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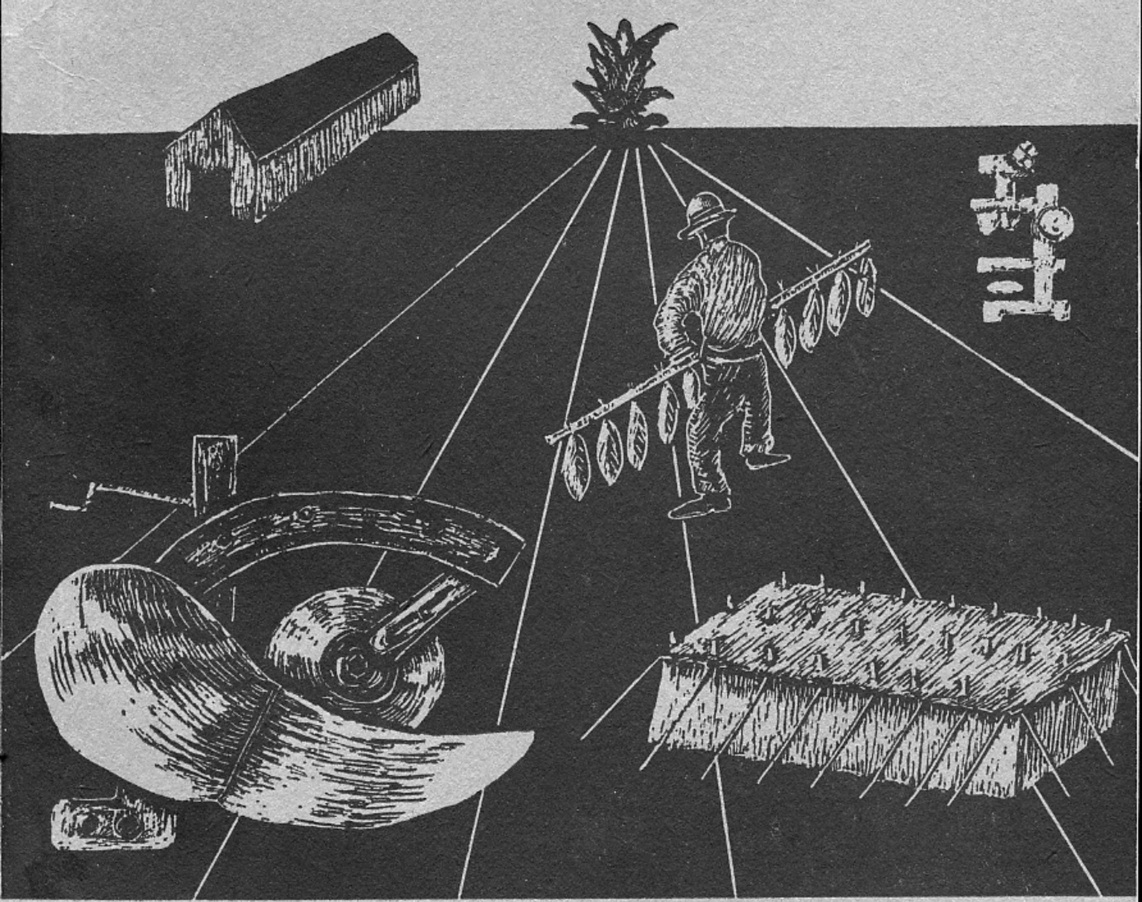
GROWING TOBACCO in CONNECTICUT

by P. J. ANDERSON



THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION - NEW HAVEN

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The Connecticut Agricultural
Experiment Station
New Haven

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FOREWORD

It has been 18 years since a general bulletin on tobacco growing in this State was published. That bulletin, "Tobacco Culture in Connecticut", Bulletin 364 of The Connecticut Agricultural Experiment Station, is now out of print but the need for such a publication is indicated by the many requests that are received. Moreover, the subject matter of Bulletin 364 requires considerable revision because of the many advances and changes that have been made in our knowledge and practices in growing tobacco. New diseases and insects, such as blue mold, nematodes and aphids, have invaded the State in those 18 years; new fungicides and insecticides have supplanted the old; new methods of curing, irrigation, seedbed sterilization, field fumigation, and insect control by aircraft are a few of the many changes that have occurred, and the reader will look in vain for information on them in Bulletin 364.

To be sure, these subjects are covered by several special bulletins and circulars but all this information has not previously been summarized in one single publication. Such is the goal of the present bulletin with the hope that it may serve as a convenient and quick reference source for growers who have not time to hunt up the separate publications or to whom they are not available.

This bulletin is designed primarily for the use of tobacco growers. Details and tabulation of experiments, on which many of the statements in this bulletin are based, are not included. Also omitted are those phases of tobacco production which are of interest only to agricultural scientists, such as the chemistry of the green plant, the chemistry of the curing and fermentation of the leaves, physiology and anatomy, and the details of tobacco breeding. There is also no discussion of the processing of the crop after it has left the farm and is in preparation for the manufacture of cigars.

The growing of tobacco has been a predominant agricultural industry in Connecticut for three centuries. About 18,000 acres of the best agricultural land in the State are currently planted to tobacco, almost all of it located in the broad, flat and fertile valley of the Connecticut River. The growing and processing of the crop affords full or part-time employment to 25,000 people. No field crop in Connecticut costs as much to grow: $500 to $800 an acre for the open field types, and $2,000 an acre for shade, the wrapper type. This does not include the processing costs after the crop leaves the farm and before it appears in the finished cigar. After processing, the crop is sold to the manufacturers for $35,000,000 annually. Since the largest part of this money is in turn expended for labor and fertilizer and other supplies purchased locally for the raising and processing of the crop, tobacco plays a leading role in the economy of central Connecticut.

Growing Tobacco in Connecticut

by P. J. Anderson[1]

HISTORICAL BACKGROUND

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 shrink back along its banks again in times of low prices. About 1840 another center of concentration of acreage began in the Housatonic Valley. Today the commercial production is mostly in the Connecticut Valley.

Connecticut, however, owes its preeminence in the tobacco world to the cigar. The heyday of commercial expansion began when cigar smoking became popular at the beginning of the 19th century. Previous to 1800, consumption of cigars in this country was limited to an unrecorded but probably small quantity of imported "havanas". In the first few years of the 19th century, the farmers' wives began to roll cigars in their homes using the home-grown leaf. These were the first domestic cigars. They were peddled in wagons from village to village up and down the river and throughout all the eastern states, along with tinware and various other household articles. But the home industry grew so rapidly that the rolling of cigars gradually was transferred from the farmers' houses to small shops or factories which sprang up in all the river towns. The first two cigar factories were set up in Suffield and East Windsor in 1810. 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 which were making cigars 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

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[1]Chief, Tobacco Laboratory, Windsor.

renewed prosperity. The next decade, however, saw an irregular downward trend in acreage reaching an all-time low in 1934. The acreage increased in the following years and has since remained fairly steady.

TYPES OR VARIETIES

Three varieties of tobacco are now grown in Connecticut. Two of these, Broadleaf and Havana Seed, are commonly called "out-door", "open field" 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 still others, plug types. 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 hail-cut, 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. These correspond 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 that 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 only very fine veins, and a pleasing luster and finish, which 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, shade is grown for wrappers, while the other two, Havana 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 today. 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 19th 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 half 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 coming, the tobacco growing business in New England entered a period of expansion and prosperity which continued for nearly a hundred years.

Figure 1. Broadleaf plant.

The Barbour variety of Broadleaf is still grown in some localities, but during the past century new kinds have been 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 sub-types of Broadleaf; for example, John Williams, Bantle, Frank Roberts, and Hockanum.

The bulk of the Broadleaf in Connecticut is grown east of the Connecticut River in the towns of Glastonbury, East Hartford, Manchester, South Windsor and East Windsor. A scattered acreage is found in the Havana Seed sections of Connecticut and Massachusetts. The plant is principally characterized by the drooping habit of its leaves (Figure 1). The leaves 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 acreage of Broadleaf in Connecticut for the 10 years, 1940 to 1950, was 8,180. This is much less than the acreage grown 20 years previously; the acreage for 1925 was 18,400. The average yield of Broadleaf for the 10 years, 1940 to 1950, was 1,620 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, today 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 have 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. 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 (Figure 2).

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 use Connecticut Valley Havana Seed binders. The

Figure 2. Havana Seed plant.

stemming grades of this variety are used for scrap chewing tobacco just as those of Broadleaf are. The average Connecticut acreage for the 10-year period 1940 to 1950 was 2,630, about one-half as many acres as were grown in Massachusetts those same years. Like Broadleaf, the acreage has been greatly reduced in the last 25 years; Connecticut grew 8,100 acres in 1923. Average yield in Connecticut for the 10 years, 1940-1950, was 1,620 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.

There are many local strains with real or imaginary differences. All of the common strains of 30 years ago were susceptible to black rootrot and have mostly been supplanted in recent years by resistant strains, among which K1 and H. S. 211 are presently most popular.

Shade (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. After a few years of 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.

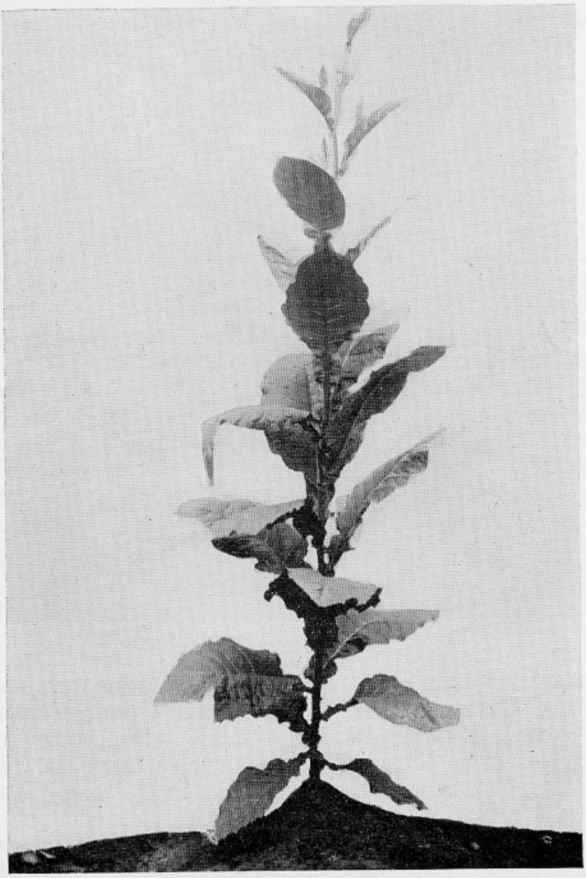

Figure 3. Shade plant.

The variety is identical to the tobacco grown generally in Cuba today 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 (Figure 3).

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 the highest priced tobacco grown in America. The price of Sumatra is somewhat higher but only because of the high import duty. The average yield for the last 10 years, 1940-1950, was 960 pounds to the acre. Average acreage for Connecticut for the 10 years, 1940-1950, was 6,640 acres.

The common Cuban strain was for many years the only one grown under cloth but in recent years new higher-yielding strains have been developed and are rapidly replacing the old Cuban. They produce 50 per cent more tobacco to the acre, are lighter and more uniform in color, and have more resistance to diseases. Connecticut 15, Connecticut G4, Connecticut 49, and Fowler Special are now grown on more acres than common Cuban.

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 tobacco soils are sandy loams of varying degrees of fineness, classified in the Merrimac, Agawam, Enfield and Manchester series, and, to a lesser extent, in the Hartford and Cheshire series. The Merrimac and Agawam types comprise the flat terraces along the Connecticut and Housatonic rivers. The Enfield and Manchester soils occur on gently rolling, somewhat higher areas. A little tobacco is grown on Wethersfield loam and Suffield clay loam but these two types are generally too heavy for producing highest quality tobacco. Most of the tobacco land is so flat that erosion is seldom a serious problem.

The Merrimac coarse sandy loam is used for shade tobacco but is not so suitable for open field 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 do not permit sufficient drainage and are usually unsatisfactory. Gravelly or coarse sandy subsoils permit too much leaching of the fertilizer and favor 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 soil types, being about 0.15 per cent. This small amount becomes available very slowly, making heavy nitrogen fertilization necessary.

The quantity of phosphoric acid on old tobacco soil is very high, due to accumulation. New tobacco soils (those 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 grown 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. Although a certain amount of phosphorus becomes "fixed", "availability" tests also show that there is a corresponding increase in available phosphorus. Hence, the addition of phosphorus in the fertilizer is of less importance than nitrogen or potash additions except on relatively new fields.

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 5.0 and 5.6 pH. Those about 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 to the ash, commonly called "muddy" or "bricky". The more acid the soil, the greater the absorption of manganese by the plants.

