,082
1892	7,104	1600	11,366,400	21.0	2,386,944
1893	7,459	1429	10,658,911	14.0	1,492,248
1894	6,713	1516	10,176,908	16.0	1,628,305
1895	6,579	1509	9,928,000	16.5	1,638,120
1896	6,579	1550	10,197,450	13.0	1,325,668
1897	6,908	1100	7,598,800	....	....
1898	6,563	1250	8,203,750	....	....
1899	10,119	1673	16,930,770	18.0	3,047,539
1900	10,948	1684	18,435,765	15.0	2,833,041
1901	11,782	1586	18,682,319	15.0	2,756,221
1902	12,725	1712	21,785,200	16.0	3,485,632
1903	13,234	1600	21,174,400	15.5	3,282,032
1904	12,705	1685	21,407,925	22.6	4,838,191
1905	13,340	1725	23,011,500	17.0	3,911,955
1906	14,140	1735	24,532,900	18.0	4,415,922
1907	14,400	1510	21,744,000	11.5	2,501,000
1908	13,824	1680	23,224,320	17.0	3,948,134
1909	16,000	1752	28,110,000	16.5	4,638,000
1910	16,000	1730	27,680,000	16.5	4,567,000
1911	17,000	1625	27,625,000	20.5	5,663,000
1912	17,500	1700	29,750,000	24.1	7,170,000
1913	18,400	1550	28,520,000	21.0	5,989,000

TABLE 1. COMBINED PRODUCTION OF ALL TYPES OF TOBACCO IN CONNECTICUT. 1862–1933—*Continued*

Year	Acres	Yield per acre	Total pounds	Price per pound	Value
1914	20,200	1770	35,754,000	18.5	6,614,000
1915	22,200	1350	29,970,000	17.0	5,095,000
1916	22,200	1630	36,186,000	27.0	9,770,000
1917	24,000	1400	33,600,000	38.4	12,902,000
1918	25,000	1500	37,500,000	44.0	16,500,000
1919	28,000	1535	42,980,000	48.1	20,673,000
1920	30,000	1365	40,950,000	45.7	18,714,000
1921	30,800	1440	44,352,000	31.3	13,882,000
1922	28,000	1065	29,820,000	40.5	12,077,000
1923	29,000	1410	40,890,000	47.5	19,423,000
1924	28,900	1368	39,535,000	29.3	11,584,000
1925	30,000	1352	40,560,000	26.5	10,748,000
1926	22,400	1340	30,016,000	36.7	11,016,000
1927	24,200	1223	29,597,000	36.2	10,714,000
1928	25,000	1190	29,750,000	37.0	11,008,000
1929	20,800	1370	28,496,000	48.1	13,707,000
1930	23,400	1385	32,409,000	37.1	12,024,000
1931	22,500	1300	29,250,000	23.8	6,970,000
1932	15,400	1435	22,099,000	18.7	4,143,000
1933	11,600	1352	15,683,000	25.7	4,037,000

TABLE 2. ACREAGE AND PRODUCTION OF SHADE TOBACCO IN ALL NEW ENGLAND. 1900–1933.

Year	Acres	Total thousands of pounds
1900	1/3	
1901	41	
1902	720	
1903	625	
1904	33	
1905	40	
1906	40	
1907	70	
1908	200	
1909	400	
1910	1000	
1911	1995	
1912	1906	
1913	1840	
1914	2574	
1915	3609	
1916	4939	
1917	5917	
1918	6223	
1919	4866	5772
1920	5930	5393
1921	7382	7543
1922	8000	6792
1923	8400	9639
1924	6900	7385
1925	4580	4830
1926	5210	5322
1927	7100	6387
1928	8000	6923
1929	8700	10215
1930	7400	7712
1931	5800	5693
1932	4500	4499
1933	4700	4928