SEEDBEDS[1]

The seed is started during the first weeks of April in long, narrow beds covered with glass sash or with cloth (Figure 4). The size of the ordinary glass sash is 3 by 6 feet, but some growers prefer a wider bed and use 8-foot, or even 10-foot, sash. From the standpoint of convenience in weeding, pulling plants, and other seedbed operations, the 6-foot width is preferable. The length of the bed varies according to the 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 more efficiently 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, most growers use timber specially treated to prevent decay. Creosote is not suitable for this treatment because its fumes injure the young plants.

Transparent or translucent plastic materials are used to some extent as substitutes for glass in the sash. Experiments conducted for many years at the Tobacco Laboratory with a considerable number of these plastics show that just as good plants can be grown under plastic as under glass. The weakness of most of the plastics tried has been in durability. They show great variation in this quality. Some which have no reinforcing network last only one or two years; with cotton textile reinforcement, they last longer. The most satisfactory have wire screening covered with the plastic material. Plastic sash possesses some advantages over glass sash: (1) Plastics are much lighter weight so that they can be taken off and put on in less time and with less back-breaking labor; (2) there are no broken panes to be constantly replaced; (3) they can be handled more roughly and rapidly since there is no glass to be broken; (4) the final cost of plastic sash is less than for glass sash if the type of plastic is durable enough to last five years or more.

Instead of glass or plastic sash, a fine-mesh white cotton cloth may be used to cover the beds. It is a common but not universal practice to treat this cloth with linseed oil before putting it in place. 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

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[1]For more detailed discussion, see Conn. Agr. Exp. Sta. Circ. 175, "Tobacco Seedbeds", 1950.

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.

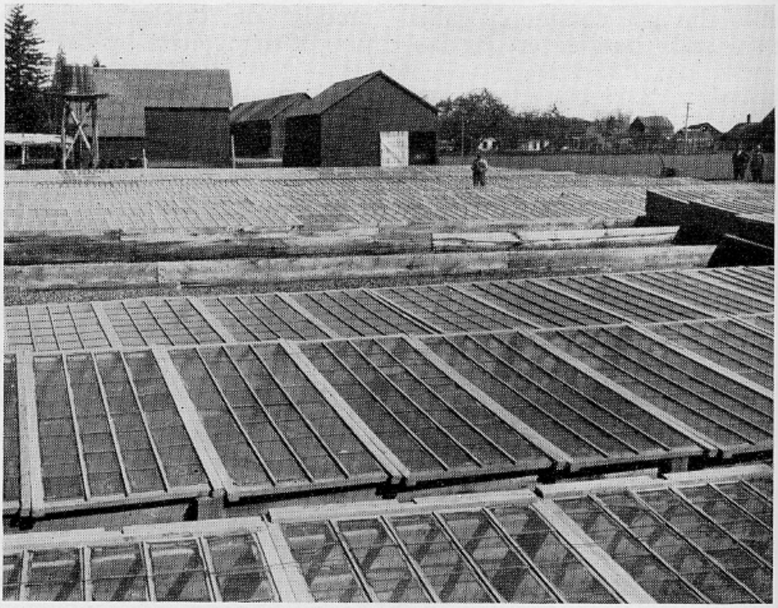

Figure 4. Tobacco seedbeds.

A protected spot that 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.

The beds are made in the same place year after year without change of soil. As long as the measures suggested below for maintaining soil fertility are practiced, such continuous use is generally advantageous and attended by no ill effects. Sometimes the soil becomes infested with certain insects or disease organisms, or angleworms, or deteriorates for no apparent reason, especially when not sterilized yearly. In this case, the grower may find it best to replace the soil in the beds with new soil, or to select a new location.

Sterilizing the Soil

Since many pathogenic organisms and noxious insects are soil borne, their injuries can be eliminated or reduced by killing them in the soil before the bed is seeded (soil sterilization). This same operation also kills weed seeds and thus eliminates the need of hand weeding. Two methods of sterilizing tobacco beds are in general use: steaming, and treatment with chemicals.

Steam Sterilization

Soil may be steam sterilized either in late autumn or in spring. The advantages of fall sterilization lie in better distribution of labor, since the spring rush is avoided, and reduction of the danger of ammonia injury. The disadvantage of fall sterilization is that the soil may become reinfested during the winter with weed seeds, insect pests and fungi. Hence, the operation should be delayed until as late in the fall as possible.

Injury to the germinating seed sometimes results when the bed is seeded immediately after steaming in the spring. It is best to wait a few days before sowing; a lapse of 10 days is desirable, if it does not delay the time of seeding too seriously.

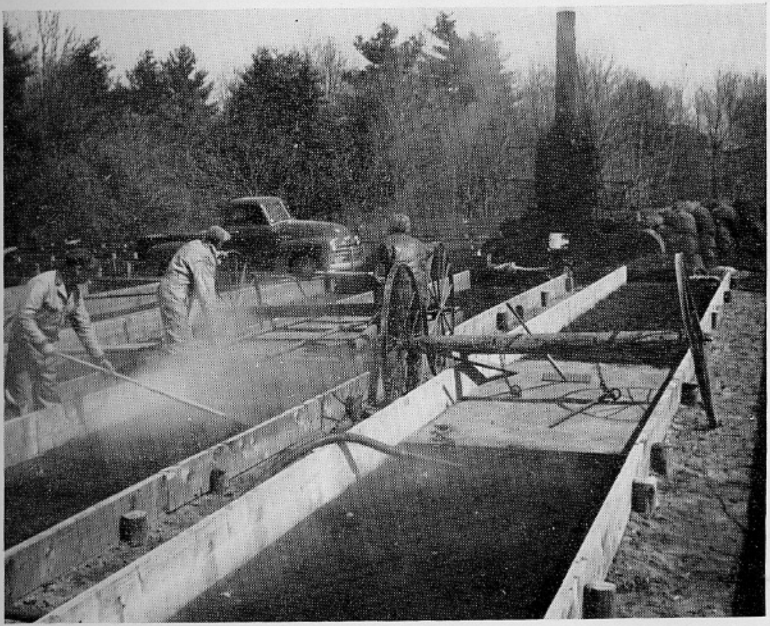

Figure 5. Sterilizing the seedbed soil by steam. (*Photograph courtesy of The Shade Tobacco Growers Agricultural Association, Inc.*)

Of the various ways of steaming soils, the only one used in Connecticut is the "inverted pan" method (Figure 5). A galvanized iron pan, reinforced 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. Steam under high pressure from a steam boiler is forced through a pipe into the end of the pan, penetrating into and sterilizing the soil. The method is too well-known to require further description except for the following precautions.

The soil should be well worked and loose before steaming. Any manure or humus to be added should be applied in advance. Commercial fertilizers may be added before or afterwards. A moderately dry soil is more easily sterilized than one that is water-logged, because steam penetrates mud very slowly. Twenty to 30 minutes with a boiler 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 inches, the steaming is sufficient. Otherwise, the length of steaming should be prolonged. The soil should not be worked deeply after steaming because there is danger of turning up some of the unsterilized earth.

Chemical Sterilization

Of the various chemicals that have been tried, only two have come into general use in Connecticut; chloropicrin (sold as "Larvacide") and methyl bromide.

Chloropicrin does not give quite as good weed control as steaming but in all other respects has been satisfactory. The principal advantage of this method is that the soil can be sterilized in one-tenth of the time it takes to sterilize it with steam. Thus, there is a big saving in labor. Moreover, the cost of the apparatus is not as great as the cost of a steam boiler and steam pans, and it can be handled and housed in less space. In small beds, chloropicrin can be applied (spot application) with a small hand applicator, a three-foot long injector built on the principle of a hypodermic needle, spacing the injections about 10 inches apart. It requires 16 to 20 pounds of chloropicrin to 1,000 square feet of bed. The volume of each injection can be regulated by a "stop" on the plunger bar and should be calibrated before starting application. For larger beds, it is more economical to use a motor-driven continuous flow applicator such as that shown in Figure 6. Chloropicrin should be applied three to four inches below the soil surface.

If chloropicrin is used, the beds should be sterilized in the *fall* because the soil is too cold in the early spring. In addition, there is danger of killing the young seedlings because the gas remains in the soil between application and seeding. The soil should be fertilized and pulverized before treatment. In dry weather it should be thoroughly watered a week or two before sterilizing. This causes weed seeds to begin germinating and makes them easier to kill. The soil should be moist but not muddy at time of treatment.

As soon as possible after fumigation, the soil should be raked level and watered so that it is wet to a depth of one inch. This seals the top and holds the gas in the soil. The seal can be improved by spreading several thicknesses of old shade cloth over the surface before watering. Another very effective method is to cover the surface with a 1½-inch layer of shredded, weed-free black humus and water it thoroughly.

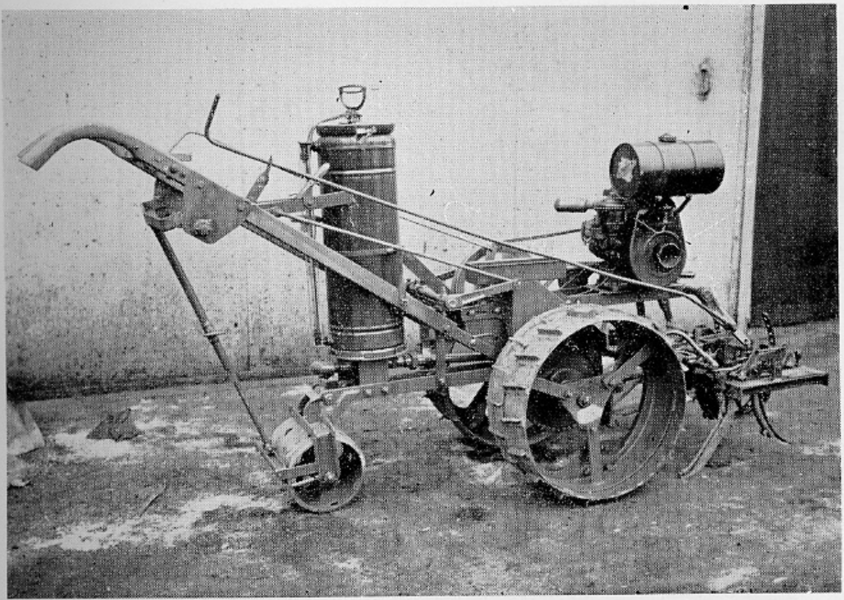

Figure 6. Motorized applicator for fumigating beds with chemicals.

Methyl bromide. At low temperatures or under pressure, methyl bromide is an odorless clear liquid, but it quickly vaporizes at temperatures above 43° F. It disperses rapidly and has remarkable penetrating powers. Its killing action is rapid and it is quickly dissipated after fumigation is completed. Thus, there is a minimum of delay in seeding the beds. It kills all weed seeds (except clovers) as well as insects, nematodes, and soil-borne pathogenic fungi, such as those causing rootrots. It stimulates the seedling to a more rapid healthy growth. Directions for application are given below.

The soil should be worked up loose to a depth of five to six inches. It should be moist enough for good growth of plants: neither dry and dusty nor wet enough to puddle. If manure or humus is to be used, it should be incorporated before treatment. Commercial fertilizer may be added before or after.

Soil should not be fumigated when at a temperature below 50° F. Best results are obtained if it is 60° or higher. It may be fumigated in fall or spring.

A gas-proof covering over the soil to be fumigated is necessary to confine the vaporized material. It is extremely important that this be free from holes because much of the gas will escape in a short time through a very small hole. We have used tarpaulins made from rubber, sisalcraft paper and, most recently, a plastic (polyethylene or vinyl film). Rubberized tarpaulins are too expensive. Sisalcraft paper is cheap but tears too readily. The plastic cover is inexpensive and not easily torn.

The cover should be placed several inches above the soil to allow free diffusion of the gas to all parts of the bed. If the cover is wide enough, it may be stretched across and over the side boards and the edges weighted down with soil outside the beds. In this case there will be little or no need of further support for the cover, since the

Figure 7. For fumigating with methyl bromide, the bed is covered with a gas-proof tarpaulin.

height of the side boards keeps it off the soil. If, however, the cover is not to be drawn over the side boards (the edge being anchored inside the boards), it is best to place crates, boxes, pipe, or any other objects that are convenient along the center of the bed. The edges of the plastic cover are pressed down and kept tight by the weight of "sand snakes"—canvas tubes of about 4 inches diameter and 6 feet long, filled with dry sand (Figure 7). This method allows the use of a much narrower cover than is necessary when it is stretched over the side boards. The cover should be as long as practicable—a 100-foot length is convenient.

The gas is forced under the cover through small flexible saran tubes. Before the cover is placed in position, these tubes, 4 to 6 feet long, are laid with one end in a metal receptacle, such as a pan, pail or trough, near the center of the bed, and the other end projecting over the side of the bed. The purpose of the receptacle is to hold the liquid until it evaporates. The end of the tube should be secured by a weight or other means, else it may be dislocated by the rush of the liquid as it comes from the can. The methyl bromide is purchased in small one-pound cans. A special can opener, called a Jiffy applicator, is attached to the free end of the saran tube and the can slipped into the applicator. By pressing a small lever with the thumb, the can is punctured and the liquid—under pressure in the can—rushes out through the tube and into the receptacle where it is immediately vaporized. The can empties itself in about a minute and then the applicator is removed and attached to the next tube where the process is repeated. After removal of the applicator, the exposed end of the saran tube should be plugged to prevent escape of the gas.

The cover should be left over the beds for 24 hours. One and one-half pounds of methyl bromide is sufficient for 100 square feet of bed.

Fertilizers

The constant removal of thousands of seedlings with their roots and adhering soil from a small area depletes the soil rather thoroughly of nutrient elements. The seedbed is as completely robbed of its plant food every year as is the field where the crop is grown to maturity. However, the seedling roots do not forage as deeply in the soil as field plants and it is essential to have an adequate food supply in the layer close to the surface.

The actual nutrient requirement of the seedbed is essentially the same as for the field. No special mixtures or mysterious formulas are needed. The main difference is in the *time* of application.

Many successful growers use no fertilizer, or at most a very light application, when fitting the bed soil for seeding in the spring. The fertilizer is applied either during the previous summer and fall or after the plants have germinated and started to grow. An excellent and commonly practiced plan is to cover the beds with a heavy coat of stable manure after the pulling season is over. This may be left on the surface until fall, or even spring, or may be plowed under at any convenient time in the summer. It will be pretty thoroughly rotted before time to seed the beds the next spring. Some prefer to supplement this by an application of regular tobacco mixture or cottonseed meal in the fall, but manure alone is sufficient. If a regular tobacco mixture or cottonseed meal is used instead of manure, or as a supplement, it should not exceed ½ to ¾ pound to a square yard of bed.

In some cases the growing seedlings may later show symptoms of nitrogen or potash starvation. If the difficulty is nitrogen starvation, this may be remedied by soaking the beds with nitrate of soda solution made by dissolving 2 to 3 pounds in a barrel of water; the same amount of nitrate of potash may be applied if the trouble is potash starvation. A gallon of the solution to a sash should be sufficient. After treatment, the solution should be washed off the leaves by sprinkling with water. Top dressings are sometimes made with fish meal, "Swiftsure", "Vigoro", or other quick-acting mixtures.

It is a common practice in bed preparation to add shredded humus or black swamp soil, covering the surface with a one-inch layer and then working it into the top soil. This improves the mechanical condition of the soil and is beneficial, but adds very little plant food.

If beds have been in the same location for many years, it is a good practice to renew the soil occasionally by bringing in soil from some fertile field. A complete soil test is useful in detecting deficiencies of nutrient elements in the seedbed soils.

Preparation of the Soil

If the soil was properly cultivated, pulverized and levelled during the sterilizing operation, very little additional work is necessary to get it ready for seeding. The surface soil should be raked and pulverized to a depth of only two or three inches. Deeper cultivation should be avoided since there is danger of bringing to the surface some of the unsterilized soil. To make the surface firm, it may be rolled either before or after seeding. Rolling is particularly essential if a rototiller has been used. The surface is made as level as possible so that there will be no pockets into which the water will settle after seeding. Too, there should be no slope from one side to the other.

Sowing the Seed

Most seedbeds are sown during the first half of April. There is nothing to be gained by seeding earlier than this, even though it can frequently be done in March during early springs.

The seed may be sown dry or it may be pre-sprouted. The only advantage of pre-sprouting is that plants can be pushed ahead and may be ready for setting in the field a few days earlier. For pre-sprouting, a weighed quantity of seed is mixed with some fine absorbent organic material, such as sifted rotted wood punk (apple tree punk is an old favorite), ground cocofibre or black swamp humus. The bulk of the absorbent should be 10 to 20 times as much as the seed. The mixture is placed in jars and moistened with as much water as it will absorb without an accumulation in the bottom of the jars. The jars are kept in a warm room until the seeds crack and the little white primary roots can be seen pushing out. They are then ready to distribute in the beds. Knowing the weight of dry seed added to each jar, the square feet of bed on which each should be distributed can be calculated easily.

It pays to have the seed tested for germination before the beds are sown. Percentage of germination may be learned by sending a sample to the Tobacco Laboratory at Windsor, or the grower can easily make his own tests. One hundred seeds are counted out and kept on a moist blotting paper or filter paper in an enclosed dish in a warm room for 14 days. The dishes should be at least in duplicate to get an average. As fast as the seeds show the white emerging rootlets, they are removed. The number of seeds which have failed to germinate at the end of 14 days is subtracted from 100 to give the percentage of germination. Any lot that germinates less than 70 per cent should not be used. Those that germinate above 90 per cent are excellent.

If dry seed is used, it is first mixed with a much larger amount of some dry diluent, such as sifted sand, coal ashes or bone meal, since this insures better distribution. Use of a white diluent will show plainly the part of the bed that has been sown.

Figure 8. Sowing the seed after mixing with wood punk.

A standard sowing rate is 1 ounce (3 heaping tablespoons) of seed to 1,000 square feet of bed area. A heavier rate makes the beds too thick, with resulting spindling, weak plants. Thick stands invite diseases. The seed, with diluent, is spread by hand as evenly as possible over the bed (Figure 8). A measured amount of seed is sown on each bed or each portion of a bed to insure uniform stand. Some growers divide the seed for each section into two equal lots and sow the bed twice to make it more uniform.

After distribution, the seed is barely covered by very light raking. Some growers rake the rolled soil before sowing and then depend on watering to cover the seed. Regardless of the method practiced, it is essential that the seed be very close to the surface of the soil or only half buried. The bed is next watered carefully with a fine sprinkler nozzle, going over it several times to avoid puddling but still wetting the soil thoroughly. Some prefer to cover the soil with a layer of shade cloth before watering. This prevents washing, holds moisture and helps to prevent the soil from drying out so quickly in spots. The cloth should be removed just as soon as the first green plants come through it. The beds are covered with sash just as soon as sown. It is a good practice to cover the sash with several thicknesses of shade cloth to furnish partial shade until the plants show green; this practice, however, is not essential to success.

Watering

Proper watering during the early seedbed period is a "must" for good even beds. The germinating seeds are close to or even directly on the surface of the soil. If they dry out after the rootlets have started and before they get established in the soil, they die. Bare spots in growing beds and uneven stands are mainly due to allowing spots to dry out during this critical period, thus killing the seedlings. Under some conditions it is necessary to water the beds twice a day to prevent the appearance of dry spots. A sprinkler nozzle with fine holes is best and the force of the water must not be so strong that it will wash the seeds about and deposit them in pockets. Overwatering will have the same effect.

After the plants have become established and have four to six leaves, the system of watering may be changed. Water less often but apply more water each time. As the plants become larger, they will consume larger quantities of water. They should always have enough water to prevent wilting. However, overwatering should be avoided because it encourages bed rot, mildew and wildfire, and makes the plants too tender. It may also leach the nitrogen out of the soil.

Several systems of watering through a water pipe running lengthwise of the bed beneath the sash and fitted every two feet with small spray nozzles have been tried and at least one of them is coming into general use. This seems to be a good method since it eliminates the labor and time of raising or removing the sash. Moreover, the fine mist of these small nozzles does not cause washing of the soil as larger nozzles tend to do. With this system a whole bed of any length can be watered in five minutes. Objections to some of these systems have been clogging of some of the fine nozzles and excessive water deposited in some spots.

Ventilation

If beds are not sufficiently ventilated, the air inside becomes too humid and the plants are forced and tender. Such plants do not develop a large enough root system and are not hardened sufficiently to resist the dessication they experience when transferred to the field. Moreover, the humid air favors growth of "green mold" algae and various disease-producing fungi mentioned in the next section of this bulletin. Too, on bright sunny days the air under the glass may become too hot for the plants to endure unless the beds are ventilated. The temperature in the bed should never be allowed to rise above 95° F.

There are many ways of ventilating beds and all have their advocates. The commonest way is by raising one end of every second sash on one side of the bed, usually the higher side. The raised end is supported above the top of the board on wooden blocks 2 by 4 by 6 inches, such blocks furnishing a choice of three heights to which the sash may be raised to give the desired size of opening. Alternatively, the blocks may be placed under the side of each sash (Figure 9) and supported on the first mullion of the next sash. Another method is to place a loose board 4, 6, or 8 inches wide between each of the sash when the bed is first made up. These boards can then be taken out whenever ventilation is needed.

The beds are usually opened for ventilation during the day and closed at night. During warm nights they may, however, be left open. When the plants are nearly large enough to start transplanting, it is customary to remove the sash from the beds during warm days or even at night to "harden off" the plants.

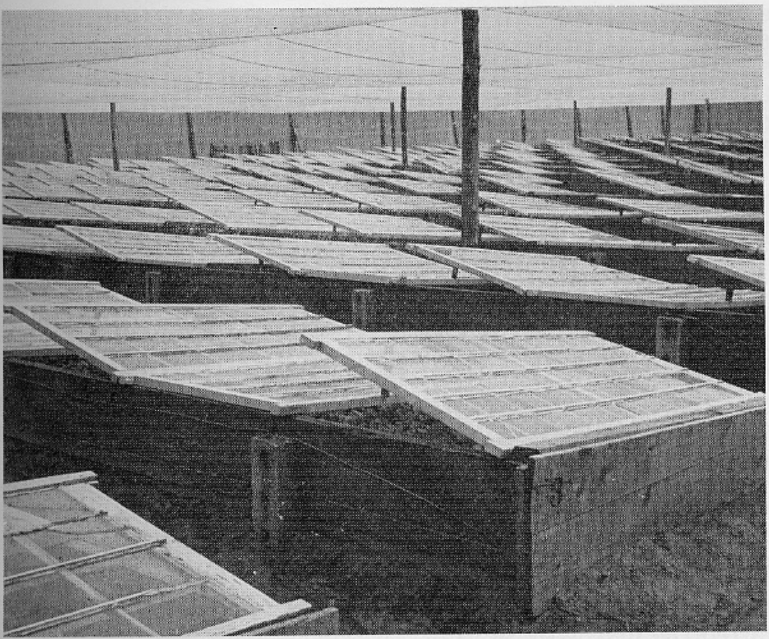

Figure 9. One method of ventilating beds. Bed area is protected by shade cloth.

In the first stages before the seeds have germinated, it is usually not necessary to ventilate at all, unless there is trouble with molds. After the first tiny green leaves appear, the beds should be ventilated at least a few hours every day except on unseasonably cold windy days. More seedbed troubles arise from too little ventilation than from too much.

Control of Diseases and Insects in the Seedbeds

Every effort is made to keep the beds free of diseases and insects, not only because they may damage, kill or delay the seedlings, but because diseased plants taken from the bed are the principal source of many field diseases. The most important bed diseases are wildfire, bed rot, blue mold and mosaic (calico). The most important insects are cutworms, flea beetles and aphids. All of these and several other diseases and insects of less importance are discussed in later sections of this bulletin (page 57). In this section only a general outline for preventing damage from them is presented. Almost all pathogenic fungi and insects are destroyed in the soil by steaming or fumigation, the first step in the pest control program for beds. It is the pests that make their entrance after the beds are sown that necessitate the prevention program thereafter. (Consult also the pest control chart on page 104).

Wildfire is the first disease that needs attention in the beds. The first control measure is to spray the beds with a copper fungicide when the plants are very small and just showing two to four leaves. Bordeaux mixture, 4-4-50, applied at rate of 1 gallon to 100 square feet is the standard spray. Most growers prefer to purchase a commercially prepared copper spray. This should be diluted with water to equal the above standard in terms of metallic copper. The percentage of metallic copper is printed on the package and usually the dilution rate to equal a 4-4-50 Bordeaux is indicated. If the commercial preparation contains 12 to 14 per cent of copper, it requires 8 pounds to 50 gallons of water, 24 to 26 per cent requires 4 pounds, 48 to 51 per cent needs 2 pounds.

This spray is primarily for the control of wildfire but is also useful against early damping-off and green mold.

In order to avoid burning, beds sprayed with copper should be left open until the copper has dried on the leaves. The copper spray should be repeated after seven days. No further copper applications are necessary unless wildfire has become prevalent in the neighborhood, in which case the spray should be repeated at weekly intervals. Since wildfire has not been of serious consequence in Connecticut in recent years, the copper spray is omitted by many growers.

For the control of **blue mold** and **bed rot**, spraying twice a week is started the first week in May. Either of two fungicides is standard for this: (1) *ferbam*, sold under a variety of trade names, such as "Fermate", "Carbam-Black", "Nu-Leaf", "Ferradow" and "Carbamate", and (2) *zineb* marketed as "Dithane Z-78" or "Parzate". Ferbam is stirred in water at the rate of 1 pound in 50 gallons and zineb at the rate of ¾ pound in 50 gallons. This concentration should be doubled when the plants become half grown. About 2 quarts of spray is needed for every 100 square feet of bed, but a better measure of the quantity needed is the appearance of the spray on the leaves. Every leaf should be covered with droplets of the liquid. Any kind of a spray pump which produces a fine distribution of the liquid is satisfactory (Figure 10). These fungicides may also be purchased and applied with equally good results in dust form. The rate of application is adequate when all leaves show a good coating of dust.