TABLE 3. HISTORICAL RECORD OF CONNECTICUT TOBACCO BY TYPES. HARVESTED IN 1919–1933*

Year	Acres harvested	Acre yield	Total production	Farm price per pound	Total value
Broadleaf					
1919	16,800	1600	26,880,000	45.1	$ 12,109,000
1920	17,700	1465	25,930,000	40.0	10,365,000
1921	17,000	1546	26,282,000	20.0	5,273,000
1922	12,800	1120	14,336,000	30.0	4,296,000
1923	13,200	1510	19,932,000	35.0	6,984,000
1924	14,900	1497	22,305,000	20.0	4,461,000
1925	18,400	1400	25,760,000	19.1	4,908,000
1926	13,200	1400	18,480,000	26.1	4,814,000
1927	12,700	1309	16,624,000	21.0	3,483,000
1928	12,000	1310	15,720,000	21.0	3,303,000
1929	7,900	1451	11,463,000	27.1	3,106,000
1930	11,900	1495	17,790,000	25.1	4,461,000
1931	12,800	1409	18,035,000	14.0	2,525,000
1932	9,300	1580	14,694,000	11.5	1,690,000
1933	7,000	1490	10,430,000	11.5	1,199,000
Havana Seed					
1919	6,100	1580	9,638,000	31.0	2,988,000
1920	6,100	1449	8,839,000	36.0	3,182,000
1921	6,200	1500	9,300,000	23.0	2,139,000
1922	8,000	1125	9,000,000	29.0	2,610,000
1923	8,100	1460	11,826,000	35.0	4,139,000
1924	7,800	1345	10,491,000	19.0	1,993,000
1925	7,500	1380	10,350,000	17.0	1,760,000
1926	4,700	1463	6,876,000	28.0	1,925,000
1927	5,400	1343	7,252,000	23.0	1,668,000
1928	6,000	1300	7,800,000	24.0	1,872,000
1929	5,500	1508	8,294,000	30.0	2,488,000
1930	5,500	1518	8,349,000	23.0	1,920,000
1931	5,000	1383	6,915,000	13.0	899,000
1932	5,300	1556	8,247,000	9.0	742,000
1933	2,800	1458	4,082,000	9.0	367,000
Shade					
1919	3,900	1180	4,602,000	105.	4,832,000
1920	4,700	890	4,183,000	100.	4,183,000
1921	5,700	1040	5,928,000	95.	5,632,000
1922	6,300	846	5,330,000	90.	4,797,000
1923	6,800	1130	7,684,000	100.	7,684,000
1924	5,500	1050	5,775,000	85.	4,909,000
1925	3,800	1048	3,982,000	100.	3,982,000
1926	4,200	1000	4,200,000	98.	4,116,000
1927	5,700	900	5,130,000	105.	5,389,000
1928	6,600	858	5,663,000	100.	5,663,000
1929	7,200	1170	8,424,000	95.	8,003,000
1930	6,000	1045	6,270,000	90.	5,643,000
1931	4,700	915	4,300,000	82.	3,526,000
1932	3,700	1006	3,722,000	59.	2,196,000
1933	3,800	1070	4,066,000	80.	3,253,000

*Estimates of the Crop Reporting Service of the U. S. Department of Agriculture.

Table 3. Historical Record of Connecticut Tobacco by Types. Harvested in 1919–1933—*Continued*

Year	Acres harvested	Acre yield	Total production	Farm price per pound	Total value
			Primed Havana		
1919	1,200	1550	1,860,000	40.0	744,000
1920	1,300	1320	1,848,000	50.	924,000
1921	1,700	1495	2,542,000	30.	763,000
1922	700	1249	874,000	30.	262,000
1923	400	1600	640,000	42.	269,000
1924	600	1373	824,000	23.	190,000
1925	300	1560	468,000	21.	98,000
1926	300	1533	460,000	35.	161,000
1927	400	1478	591,000	30.	177,000
1928	400	1418	567,000	30.	170,000
1929	200	1575	315,000	34.9	110,000
			Roundtip		
1920	100	1500	150,000	40.	60,000
1921	200	1500	300,000	25.	75,000
1922	200	1400	280,000	40.	112,000
1923	500	1616	808,000	43.	347,000
1924	100	1400	140,000	22.	31,000