In view of the danger of spreading blue mold to the fields, it is important that the regular spray program be continued all during the time the plants are in the seedbed.

Figure 10. Spraying the seedbeds to control blue mold. Small power sprayer with spray gun.

Mosaic (calico) is not often seen in the beds, but is often more prevalent than it appears. While mosaic does not seriously injure plants in the seedbeds, they may be the source from which the disease spreads to the fields where it causes serious losses. No sprays or dusts are effective against calico once it becomes established, but some precautionary measures aid in preventing its introduction and spread in the beds:

1. Tobacco refuse from curing sheds, sorting rooms and other sources should never be brought to the beds because such refuse is often a carrier of the mosaic virus.

2. Workers should not smoke or chew tobacco while they are weeding, pulling, setting, or otherwise handling the plants. The virus on their hands from such sources may easily infect the growing plants.

3. Plants should never be set in the field from a bed known to have any mosaic plants in it. Affected plants are difficult to spot in the bed. If just a few are seen, it is very likely that there are many others in the same bed which do not yet show the symptoms. Rather than to risk spreading mosaic in the field, it is better to discard the whole bed.

Cutworms sometimes cause considerable damage in seedbeds. When they are found, the beds may be dusted with a 10 per cent toxaphene dust at the rate of 1 pound to 25 sash or until there is a white coat of dust on all plants. An older remedy is to scatter Paris green bran bait, such as is used for field control, over the beds. This, however, usually causes some leaf burning.

Flea beetles frequently damage the seedlings by eating "shot holes" in the leaves late in the seedbed period. When they appear, they are easily killed with DDT. The beds may be dusted with a 5 per cent DDT dust, or since this is the period when the beds are being sprayed for blue mold, it saves time to add DDT to the blue mold spray. One pound of 50 per cent wettable powder (or its equivalent) added to 50 gallons of spray is adequate. Marlate, rotenone or lindane may be used if preferred.

Aphids do not cause serious damage to plants in the bed but they are often present in small numbers. Even a light infestation which would ordinarily escape notice can be the means of distributing this pest to the fields where great damage may result. Regular applications of DDT, as for the control of flea beetles, will keep aphids in check. If they appear in the beds, they may be controlled by dusting with 1 per cent parathion.

Ants, earthworms and **springtails** occasionally cause some damage in the early seedbed period. They may be controlled by dusting the soil with 5 per cent chlordane at the rate of ½ pound to 100 square feet.

Pulling the Plants

When the seedlings have grown to a height of four to six inches, they are ready to be set in the fields. Before transplanting, however, they should be "hardened" in order to help them withstand better the change from the sheltered life in the beds to the more severe weather in the field. This is done by keeping the glass off the beds night and day as much as possible for a week or more, closing them only for frosty nights or heavy storms.

Before pulling, the beds are heavily watered until the soil is muddy and the plants can be pulled with no snapping of roots. If there is plenty of humus in the soil, each plant will come out with a ball of soil clinging to the roots. Only the larger, stronger plants are taken. Grasping the tip of the tallest leaf between thumb and finger, a sideways pull removes the seedling without seriously disturbing adjacent plants.

After the stand of plants is thinned out by a pulling, the remaining plants have a tendency to fall over or tilt. If they are left exposed to the weather, such plants develop crooked stems as the growing buds turn upward. Crooked plants are unsuitable for setting. If, however, the glass is replaced on the beds immediately after pulling, the stalks straighten more quickly and are better for setting.

In order to stimulate growth of the smaller plants left after pulling, it is a common practice to topdress the plants several times during the pulling period with fertilizer. "Swiftsure", fish meal, nitrate of soda or nitrate of potash are most often used. Often, this is not necessary, but it is a good practice if the beds are not furnishing plants fast enough. The fertilizer should be completely washed from the leaves into the soil by sprinkling them thoroughly after such treatment. A thrifty bed may be pulled over every three or four days.

Destroying the Plants in the Beds at Season's Close

After the last re-stocking of the fields, there are usually numerous plants left in the beds for which the grower has no further use. If allowed to grow in the beds all summer, these plants may become diseased and infested with insects. Many field infestations can be traced directly to such neglected beds. It is, therefore, best to destroy these plants just as soon as the grower is sure he will have no further need for them. This may be done by pulling or hoeing them out. A better method is to kill them with formaldehyde or other chemicals. This not only kills the plants but also destroys any insects or pathogens that may be present. The formaldehyde is diluted at the rate of 1 gallon in a barrel of water, the plants are thoroughly sprinkled with the solution and then the glass sash put tightly on the beds to confine the fumes. It is best to do this on a bright hot day.

Care of Beds Between Seasons

From the last of June until the following April, no tobacco plants are raised in the beds. This is the period when fertilizer, manure and humus should be applied as described in the section on fertilizers. Also, the soil should be sterilized either in the spring or fall.

It is important that weeds be kept from growing in and around beds and shedding their seeds in the bed soil. The beds may be kept fallow by hoeing or cultivating at frequent intervals during the summer. Many growers prefer to keep weeds down by planting the beds to some crop which can be clean cultivated. Squash, cucumbers, cabbage and other vegetables are thus used and furnish extra food for the farmer's table. Some growers set the seedbed area to tobacco, spaced as in the open field, thus increasing the tobacco harvested. This is a questionable practice, however, because these plants may serve to carry over diseases or insects into the next crop of seedlings. The grower is tempted to use weedicides, such as 2, 4-D, to keep the area free of weeds. Some unfortunate experiences, such as accidental escape of 2, 4-D from the aisles into the beds, have discouraged this practice. No doubt a safe use of weedicides can be devised, however, and will ultimately become standard practice. For the present, caution is advised.

FITTING AND FERTILIZING THE FIELDS

The fields are usually plowed in April or May. A few growers plow in the fall and experiments have shown that this gives just as good results. However, since fall cover crops are grown on most of the fields, and because it is not so easy to fit the land in the spring without turning it under, not many growers practice fall plowing. Fall plowing is useful in controlling calico in the field and is practiced to some extent for that purpose. Sometimes, also, if the grower has sod land, he plows it in the fall to give the sod a longer period to rot. Experiments have shown that plowing is not necessary at all except as a means of burying the cover crop or other residue on the surface. It helps also in killing cutworms. Otherwise, on ordinary tobacco land, just as good crops can be grown by using only the disc harrow in preparing the land in the spring.

The soil is plowed to a depth of 7 or 8 inches, mixed and pulverized with a harrow and then it is ready to fertilize. Insecticides for control of cutworms and wireworms should be applied before the plants are set (see pages 84-85).

Usually the fertilizer is broadcast on the surface with a fertilizer or lime sower and is then thoroughly harrowed into the soil. Row application of fertilizer is not practiced in this State. Experiments have shown that with the heavy applications of fertilizer used in Connecticut, row application involves danger of root burning and has no worthwhile advantages over broadcasting. Sometimes a portion of the fertilizer, especially the bulky organic portion, is turned under when the land is plowed. Placing a part of the fertilizer on the plow sole has given improved results in tests at the Experiment Station.

Composition of the Fertilizer Mixture[1]

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. The 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 is supplied at the rate of about 200 pounds to the acre. In heavier, more retentive land, some growers reduce the amount to as little as 150 pounds without detriment. On sandy places subject

[1]For more complete information on fertilizers, see Conn. Agr. Exp. Sta. Bul. 503, "Fertilizing Connecticut Tobacco", 1947.

to rapid leaching, it is sometimes necessary to add more of the material later as a side dressing in seasons of heavy rainfall. 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. Not only are they of inferior quality, but 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. Cottonseed meal is used most often and nearly all formulas contain a considerable proportion of it. Castor pomace is another good organic material that is much used, especially when the cost of cottonseed meal is excessive. Used, pound for pound, to substitute for cottonseed meal, it gives comparable results with open field types and may be used in smaller proportion in the growing of shade tobacco. Linseed meal, soybean meal and dry ground fish are also frequently used to augment the organic portion of the mixture. 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.

Of the mineral sources of nitrogen, nitrate of soda has been used longest and most commonly. Recently, nitrate of ammonia has partly supplanted it. 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 can now be prepared synthetically from air nitrogen and has become as cheap as any other nitrate material. Nitrogen in the nitrate form is ready to be taken into the roots immediately without further change and is therefore frequently used as a "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 not more than one-fourth or one-fifth of the total nitrogen should be in this form.

Urea, or uramon, 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 the early days of tobacco growing the crop received large doses. More recently, urea has been synthesized from air nitrogen and is now supplied as a 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 suitable for tobacco mixtures. Field tests at the Tobacco Laboratory showed that sulfate of ammonia produced dark tobacco of inferior quality and poor burn.

Potassium is the second important nutrient element. It is necessary for the proper growth of the plant and 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 applied. It does not leach away as rapidly as nitrogen and it is probably never necessary to make additional applications during the summer. Yet it leaches slowly throughout the year. As a result, there is no great accumulation of available 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.

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 and are now used with satisfactory results by many growers. The magnesia which this material contains (about 5 per cent) increases its value. Pure carbonate of potash is also a good potash material but is 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 are readily available to the plant.

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

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

Phosphorus is used by the tobacco crop in small amounts. An acre of tobacco removes less than 20 pounds of phosphoric acid (P_2O_5) from the soil. Moreover, phosphorus does not leach away in the drainage water. Yet the usual practice is to apply 100 to 120 pounds of P_2O_5 annually. This is the cause of a heavy accumulation of phosphorus in old tobacco soils and usually these fields show little, if any, response from additional phosphorus. On fields which have been in tobacco less than five years there is a response to phosphorus fertilization. Moreover, there are some soils which "fix" phosphorus in a condition that is not available to the plant. The purpose of the apparently superfluous quantity of 100 to 120 pounds annually is to furnish for the plants' use a supply above that which is fixed. On relatively new fields, it is always advisable to use at least 100 pounds of phosphorus. In some cases where the soil test shows low supply, additional phosphorus is added in superphosphate in the fall or early spring.

The commonly used forms of phosphorus carriers are precipitated bone and bone meal. Recent experiments have also shown that triple superphosphate is a good form.

Magnesium is the fourth element which must be considered although it does not always have to be supplied on all tobacco 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 or 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 produce a good burn. 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 magnesian lime, is perhaps the most economical and convenient material with which to meet the magnesium requirements. The magnesia content should be as high as possible. Limestone with an MgO content up to 20 per cent and hydrated lime containing 30 per cent MgO are easily obtainable. If the material is to be mixed with other ingredients, ground limestone is better. Caustic lime may liberate the ammonia from other materials.

Double manure salts is a source of magnesia. Cottonhull ashes contain about 5 per cent. The percentages in other ingredients are given in Table 1.

Calcium is another food element needed in rather large amounts by the tobacco plant. Optimum percentage of calcium is about 5 per cent of the dry weight of leaves and a minimum percentage is 2 per cent for normal growth. Calcium has several functions in the growth of the plant because (1) it is a constituent of the middle lamella; without it, no new cells can be formed, and growth ceases, (2) it neutralizes the organic acids which are so important in tobacco, (3) it translocates nitrogen from one part of the plant to another. In the cigar increased amounts of calcium give better ash and taste.

On the field it is applied largely to neutralize acidity of the soil and keep the soil at a proper reaction for the best growth and quality. Too much calcium in alkaline carriers is avoided because an alkaline soil favors black rootrot. Moreover, since calcium is antagonistic to the soil bases, too much may restrict the uptake of potassium and magnesium unfavorably.

Many of the components of the fertilizer mix, such as the phosphates and cottonhull ash (see Table 1), contain large amounts of calcium and often it is not necessary to add special carriers. But if the soil test shows the need of calcium, it can be supplied in any of the lime materials or, in case the soil reaction is already high enough, in gypsum, which is neutral in its reaction. Hydrated lime contains 45 to 65 per cent of calcium oxide (CaO); ground limestone, 30 to 45 per cent, and gypsum (landplaster), 32 per cent. Percentage of calcium in other carriers may be found by consulting Table 1, page 36.

Calcium leaches rather readily from the soil, and, therefore, some should be applied every year to most soils. The amount and type of calcium carrier can be determined best from a soil test.

Trace Elements. Plants cannot grow without minute amounts of boron, manganese, chlorine, sulfur and iron. Other elements, such as sodium and aluminum, are always found in small amounts in tobacco leaves, but it has not been demonstrated that they are needed. All of these are present in small amounts in tobacco soils and there is no need of considering them in making a fertilizer formula with the possible exception of boron. Boron is present in small amounts in almost all soils, a fact which probably explains why we have never observed actual symptoms of boron starvation in any Connecticut fields. Growth is normal at a concentration of only 0.4 parts per million in the soil but experiments have demonstrated that the growth and quality of tobacco may be improved by increasing this up to as much as 4 parts per million. If the soil test shows low boron, it may be improved by adding 10 to 20 pounds of borax (11 per cent boron) to the acre. Some commercial fertilizer mixtures contain 5 pounds of borax to the ton for annual application. Larger amounts are avoided because just a slight excess may cause stunting or failure of a crop.

Fertilizer Formulas

A fertilizer formula is a list of materials to be mixed together to furnish adequate plant food in suitable proportions and amounts for proper nourishment of a crop. It corresponds to a recipe in a cook book for making cake. There are dozens of good formulas and no one is best for all farms. Any farmer can make up his own formula if he does not wish to buy a standard commercial brand. A few simple rules may be summarized from the discussion above:

1. It is best to figure in *pounds of plant food per acre*, rather than per ton of mixture.

2. An average acre of tobacco needs 200 pounds of nitrogen (N) and 200 pounds of potash (K_2O) and one-half that amount of phosphoric acid (P_2O_5).

3. About two-thirds of the nitrogen should be derived from organic materials, such as cottonseed meal, castor pomace, linseed meal and fish. The remainder may be furnished by such sources as nitrate of soda, ammonium nitrate, nitrate of potash and urea.

4. There is probably some advantage in deriving each nutrient from several sources.

5. All compounds containing more than 2 per cent of chlorine should be avoided. Compounds containing high percentages of sulfur should be avoided if practicable.

6. If the soil test indicates need for magnesium, about 75 pounds of MgO to the acre should be added.

In Table 1 average analyses of many materials used in tobacco fertilizer mixtures are shown. These can be mixed in numerous combinations, any one of which would be suitable for growing good tobacco provided the few rules enumerated above are followed. An example of such a formula is shown in Table 2. Many variations of this combination could be made which would be just as suitable for tobacco.

Mixing the Fertilizer

After having decided on the formula which he believes is most suitable for his needs, the grower has four choices for getting his fertilizer mixed and ready for application.

1. He may purchase a standard brand of mixture, of which many good ones are sold by reliable dealers.

2. He may turn over his desired formula to a commercial fertilizer mixer and dealer to be compounded according to his directions. Usually, the commercial mixer also sells him the separate ingredients.

3. He may own a power mixing outfit where he can use his own labor. This is a method commonly used by the growers of large acreages, or by several growers collectively. They purchase their own ingredients wherever they can get the best prices.

4. He may purchase his own ingredients and mix by hand without any special equipment. This method is employed by many growers of small acreages.

TABLE 1. AVERAGE ANALYSES OF MATERIALS WHICH MAY BE USED IN TOBACCO FERTILIZATION

Name of materials	Percentage of nutrients						
	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)	Calcium (CaO)	Magnesia (MgO)	Sulfur (SO_2)	Chlorine (Cl)
Ammonium nitrate	32.5	....	....	....	....	....	....
Ammophos A	11	48	....	1.8	.6	6.5	.03
Ammophos B	16.5	20	....	.4	.3	38.5	Trace
Bone meal (raw)	3.5	24	....	31	.8	.6	.2
Bone meal (steamed)	2.5	23	....	33	.4	.3	.07
Bone, precipitated	....	40	....	30	.5	3.4	1.2
Carbonate of potash	....	....	64	.2	None	.6	.4
Castor pomace	5.5	2	1	1	1	....	....
Corn gluten meal	6	1.3	.6	....	.6	....	....
Cottonseed meal	6.5	3	2	.3	.7	.5	.04
Cottonhull ash	....	3	25–40	11	5	2.5	1.5
Dry ground fish	9	7	1.1	8.6	.4	4.6	.45
Emjeo (magnesium sulfate)	....	....	....	3	30	66	....
Horn and hoof meal	15	....	....	2.7	.2	1.8	....
Kieserite (magnesium sulfate)	....	....	....	.6	32	64	.02
Landplaster	....	....	....	32	.7	43	Tr-.3
Lime, hydrated (high calcium)	....	....	....	65	1.5	....	....
Lime, hydrated (high magnesia)	....	....	....	45	27	....	....
Limestone (high calcium)	....	....	....	44	5.6	.1	Trace
Limestone (high magnesia)	....	....	....	30	20	....	....
Linseed meal	6	2	1	.6	.8	.9	.07
Manure, cow (fresh)	.5	.3	.5	.2	.1	.1	.1
Manure, horse (fresh)	.6	.7	.4	.5	.2	.1	.1
Manure, poultry (fresh)	1	1.3	.5	1.6	.3	....	.17
Nitrate of lime	15	....	....	27	2.5	.05	.17
Nitrate of potash	13	....	44	.6	.4	.7	1.1
Nitrate of soda (Chilean)	16	....	....	.2	.2	.2	.6
Nitrate of soda (synthetic American)	16	....	....	.1	.06	.2	.2
Nitrate of soda-potash	14	....	14	.2	.16	.07	.5
Peruvian guano	16	10.8	2.7	11	.9	3.6	1.9
Soybean oil meal	7.2	1.6	2.5	.6	.6	.3	.03
Sulfate of potash (European)	....	....	48	.5	1	43.5	2.1
Sulfate of potash (American)	....	....	50	....	....	47	....
Sulfate of potash-magnesia	....	....	25	2	11	46	2
Sunflower seed meal	7.7	2.3	2	....	.9	....	....
Superphosphate (low grade)	....	20	....	27	.5	29	.3
Superphosphate (triple)	....	47	....	30	....	....	....
Tobacco stems, ground	1.3	.7	5.7	5–10	.6	1	1.2
Tobacco stems, long	2.5	.7	6	5	.6	1.2	....
Tobacco stalks, ground	3.4	.8	4.6	....	....	....	....
Urea (European)	46	....	....	....	....	....	....
Urea (Uramon)	42	....	....	....	....	....	....
Wood ashes	....	....	4–6	28–36	3.5	1	.5

TABLE 2. EXAMPLE OF FERTILIZER FORMULA

Pounds of material per acre	Name of material	Pounds nutrients per acre				
		Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)	Calcium (CaO)	Magnesia (MgO)
1,800	Cottonseed meal	117	54	36	5	13
500	Castor pomace	33	10	5	...	4
200	Dry ground fish	18	14	...	...	...
100	Ammonium nitrate	32	...	...	...	...
200	Precipitated bone	...	80	...	60	...
200	Cottonhull ash (30%)	...	6	60	22	10
200	Sulfate of potash (American)	...	...	100	...	...
100	Dolomite	...	...	...	30	20
200	Landplaster	...	...	...	64	...
3,500	Total	200	164	201	181	47

The grower naturally tends to select the method that is most economical in his particular circumstances. The use of a ready mixed standard brand is subject to the objection that it is the least flexible, least easy to adapt to the special needs of particular fields or farms. This objection may frequently be overcome by applying additional materials separately. When there is a shortage of labor on the farm, it is often economical to purchase standard brands or to have the formula mixed by a commercial mixer. On many farms, however, there is a surplus of labor during slack times of the year or periods of inclement weather—labor that must be paid for, idle or busy. In such cases, it is commonly more economical for the grower to purchase his ingredients separately, mix and bag them on the farm. Whether or not he should purchase a small mechanical mixing outfit for this purpose depends on the size of his operations. There has been a great increase in the number of such outfits owned by individual farmers, firms or combinations of growers.

Hand Mixing

For this task, no equipment beyond that found on any farm is needed: a few shovels, a level floor in the barn or shed, and a platform scale.

The following very simple plan of procedure will give just as good a mixture as can be obtained in a commercial mix.

1. Select materials to be used and calculate the amount of each needed for each acre.

2. Mix in acre batches. Except for the more concentrated materials, bags need not be split.

3. Spread the material used in the largest amount (usually the seed meal) in a layer not more than a foot deep on the floor. Spread the other ingredients, one at a time, in successive thin layers on top of the first.

4. Start at one side and shovel all into a pile on the other end of the floor, shovelling from the bottom of the old pile and throwing on the top of the new pile. In the same way, mix further by moving the pile two or three times from one side of the floor to the other until the mixture is uniform in color.

5. If necessary, use a coarse screen (set at an incline like a sand screen) to separate lumps for crushing. If all the mixture is thrown through the screen in the last move of the pile, it will improve mixing.

6. Bag mixed fertilizer with the same weight in each bag to facilitate uniform application on the field.

SETTING THE PLANTS

The best time to set the open field tobacco is from June 1 to 20. Shade tobacco is usually set a little earlier, beginning about May 20. The usual distance between rows for Havana Seed and shade is 36 to 40 inches, while Broadleaf is usually 42 to 44 inches. 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.

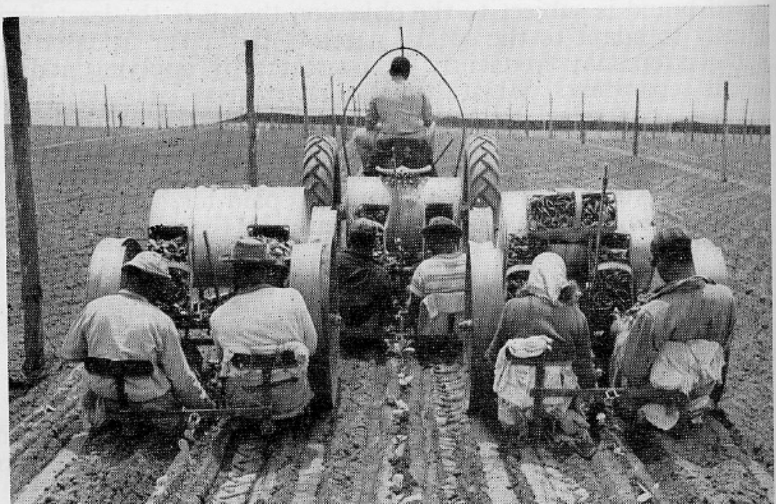

Figure 11. Three-row transplanter at work. (*Photograph courtesy of The Shade Tobacco Growers Agricultural Association, Inc.*)

A transplanting machine or "setter" drawn by horses or tractor makes the furrow, deposits about one-half pint of water where each plant is placed and then draws up the soil around the plant (Figure 11). By means of this machine, operated by one driver and two "droppers", two or three acres per day may be set. Two-row or three-row tractor-drawn setters are now used by many 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 as 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 1 to 2 pounds per barrel) is sometimes dissolved in the water of the setter barrel to give the plants a quick start. Tests with this and other "starters" in the setter water indicate that the value of this practice is questionable. Insecticides for control of wireworms and maggots may be added to the setter water as described in the section on insects.

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 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.

CULTIVATION

As soon as the plants have become established (a week or 10 days after setting), the cultivator should be started. The field should be tilled about once a week as long as it is practicable to work between the rows without breaking the leaves. Various types of cultivators are used—one-row, two-row, riding cultivators, or several one-row cultivators drawn by a single tractor (Figure 12)—but the principles are the same. The first cultivation should be with 1½ to 2-inch shovels, set deep to loosen as much soil as possible. The inside shovel is set as close to the row as can be done without covering or dislodging the plants. 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 farther away. Broader shovels ("sweeps") may now be used and the soil gradually worked up toward the rows. The ridge is built higher under cloth than in the open, and during wet years than during dry seasons. 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 or wide shovels are 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 (Figure 13) and again two weeks later. The object is to break up the soil between the plants in the row and to destroy weeds.

Figure 12. Cultivating young shade plants with machinery.

Figure 13. First hoeing.

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, to a lesser extent, other elements, leach out of the soil into the drainage water. When this happens, there is danger that tobacco plants may suffer and stop growing because of insufficient 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 on sandy soils, especially where the substratum 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.

Figure 14. Fertilizer side dressing with wheelbarrow sower.

Side dressings, however, may be detrimental to quality and their use 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: Before setting, broadcast all the fertilizer which should be needed by a normal crop in a normal year. 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 "wheelbarrow" sower (Figure 14) is used, it may be worked in with a cultivator.

After heavy rains, the grower is often in doubt as to whether he has lost sufficient nitrogen to warrant additional application. A laboratory soil test is the only reliable way to answer this, but his previous experience on the same field may be a sufficiently accurate guide.

Since nitrogen is usually the only element lost in sufficient amount to need replenishment, the quickly available nitrate of soda is most often used. Nitrate of ammonia is also sometimes applied. Either may be used alone but it is common practice to mix the nitrate with 200 to 300 pounds of a diluent such as cottonseed or linseed meal to facilitate distribution. Two hundred pounds of nitrate of soda or 100 pounds of ammonium nitrate to the acre is sufficient. In extremely wet years it may be necessary to repeat the application.

IRRIGATION

A season with too little or poorly distributed rainfall occurs about every second or third year. A dry weather crop may or may not weigh less, depending on the severity of the drouth, but is always poorer in quality than one grown in a season of adequate rainfall. The dry weather leaves are thicker, darker, have more gum, do not ferment as readily, have a reduced fire-holding capacity, and inferior taste and aroma.