TABLE 4. ACREAGE OF TOBACCO BY TOWNS AND BY TYPES. 1925–1933*

Town	Type	1925	1926	1927	1928	1929	1930	1931	1932	1933
Avon	H	67.5	38.0	28.0	31.0	35.5	34.5	31.0	29.5	8.0
	B	.....	.....	.....	.....	.....	.....	1.5	.5	.5
	S	25.	26.	57.5	57.5	60.	62.	52.	21.	25.2
		92.5	64.	85.5	88.5	95.5	96.5	84.5	51.0	33.7
Barkhamsted	H	20	14	14	29	13	13	12	12	8
Bloomfield	H	147	142	149	143	149	141	94.5	77	49.5
	S	276	270	415	456	518	460	384	200	260
		423	412	564	599	667	601	478.5	277	309.5
Bridgewater	H	43.7	36.7	35	33.5	28.5	19.2	15.9	10.5	6
Brookfield	H	69.8	67.8	58.8	49.3	44.8	38.8	28.5	21	7
Canton	H	49.5	42	36	33.5	42	41.5	44	38.8	13.8
	B	.....	.....	.....	.....	.....	.....	3	.....	.....
	S	23	23	23	23	21	17	.....	.....	.....
		72.5	65	59	56.5	63	58.5	47	38.8	13.8
Cromwell	H	73	67	63	63.5	49.5	49.5	48.5	48.5	8.8
	B	40.5	35.5	23	23	14	62	55	57	57
		113.5	102.5	86	86.5	63.5	111.5	103.5	105.5	65.8
East Granby	H	528.2	472.7	528.7	481.7	420.7	427.5	466.9	447.2	276.2
	B	8.5	34.5	8.5	8.5	8.5	14.5	31.5	.....	.....
	S	127	128	163	167	262	251	289	216	263
		663.7	635.2	700.2	657.2	691.2	693.0	787.4	663.2	539.2
East Haddam	B	15	33.1	3.5	10	5.5	10.5	6.5	.....	.....
East Hartford	H	51	32.5	32.5	86.5	77.5	55	51	22	22
	B	2152.2	2067.2	2163.7	2065.2	1930.7	1834.2	1836.2	1389.4	1009.1
	S	.....	.....	183	390	487	318	186	115	130
		2203.2	2099.7	2379.2	2541.7	2495.2	2207.2	2073.2	1526.4	1161.1
East Windsor	H	8	8	8	124	35	49	11	79.8	3
	B	1996	1867.3	1834.3	1727.3	1841.8	1893.5	1959.3	1380.3	1035.9
	S	251	331	543	691	794	364	205.5	150	191
		2255	2206.3	2385.3	2542.3	2670.8	2306.5	2175.8	1610.1	1229.9

*Census of acres planted. Data collected in January, 1934, by enumerators in each tobacco town under the provisions of the Civil Works Act.

TABLE 4. ACREAGE OF TOBACCO BY TOWNS AND BY TYPES. 1925–1933—*Continued*

Town	Type	1925	1926	1927	1928	1929	1930	1931	1932	1933
Ellington	H	.....	.....	.....	25	15	15	3	3	.....
	B	688	625	678.5	650	686.7	811.8	885.5	573.3	341.5
	S	357	375	380.5	368	330	141	85	69	74
		1045	1000	1059.0	1043	1031.7	967.8	973.5	645.3	415.5
Enfield	H	400.5	363.2	394.3	457	441	439.5	408.6	350.1	164.1
	B	748.7	717.8	741.2	729.2	798.2	804.7	822.2	718	545
	S	243	325	412	632	562	604	577	398.5	225
		1392.2	1406.0	1547.5	1818.2	1801.2	1848.2	1807.8	1466.6	934.1
Glastonbury	H	20	.....	.....	44	37	3	3	7	.....
	B	1423.3	1367.8	1365.8	1329.8	1386.3	1428.7	1434.2	1055.4	681.8
	S	36	20	25	25	25	25	.....	.....	.....
		1479.3	1387.8	1390.8	1398.8	1448.3	1456.7	1437.2	1062.4	681.8
Granby	H	307	298	286	281	271.5	262	249.2	189.7	55.2
	B	12	12	12	12	16	16	10	10	10
	S	224	91	218	573	603	571	382	332	369
		543	401	516	866	890.5	849	641.2	531.7	434.2
Hartford*	H	.....	.....	85	35	35	.....	.....	41	40
	B	145	40	325	350	255	935	624	220	315
		145	40	410	385	290	935	624	261	355
Kent	H		84.1	75.6	70.6	57.8	50	41.2	22.2	9.2
Manchester	H	.....	.....	22	.....	22	.....	.....	.....	.....
	B	563.5	492	477	505	471.5	504	549.5	399.9	231
	S	225	214	278	315	321	228	110	156	188.5
		788.5	706	777	820	814.5	732	659.5	555.9	419.5
Middletown	H	4	4	8	11.5	13.5	9	9.5	2	.....
	B	27	27	29.8	24.8	21.8	21.6	20.6	7	2
		31	31	37.8	36.3	35.3	30.6	30.1	9	2
New Hartford	H	22.5	20.5	23.5	24.5	[illegible]	35	32	28.5	9
	B	.....	.....	.....	.....	.....	14.5	14	.....	.....
	S	37	39	35	36	34	4	.....	.....	.....
		59.5	59.5	58.5	60.5	59.5	53.5	46	28.5	9
New Milford	H	727.6	676.4	668.6	615	536.8	519.8	454.5	348.3	154.6

*This acreage was reported by Hartford firms but grown in other towns. The enumerators did not allocate it to the towns. No tobacco is grown in Hartford.

TABLE 4. ACREAGE OF TOBACCO BY TOWNS AND BY TYPES. 1925–1933—*Continued*

Town	Type	1925	1926	1927	1928	1929	1930	1931	1932	1933
Portland	H	182	146	142.5	142	137.5	112	109.5	102.5	52.5
	B	15	15	15	15	15	15	15	7	4.5
	S	.....	.....	2	10	93	145	149	187.5	156.5
		197	161	159.5	167	245.5	272	273.5	297.0	213.5
Roxbury	H	45.5	44.7	38.7	37.2	28	20	20	11	9
Sherman	H	58.5	48.5	48	43.5	47	41.5	40.5	26.7	9.5
Simsbury	H	255.5	213	242	225.3	212.3	189.8	218.5	163.5	73
	B	18	18	15	24	29	49	6	.....	.....
	S	390	520	706	690	674	550	380	181	209
		663.5	751	963	939.3	915.3	788.8	604.5	344.5	282
Somers	H	55.3	53.3	56.3	69.3	62.3	60.3	60.3	58.4	25.5
	B	166.5	161	169	182	180	208	238.5	140.8	73.8
	S	45	43	45	.....	.....	...	.	.....	.....
		266.8	257.3	270.3	251.3	242.3	268.3	298.8	199.2	99.3
Southbury	H	2.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	.....
South Windsor		.....	18	18	33	20.5	20.5	18	22	18
		3611.6	3421.6	3363.6	4523.3	3366.3	3364.5	3355.5	2449.2	2108.5
	S	50	187	274	240	343	123	35	57	67
		3661.6	3626.6	3655.6	4796.3	3729.8	3508.0	3408.5	2528.2	2193.5
Suffield	H	2047.5	2025.0	2053.5	2023.2	2099.7	2272.5	2295.1	2180.0	1373.6
	B	450.5	481.5	543.5	551.5	544	612	663	522.5	414.9
	S	375	228	291	404	487	251	363	174	213
		2873.0	2734.5	2888.0	2978.7	3130.7	3135.5	3321.1	2876.5	2001.5
Vernon	H	.....	.....	.....	14	14	.....	.....	.....	.....
	B	146	155.5	131	112	129.5	142.5	155	126.5	75.8
	S	62	25	60	70	82	73	80	75	36
		208	180.5	191	196	225.5	215.5	235	201.5	111.8
Washington	H	25	23.5	18	11.5	7	7	7	6	4