These defects may be largely overcome by proper irrigation, a practice which has come into more general use in recent years than a few decades ago. Two methods of applying the water have been used, the older gravity flow method and the more recent portable sprinkler method.

In using the gravity flow method, the water is conducted by large pipes or flexible fire hose to the higher end or part of the field and flows downward in the furrows between the rows. Unless the slope is very gentle, dams are built at intervals in the furrows to keep the water from flowing down the row so fast that it will not have time to soak into the soil sufficiently. A serious objection to this method is that it causes local leaching of the nitrogen, especially at the high ends of the rows over which the whole water supply must pass and in depressions of the field where too much water accumulates. Starvation of the plants by this nitrogen leaching frequently results in no improvement or even poorer crops than lack of irrigation causes. In a long series of experiments on the Station farm at Windsor,[1] it was shown that this fault could be overcome and the crop greatly improved by irrigation if nitrate of soda in solution at a rate of 100 to 200 pounds to the acre was added to the water at the point where it first flows into the rows.

The portable sprinkler method now most generally used (Figure 15) does not cause nitrogen leaching when properly regulated, gives more uniform distribution of the water, requires less labor and in these

[1]Tobacco irrigation experiments during fifteen years. Conn. Agr. Exp. Sta. Bul. 487: 279-282. 1945.

respects is superior to the older method. The equipment required is more expensive, however. The water is carried through large aluminum (or galvanized) pipes, 4 to 6 inches in diameter in 20 foot lengths with self tightening, quickly adjusted couplings. At the end of each length of pipe is a fitting for an upright "riser" of smaller diameter and of sufficient height to reach over the tops of the plants, or, in the shade fields, above the top cloth. At the top of the "riser" is a water-propelled rotating nozzle which distributes the water out over a radius of 30 feet or more, depending on the water pressure. The introduction of this system about a decade ago stimulated a great increase in the acreage of tobacco under potential irrigation. It eliminates most of the faults of the older system and is much easier to operate.

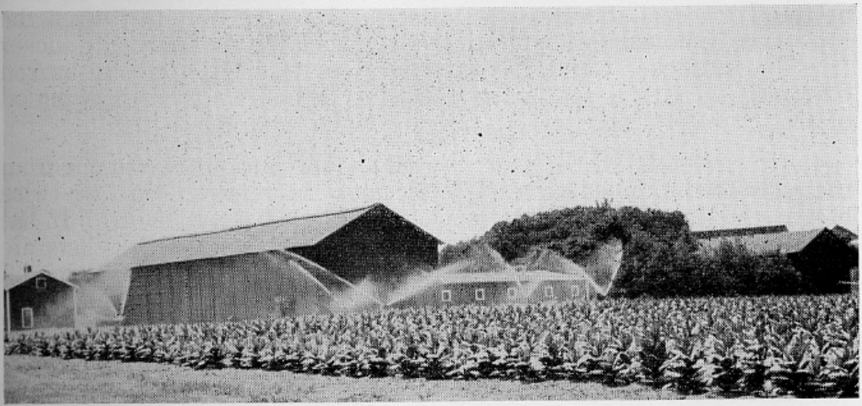

Figure 15. Overhead irrigation.

When and how often to irrigate? A common fault in irrigating is to wait until it is too late before starting. After the plants are already stunted and are topping out, they are not much benefited. Mere wilting of leaves on a hot afternoon is not a sign that irrigation should start. When they begin to wilt in the morning, do not recover until night, and the experienced grower says they are "standing still", it is time for the first irrigation. Frequency of irrigation will also depend on the weather. In continuous dry, hot weather, it is necessary to repeat once a week but never oftener. Frequently, longer intervals are as good. We have not yet seen a season when it was necessary to irrigate more than three or four times.

About an inch of water is usually sufficient for each application except in extreme drouths or where one has waited too long. The appearance of the soil and the plants, however, is the best guide to amount of water and frequency of application. Enough water should be applied to wet all of the top soil down to the naturally moist soil below. Excessive watering should be avoided because it causes leaching of nutrients and, in a muddy soil, the plants are too easily blown down.

The magnitude of increase in crop value through irrigation depends on the severity of the drouth. The five-year average increase measured in the tests previously mentioned at the Tobacco Laboratory farm was 37 per cent. Burn tests on another series gave an increase of 30 per cent in the fire-holding capacity of irrigated tobacco.

TOPPING AND SUCKERING

With respect to these two operations, there is a marked distinction between shade tobacco and the open field or stalk tobacco. The latter should be topped at about the time that the first blossom opens. There is considerable difference of opinion among growers as to the amount of top which should be removed from the open field types. In tests at the Tobacco Laboratory the best results were obtained when the tops were removed to about three leaves below 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. Some of the more recently introduced taller varieties of shade tobacco, such as Connecticut 15 and Connecticut 49, develop their smaller seed heads so late in the season that no topping is necessary.

Since the operation of "suckering" requires a great deal of expensive labor, there have been various attempts and experiments in recent years to eliminate this by applying to the plants at the time of topping certain chemicals which inhibit or prevent the growth of suckers. These chemical substances are of two types: (1) various oils in several forms, which are applied directly to the stub of the stalk after topping, and (2) maleic hydrazide and its derivatives, which are sprayed in weak dilutions on the top leaves. Both of these methods have been effective in stopping the growth of suckers but the possibility of harmful effects on the quality of the leaves has not been sufficiently studied. Therefore, at present, they are not suggested for general practice. Through further investigation, it is quite possible that effective and safe chemical methods of sucker control will be found.

HARVESTING

The binder types, Havana Seed and Broadleaf, are harvested by cutting the stalks and hanging the entire plants with attached leaves for curing, while shade tobacco is harvested by breaking the leaves off the stalks in the fields.

Figure 16. Spearing Havana Seed tobacco.

Figure 17. Harvesting with a stringing horse.

Stalk Cutting

The Broadleaf and Havana Seed types are locally called "stalk cut" tobacco. Two or three weeks after topping or as soon as the grower decides from the appearance of top leaves that the tobacco is ripe, he cuts off the stalks with a specially designed 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. Burned tobacco never cures properly.

Next, the plants are strung on 4-foot lath by means of a steel spear head which slips loosely over the end of the lath (Figure 16). The stalk is speared about 6 inches above the point where it was cut. An average of six Havana Seed or five Broadleaf plants are hung on one lath. 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" (Figure 17), 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 where it is supported between two poles set about 42 inches apart and with the plants hanging upside down. Then it is drawn on the wagon racks to the curing sheds.

Figure 18. Typical curing shed with tobacco in process of wilting in foreground.

The construction and dimensions of curing sheds vary. We can only describe the construction size and fittings of a typical shed without implying that other types are not just as good. 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 eaves and a shingle ridge roof. The sheds are divided

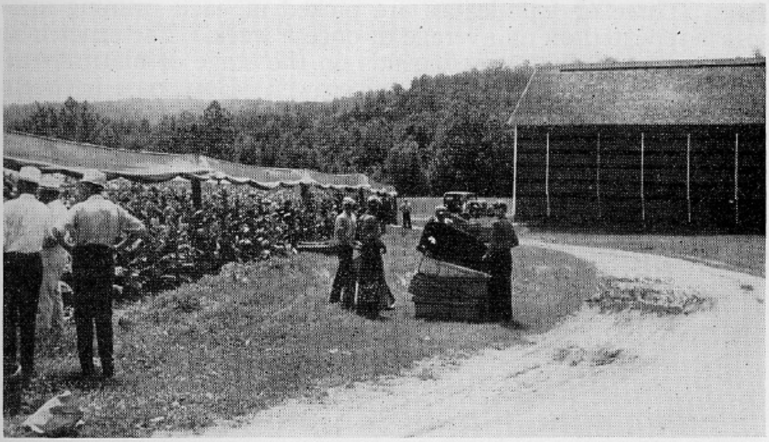

Figure 19. Harvest scene on shade farm. Also shows ventilators in shade barn.

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 (Figure 18). 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 (Figure 19). 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 4 by 4 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. The space between tiers is about 5 feet. The lath are placed on these poles about 7 to 8 inches apart, depending on the size of the tobacco and the method of curing to be used. Larger tobacco should 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 2½ feet apart instead of 5 feet.

Priming

All shade tobacco is harvested by priming, i.e., picking the leaves from the stalks. Since the lower leaves mature first, they are picked off first. Three or four leaves are picked at each priming and the process is repeated on an average of once a week. The exact interval between primings, however, 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 (Figure 20). Another set of boys draws large canvas baskets between the rows and collects the leaves which are then drawn to the curing sheds. Here they are "sewed" by hand on 4-foot lath by girls and women (Figure 21), or special stringing machines, which have come into general use in recent years, may be employed (Figure 22). Each end

Figure 20. Priming shade tobacco.

of the lath has a saw notch about ½ 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 22 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 the lath are crowded together closely on the poles.

Figure 21. Sewing the leaves on the lath by hand.

CURING

While hanging on the poles in the shed, the leaves dry out and slowly die, changing in color from green to yellow to brown. This curing process lasts for two to six weeks. During this period the leaves lose about 80 per cent of their weight, largely as water. Drying, however, is not the most important change during this process by which a raw bitter green leaf is converted into a mild brown aromatic one with suitable smoking qualities. Drying is merely incidental to a complicated series of chemical changes that take place inside the tissues of the leaves. The green pigment, chlorophyll, breaks down and the yellow pigments, zanthophyll and carotenes, are formed to make the leaf yellow. The yellow color is gradually masked by the brown pigments, polyphenols, flavones and others. The starch of the green leaves is changed to sugars which, in turn, are consumed in respiration, and carbon dioxide is released. Protein breaks down into simpler nitrogenous compounds, amino acids and ammonia, malic acid decreases, citric acid increases, and some of the nicotine disappears. These are a few of the chemical reactions that must go on before the leaf is properly cured. The extent of the chemical transformations has a profound influence on the quality of the cured leaves. An average crop may be greatly improved by proper curing while the best crop grown may be ruined by a poor cure.

Figure 22. Sewing the leaves on lath by machine.
(*Photograph courtesy of The Shade Tobacco Growers Agricultural Association, Inc.*)

Influence of environmental factors. The temperature, relative humidity, and movement of the surrounding air are all important in their effect on curing. Moreover, the three are interdependent and no one of them can be evaluated without considering the influence of the others. The optimum temperature is 85 to 95° F. but when the outside temperature is low, e.g., 65°, it is best not to maintain such high temperatures in the shed because the relative humidity produced by such a spread may cause too rapid drying. A general rule is to keep the temperature inside the shed 10 to 15° F. above the outside. The relative humidity should be about 10 points, expressed in degrees, below the temperature, e.g., at a temperature of 90°, the humidity should be 80 per cent. A too high humidity favors pole rot (see page 79 for pole rot) and must be avoided. A higher humidity can be maintained, however, if accompanied by good air movement. Air currents are beneficial, especially in the first stages of curing, because tons of water must be evaporated from the green leaves and carried into the outside air. Otherwise, the air around the leaves becomes saturated with moisture and there is danger of ruining the crop through pole rot.

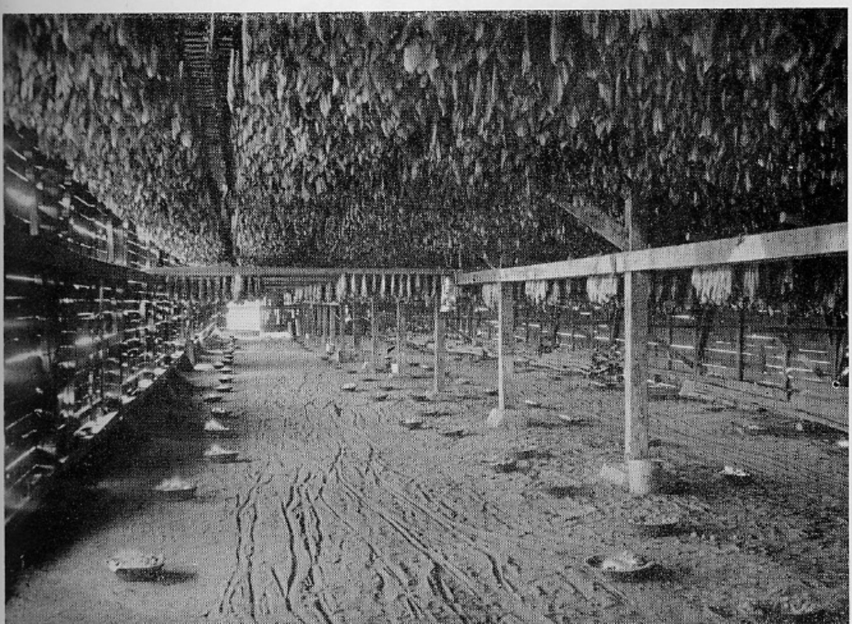

Figure 23. Curing with the aid of charcoal fires.

Artificial heat. During some seasons atmospheric conditions naturally approach the optima stated above and good crops with no rot and of favorable quality may be cured without further care. But more often the weather is not so accomodating and growers have to resort to artificial heat to raise temperature and reduce humidity. This practice is commonly called "firing" the sheds. Firing has two functions: (1) it helps to prevent rot, and (2) at high temperatures the important chemical changes are more active and go more nearly to completion.

Green firing. Firing is especially important just after tobacco is hung in the shed. Therefore, all shade growers and many stalk growers practice "green firing" (also called "initial firing" or "firing to wilt") every year. Most of the chemical reactions occur within the first few days after tobacco is hung. Pole rot organisms are also more active during this period and the danger of rot is reduced in proportion as the leaves become wilted and the surfaces dry.

Fuels. Up to the last four years the fuel universally used was charcoal, either lump charcoal or processed briquets. This was burned either in shallow pits dug into the soil on the floor of the sheds or in pans (Figure 23) or metal burners. Usually about four fires are placed in each 16 foot square "bent". More recently, liquefied petroleum gas has come into more general use.[1] This gas is piped into special burners on the floor of the shed (Figure 24) from large tanks outside.

Figure 24. Firing sheds with gas burners.

When to fire and how long. For the "green firing", the fires should be started just as soon as the shed is filled with tobacco and continued night and day for three days or until the leaves are limp and wilted. Later firings may be necessary in periods of damp weather. One day of such weather is usually not dangerous, but if it continues for two or more days, the fires are started again and kept going until the leaf surfaces are dried. Firing always continues for at least one day, except when high winds may make it safer to extinguish the fires. The firings subsequent to green firing are primarily to prevent pole rot and should be repeated as often as long damp periods recur until the leaves are all brown and most of the midribs dried.

Air circulation. Air currents passing across the leaf surfaces are an effective means of removing the water evaporating from the leaves.

[1]Conn. Agr. Exp. Sta. Circ. 183, "Principles of Curing Broadleaf and Havana Seed Tobaccos," 1952.

Moreover, air currents keep the leaves moving so that they are not continuously in contact with each other and thus do not favor the progress of rot from leaf to leaf or stalk to leaf. Large electric fans are sometimes used to circulate the air. In good curing weather, fans alone may be sufficient, but experiments have shown that in long continued periods of wet weather, when the outside atmosphere is saturated, fans alone will not prevent rot. They can well be used to supplement artificial heat rather than to replace it.

Manipulation of ventilators. The amount of moisture in the shed, and often the severity of rot, can be reduced considerably by proper manipulation of side and top ventilators and doors. When they are open, they allow the breezes to pass through the tobacco to remove excess moisture. Their capacity to keep moist air out of the shed, however, is quite limited, contrary to popular belief, because shed construction is usually too loose to prevent the infiltration of any kind of air from the outside for any length of time. During the early stages of curing, when not firing, all ventilators should be wide open to allow the maximum quantity of water to pass off from the green leaves. The only occasions for closing the ventilators at this stage (except while firing) are *in too windy weather*, to *prevent wind whip*, and *during rains*, to *prevent rain splashing.* During later stages, when the cure is nearing completion, it is usually better to close the ventilators at night and open them during the day except during rains. However, during windy days, ventilators on the windward side should be closed to prevent damage to the dried leaves by whipping. After the midribs are dried out, the shed may be kept closed all the time except when a long damp spell threatens to cause mold on the leaves. In this case the tobacco should be ventilated until the leaves become dry and hard.

More tobacco is ruined by too little ventilation than by too much. Many successful growers keep the ventilators wide open during the entire curing season except for periods of high winds or blowing rains.

The side ventilators are closed during firing but the roof ventilators should always be open. Some consider it a good practice to open the side ventilators occasionally for short periods during the firing.

STRIPPING AND 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", i.e., a period of rainy weather or fogs when the air becomes saturated. The leaves contain mineral salts which enable them to 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 tobacco may now be removed from the poles and piled on the ground in such a way that it 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.

The lath of stalk tobacco are taken down from the poles and the stalks of tobacco are stripped from the lath by hand or by a motorized stripping machine and laid in piles with the tops overlapping and the butts extending outward. This pile may be covered with tarpaulins, mats, 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 more than two feet high.

Holding the stalk in his left hand, the stripper pulls off the leaves with his right, beginning at the base of the stalk and 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 50 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 to be sold or taken to the sorting shop.

SORTING

Stalk tobacco may be sold unassorted in the bundle after it is taken down in the curing sheds or it may be first sorted into grades on the farm before selling. Almost all of the Havana Seed type is sold in unassorted bundles and is taken by the buyers to packing houses, or warehouses, where it is sorted and processed for the manufacturer. Some of the Broadleaf is handled in the same way but many growers have small sorting shops on the farm where they sort their crops. Shade tobacco is sorted, packed and processed in large central warehouses, never on the farm. Sorting of all types of tobacco is done during the winter months.

The principal characteristics which determine the grades into which leaves are sorted are color, thickness, length, soundness, gum, vein and shape. There are 6 to 10 grades of stalk tobacco and 10 to 16 grades of shade tobacco, variation in number depending on the grade requirements of different warehouses. The principal grades are further "sized", i.e., separated according to length at intervals of two inches for Havana Seed and one inch for shade. Each length of each grade is then packed into large wooden cases (stalk tobacco) or bales (shade) covered with fibre mats. Before packing, the leaves are tied together in small bunches called "hands". Stalk tobaccos are then fermented by keeping the packed cases in a warm room for several months. Shade tobacco is fermented by piling it in large "bulks" before sorting.

Since these processing operations are not done on the farm, it is not within the scope of this bulletin, which is written primarily for tobacco growers, to describe them in more detail.

Grades of tobacco are not easily described and can be learned only by experience in the sorting shop. Grades of one type, e.g., Havana Seed, do not correspond with the grades of another type, e.g., shade. In a general way, the characteristics and, thus, the grade, correspond to the position of the leaves on the stalk. For example, in Havana Seed, the grades usually made, their characteristics, and position on the stalk (14 leaves) are:

Fillers. The lowest two leaves. Light color, short, usually 15 inches or less, dull and without gum, good grain.

Seconds. Next four leaves. Light color, more than 15 inches long, not much gum, good grain, broad shape.

Light wrappers. Next two leaves, the best quality on the plant. Light uniform color, silky, broad shape, good length, usually less grain than the seconds.

Medium wrappers. Next two leaves. Much the same as light wrappers but darker, greenish color, more gum and less grain.

Darks. The top four leaves. Dark color, most gum, thick, more pointed shape, little, if any, grain. Often divided into two grades, long darks and short darks (17 inches or less).

Brokes. Leaves from all grades which have been damaged by tearing in handling, or by hail, wind, pole rot, insects, diseases and the like and, therefore, are thrown out of the other grades.

The object of sorting and packing tobacco by grades and sizes is to meet the requirements of the cigar manufacturer. For a certain shape and size of cigar he finds a certain size of leaf is most economical and he is not interested in the other sizes. Or he finds that a light grade is better for a binder of one brand while a dark binder makes a better blend for another brand. The other grades may be more attractive to another manufacturer. The manufacturer prefers to purchase only the sizes and grades that he can use.

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 of plant nutrients, 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 are 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 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. Some of this is well fertilized soil which is not always re-deposited where it will be useful for the next crop. Blowing of soil can be largely prevented by proper use of cover crops.

Cover crops prevent washing away 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 from 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 had a tendency to make the following crop of tobacco dark. On account of its growth habits, alfalfa does not cover the ground well and, therefore, does not prevent blowing.

In field tests at Windsor, oats gave the best results of any of 10 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 five-year field test at Windsor it rated 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 gave better results than timothy. The growth habits of the two are quite similar.

Seed for the cover crop 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 bushels to the acre
Alfalfa, red top, timothy	20 pounds to the acre
Vetch	80 pounds to the acre

Preparation of the land for seeding is easy at this time. It is not necessary to turn the soil with a plow, although it has been found that fall plowing reduces the danger of mosaic (calico) the following year. 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[1]

In the following pages only those diseases of tobacco which are of fairly common occurrence in the State are described. There are others 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 seedbed diseases, then those which occur both in seedbed 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 seedbed
   1. Seedlings in two or four-leaf stage dropping over with lower part of stalk shrivelled. *Early Damping-off*
   2. Patches of older plants with slimy brown rot of stalks spreading later to other parts of plants. *Bed Rot*

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[1]For further information consult Conn. Agr. Exp. Sta. Bul. 432, "Diseases and Decays of Connecticut Tobacco", 1940, and Bul. 527, "Controlling Diseases of Tobacco", 1949.

3. Patches of stunted plants with rotted roots but stalks intact.
   a. Some of the roots black. *Black Rootrot*
   b. Roots disintegrated but hardly discolored. *Pythium Rootrot*
4. Yellow spots or patches on leaves.
   a. Spots round with regular halo, may be accompanied by patches of wet rot in the beds. *Wildfire*
   b. Patches irregular with violet colored mildew on underside. *Blue Mold*
5. Entire plants becoming pale without other symptoms. *Nitrogen Starvation*
6. Leaves "hobbly" with downward inrolled margins and 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. Pale tops twisted to one side, dark brown under bark. *Fusarium Wilt*
   c. Wet rot of pith finally making stalk hollow. *Hollow Stalk*
2. Root diseases causing stunted patches of plants.
   a. Some of the roots black. *Black Rootrot*
   b. Many of the dead roots brown. *Nematode Brown Rootrot*
3. Leaf Diseases.
   a. Irregularly mottled with alternating areas of light and dark green. *Mosaic (Calico)*
   b. Leaves narrow, strap shaped in abnormally large numbers. *Frenching*
   c. Dead spots on leaves.
      (1) Spots with definite broad yellow halos. *Wildfire*
      (2) Without halos. *Physiological Spots (or Mosaic Fleck)*
   d. Lower leaves chlorotic between veins, thick, without inrolled margins. *Magnesia Hunger*
   e. Leaf surface hobbly, margins and tips of leaves rolled downward. *Potash Hunger*
   f. Plants stunted, dark green. Leaves narrow, spatulate, pinched, with bronze cast. *Phosphorus Starvation*

III. In the curing shed
1. Rotting during curing. *Pole Rot*
   (Several types of pole rot are:)
   a. Web of leaf becoming tender and discolored. *Web Rot*
   b. Veins disintegrated and splitting from the web. *Stem Rot*
   c. Stalks slimy or covered with grey felt. *Slimy Stalk*
   d. Stalks drying prematurely and with black hard pellets on surface or inside hollow stalk. *Rattle Box*

Early Damping-Off

This is the first disease of the season, occurring every year. It is usually not sufficiently severe to cause loss of beds but frequently causes such a thinning of the stand that the grower does not have plants enough to set his intended acreage.

Symptoms. This is a disease of the tiny seedlings in the two-leaf (cotyledon) stage and should not be confused with the later bed rots described on page 60.

The grower first notices that, although the beds looked thick enough when the seeds first started, they become thinner every day. On close examination, he finds that many of the seedlings have fallen over to the ground and the stems are shrivelled to strings. The dead plants soon wilt or rot completely and disappear with the first watering.

This type of damping-off is caused by the attack of a soil-inhabiting parasitic fungus[1] which may be found in most fertile soils and causes a similar damping-off of young seedlings of a large number of vegetables, flowers and other plants.

Control. It is easy to kill the causal fungus by the usual sterilization of the soil by steam or chloropicrin. Unfortunately, however, this is not effective in stopping the disease because the soil becomes reinfested too quickly. Control measures applied after the disease is noticed in the bed are usually too late.

The most effective method of control is to treat the soil with formaldehyde just previous to sowing the seed. This must be done carefully because an overdose may kill the plants. Directions are as follows:

1. Stir 1 pint of formaldehyde into about 1 gallon of water in a sprinkling can.
2. Have soil pulverized and ready for sowing.
3. While raking over the soil the last time just before sowing, sprinkle the above amount of solution evenly over an area of four or five sash (72 to 90 square feet). Mix thoroughly into the top 3 inches of soil with the rake.
4. Level the surface and sow the dry seed as usual.

The formaldehyde fumes remain in the soil long enough to kill or prevent growth of the fungus during the period when the seedlings are becoming established, but are not concentrated enough to injure the tobacco plants.

Coating the seed with fungicidal dusts gives some control but sometimes is not effective. In a series of trials at the Tobacco Laboratory, the three that gave best results were "Arasan", "Cuprocide" and "Fermate", in the order named.

Spraying with copper fungicides as described under "Blue Mold" is beneficial but is usually too late to be dependable.

Mildew or Blue Mold

This is the most troublesome disease of seedbeds and rightly has first consideration in any seedbed spray program. If it gets into the beds when the plants are quite small, it kills many of them and may even destroy the whole bed. If the plants are large, it kills parts or all of the leaves but the plants survive and put out new foliage. This, however, may cause serious delay in getting the plants set in the field.