TABLE 4. ACREAGE OF TOBACCO BY TOWNS AND BY TYPES. 1925–1933—*Continued*

Town	Type	1925	1926	1927	1928	1929	1930	1931	1932	1933
Windsor	H	1091.2	1028	965.7	1044.2	967.2	893.2	936.3	864.4	458
		200.5	164.5	128	189	207	316	210	44	65.7
	S	768.5	985	1389	1369	1557	1687	1394	1140.5	1356.5
		2060.2	2177.5	2482.7	2602.2	2731.2	2896.2	2530.3	2049.9	1877.2
Windsor Locks		139.5	125	135.5	142	124	63.5	118	100.2	25
		307	285	285	329.8	297.5	363.8	383.8	151.4	110.1
		107	107	160	161	175	150	54	.....	.....
		553.5	517	580.5	632.8	596.5	577.3	555.8	251.6	135.1
Total for the state*	H	6531	6993	6236	6475	6072	5884	5829	5314	2883
	B	12735	12021	12312	13361	12204	13422	13280	9252	7082
	S	3622	3937	5660	6678	7428	6024	4758	3473	3764

*Discrepancies between these totals and those in Table 3 are partly due to the fact that these represent acres *planted* while those in Table 3 are acres *harvested*. Moreover these are census figures while those in Table 3 are crop estimates

TABLE V. AVERAGE ANALYSES OF MATERIALS WHICH MAY BE USED IN A TOBACCO MIXTURE

Materials	Nitrogen (N)	Phosphoric Acid (P_2O_5)	Potash (K_2O)	Magnesia (MgO)	Lime (CaO)	Sulfate (SO_3)	Chlorine (Cl)
Cottonseed meal	6.6	3.	2.	.7	.3	....	....
Castor Pomace	5.0	2.	1.	.8	.8	....	.8
Linseed meal	5.8	2.	1.	.7	.5	....	....
Dry ground fish	8.6	7.	1.1	.4	8.0	5.0	.2
Hoof and horn meal	15.0	......	...	.....	...	....	....
Peruvian guano	15.0	9.	2.	.....	...	....	1.6
Urea	46.0	......	...	.....	...	....	....
Calurea	34.0	......	...	.1	14.0	....	....
Nitrate of Soda	15.4	......	...	.....	...	....	.5
Nitrate of Lime	15.4	......	...	.3	28.0	....	....
Nitrate of Potash (German)	12.3	......	44.	.....	...	....	.6
Nitrapo (Nitrate of Soda and Potash)	14.5	......	12.	.....	...	....	.7
Ammonium Phosphate (Ammophos A)	11.0	46.	...	.....	...	....	....
Ammophos (20–20) (Ammophos B)	16.5	20.	...	.....	...	....	....
Precipitated bone	....	38.	...	.....	45.0	.7	1.5
Steamed bone	1.7	28.	...	.....	33.0	.4	.2
Bone meal	2.5	24.	...	.....	28.0	.4	.2
Superphosphate	....	16.	...	.....	28.0	5.4	....
Cottonhull ash	....	3.	28.0	5.	11.0	2.4	.2
Wood ashes	....	2.1	6.5	5.7	36.0	2.4	.5
Sulfate of potash	....	......	48.0	1.3	.2	43.6	1.6
Double manure salts	....	......	26.0	11.	...	46.7	2.0
Carbonate of potash	....	......	64.0	.....	...	....	.5
Ground tobacco stems	1.3	.7	5.5	1.5	10.0	1.2	....

With these analyses before him and keeping in mind the principles on which the mixture should be based, the grower may figure out dozens of good formulas.

If he buys ready-mixed goods, he should insist that they conform to the principles laid down above.

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