Symptoms. Mildew first causes yellow blotches on the upper surfaces of the leaves which then become distorted. The sure diagnostic symptom, however, is the mold-like growth of fungus[2] which

[1] *Pythium debaryanum.*
[2] *Peronospora tabacini.*

soon appears on the lower surface of the leaves. This growth may have a violet color when fresh, hence the popular name "blue" mold, but it soon assumes some shade of gray or brown. If the bed atmosphere is moist, the leaves develop a wet rot; under drier conditions, they shrivel and lie like twisted strings on the soil.

Mildew usually first appears in Connecticut about May 15 but during early springs it may attack before that date. It spreads rapidly by means of spores which are blown about in the air and, when it is found in one bed, it almost always shows up quickly in other beds in the neighborhood.

Control. Blue mold in the beds is successfully controlled by spraying or dusting with ferbam or zineb. For procedure, see pest control chart for beds, page 105, sections 9 and 10. These fungicides may be applied just as effectively in dust form (15 per cent ferbam or 10 per cent zineb).

In case the blue mold is already in the beds, it is better to fumigate the beds with paradichlorobenzene as directed in the pest control chart for beds, section 12, on page 105.

Blue mold is not usually a serious menace in the fields, but during some cool wet seasons it may damage tobacco in the tents. Good control has resulted from dusting the fields twice a week up until early July with zineb 18 to 20 per cent in a tobacco dust diluent.[1]

Bed Rots

Bed rot attacks plants in the later seedbed stages, from the time they are half-grown until they are pulled. The disease appears with greater frequency as the plants grow and become more crowded. Beds that are too thick, too little ventilated or overwatered are most often affected, although the disease is not confined to such beds.

Symptoms. There are four different kinds of bed rots that occur here, each caused by a different species of parasite[2] and having slightly different symptoms. The general effects on the plant, however, are about the same and since all seem to respond to the same treatment, they will be considered collectively here. Patches of plants, from a few inches to several feet in diameter, wilt and then collapse in a wet rot. Close examination of the plants on the periphery of a patch usually shows a wet brown rot on the stalk at the surface of the ground. Beginning here, it travels up the stalk and into the leaves. When the plants are dense, however, the rot may run from plant to plant through the leaves. Finally, the whole mass of plants sinks to the ground and dries out as a parchment-like brown or bleached mat over the soil. Under wet conditions, the spot spreads centrifugally and kills all the plants as it goes. With a return of dry conditions, it stops and there may be no further trouble. Around the edge of the patch some plants are usually left which do not die but survive with brown lesions on the

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[1]See Conn. Exp. Sta. Circ. 181, "Combating Blue Mold of Tobacco", 1952.

[2]*Rhizoctonia Solani, Pythium aphanidermatum, Botrytis cinerea* and *Bacillus aroideae.*

stalks. Such plants often die when set in the field and are the start of stalk diseases, such as stalk rots and sore shin, mentioned later in this bulletin.

Control. The first line of defense against bed rot is the sterilization of the soil by steaming, chloropicrin or methyl bromide. This kills the parasites which are in the soil at the time but does not prevent re-infestation.

Another preventive measure is to avoid overcrowding, overwatering and too little ventilation.

Regular spraying of the beds with ferbam or zineb, as for mildew, gives almost complete control. Bed rot rarely occurs in beds that have been so treated.

Spraying with Bordeaux or the copper sprays used for wildfire control also reduces bed rot but these materials are not as effective as ferbam.

Wildfire

Formerly a very destructive disease, wildfire[1] has not caused much trouble in recent years, but there is always a danger of recurrence in destructive proportion.

Symptoms. Wildfire may be a major disease both in the seedbed and in the field. It causes dead spots in the leaves which make them unsuitable for wrappers or binders. The symptoms by which it can be readily distinguished from all other leaf spot diseases is the "halo" spot (Figure 25). This is a perfectly round spot with a dead brown center surrounded by a wide yellow band (the halo) with a smooth regular margin. As the spots in the field become older, especially in dry weather, the entire spot becomes brown and dead and may crack or drop out.

In the seedbed, wildfire starts in patches and, when severe, may kill all the young plants in these areas. The most harmful aspect of seedbed infestation, however, is not that it kills the plants but that infected plants transplanted to the field are the principal source of field infection. Almost invariably, wildfire in the field can be traced back to disease in the bed. Control of wildfire, therefore, depends largely on keeping the seedbeds free of the disease.

Control. Early spraying of the beds with a copper fungicide is the most important measure in preventing wildfire. Procedure is given in the pest control chart for beds, page 104, sections 1, 2, 3, 6, 7 and 13. See also under "Seedbeds", page 26.

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 they are quite young, they may be removed and carried from the field. If the infection is more general, this method is questionable

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[1]Caused by a bacterial species *Phytomonas tabaci*.

because healthy plants, set where the diseased ones have been pulled, commonly become infected from bacteria left in the soil.

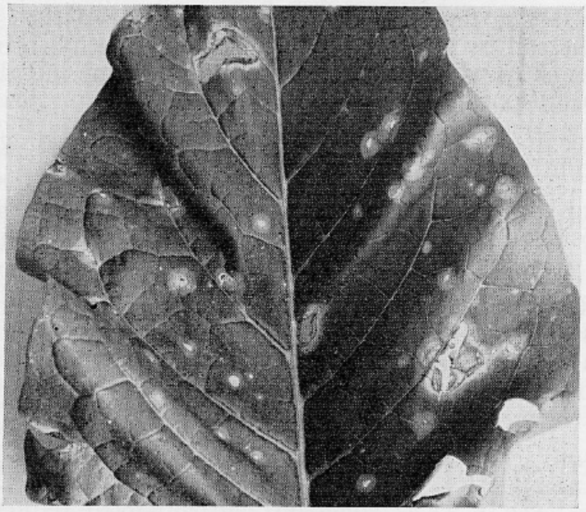

Figure 25. Young wildfire lesions showing the halo.

Resistant Strains. The growing of strains of tobacco that are immune or at least highly resistant to wildfire will probably soon be the happy solution to the wildfire problem, making the remedial measures described above unnecessary. Such strains, however, must have all the desirable qualities of types now grown. Excellent progress has already been made and we can confidently anticipate that, within the next few years, such strains will be ready for distribution to growers. Immune or highly resistant strains have already been developed by researchers in several tobacco experiment stations and it now appears to be only a matter of eliminating some "off" characteristics and standardizing to uniformity.

Brown Rootrot or Nematode Infestation

Brown rootrot is a major disease of long standing in Connecticut and causes some loss every season. During some years it becomes our most damaging field disease.

Symptoms. The above-ground symptoms are the same as those of black rootrot: stunting, slow growth and wilting, and it is impossible to distinguish between the two maladies without an examination of the roots. The root system of a plant infected with brown rootrot is not white and wide-spreading like that of a normal plant. It consists mostly of a bushy tuft of short, brown, dead, fibrous roots at the base of the stalk with possibly a few normal roots near the surface of the soil. This reduced root system naturally cannot supply the necessary water and food for the leaves; hence, the wilting and stunting. None of the dead roots are coal black as in black rootrot, but the brown color shows they have ceased to function.

Cause. It is believed that brown rootrot is caused primarily by soil-inhabiting parasitic nematodes, tiny microscopic eel-worms, which may be either inside the root tissue or on the surface of the roots. They either kill the tiny roots by feeding on them or make lesions in the roots which provide entryways for fungi or bacteria to complete the disintegration.

The relation of brown rootrot to certain crops that precede tobacco has been observed by all investigators of the disease. It is always worse after timothy, corn, or forage crops, and least serious after a preceding crop of tobacco. This has led to the belief that tobacco is not a favorite host, but that nematodes prefer and build up on such plants as timothy and corn. Thus, the soil is more thoroughly infested when tobacco is planted after these crops. Yet the disease is not entirely dependent on these other hosts because it sometimes persists several years in successive tobacco crops on the same field.

Control. If practicable, the growing of tobacco following hay, corn or forage crops should be avoided.

Fumigation of the soil with nematocides has given remarkably successful control. The two fumigating chemicals that have given good control here are ethylene dibromide and a mixture of dichloropropene and dichloropropane. "Iscobrome D" contains 10 per cent and "Dowfume W-40" contains 20 per cent by volume of ethylene dibromide. Dichloropropene-dichloropropane mixture is sold as "D-D" and "Dowfume N". "Iscobrome" is applied at the rate of 30 gallons to the acre, "Dowfume W-40" at the rate of 15 gallons and "D-D" at the rate of 30 gallons. Other commercial mixtures containing these same fumigants may be just as effective.

Soil should be damp enough for seed germination but not muddy at the time of application. The temperature of the soil should not be below 50° F. (40° for "D-D" at six inches below the surface). Application may be made either in late fall or early spring. The fumigants should be deposited at a depth of six to eight inches. Points or lines of application should not be more than 10 to 12 inches apart. Immediately after application, the soil should be rolled or dragged to seal in the fumigant. Plants should not be set in the field for at least two weeks after the fumigant is applied to the soil. Soil should be prepared for planting, harrowed and levelled before using a shank type applicator. Plow application should be preceded by harrowing to cut up trash and cover crops. If there is time, it is better to harrow the cover crop well in advance to allow roots which harbor the nematodes to decay.

For distributing the chemical in the soil, a mechanical applicator is necessary. The following two types of implements are most commonly used.

1. The tooth or shank type either built directly on the tractor or on a trailer machine. This has a motor-driven or tractor-driven (from power take-off) pump which forces a stream down through narrow tubes, attached to the back side of narrow cultivator-like teeth. This gives a continuous flow, depositing the liquid in parallel lines, not more than one foot apart, as the tractor moves across the field. The soil coverage is made more complete by a smoothing drag or board behind the machine.

2. The plow sole type is attached directly to the plow and has a motor-driven pump or gravity flow system which drives the liquid through pipes onto the plow sole just as it is being covered by the soil from the next furrow. This convenient type eliminates an extra operation for distributing the fumigant.

Black Rootrot

Black rootrot, caused by a soil-inhabiting fungus[1] is sometimes a damaging disease of tobacco in Connecticut fields.

Symptoms. The first symptom of the disease is growth stoppage. 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. On hot days the leaves wilt more quickly than does 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 patches the plants are frequently very uneven in development.

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 diseased plants many are black, either throughout their length or only in segments, with other segments appearing normal. 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 tissues. 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. This results in dwarfed growth and flagging on hot days.

Prevention. Two methods are used to combat this disease: (1) keeping the soil conditions unfavorable for growth of the pathogen, and (2) growing varieties of tobacco that are naturally resistant to rootrot.

Soil conditions. 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

[1] *Thielaviopsis basicola.*

alkaline fertilizers that rootrot became serious a generation ago. When such treatments are omitted for several years, the soil gradually returns to its original reaction. Avoidance of too much alkaline material on the land thus offers a logical means of control. Only soils testing below 5.0 pH should be limed, and then sparingly, not more than 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 5.6. If a soil test has shown that the field is too alkaline, it can be made more acid through heavy application of ammonium sulfate. This should be applied in the fall or late summer after the crop is removed, since spring treatment is detrimental to the quality of tobacco. Not more than 500 pounds to the acre should be applied. Cold, wet and heavy soils that pack readily favor black rootrot and should be avoided if rootrot occurs on the farm.

Planting resistant strains. Highly resistant strains of Havana Seed tobacco have been developed and are now being generally planted in the Connecticut Valley. Probably 75 per cent of the Havana Seed acreage is now planted to these types. Havana Seed No. 211, K1 and K2 are not only resistant but will out-yield and out-grade the older susceptible strains of Havana Seed.

Connecticut 15 and Connecticut 49 are highly resistant strains of shade tobacco. They also give an increased yield of about 50 per cent more than the old strains, due to the greater numbers of uniform leaves on the stalk.

No resistant strains of Broadleaf type have been developed but fortunately this type as a whole is naturally less susceptible to black rootrot.

In the seedbed. Black rootrot may also be very damaging in the seedbeds since growth of the causal fungus is favored by the low soil temperature of early spring. Patches of the plants stop growing and the whole bed has an uneven appearance. Wilting, unnatural leaf color and the root symptoms are the same as described above for field infestation.

Soil sterilization by steam or chemicals is a simple and effective preventive. This usually involves no extra work nor expense since most beds are now so treated to kill weed seeds. See page 17 for methods of sterilizing the soil.

Stalk-rot of Transplants

Some years there are heavy losses of plants from rotting of the stalks shortly after they are set in the field. There are two kinds of stalk-rot, a wet rot and a dry rot.

Symptoms. Wet rot is a watery, black (or at least very dark), mushy rot that completely disintegrates all the tissues of the stalk (Figure 26). It starts just at, or below, the ground level, but under favorable conditions quickly works upward, even into the bases of the leaves, and causes the plant to fall over and completely collapse. The stalk is so rotted that it no longer holds together when the plant is pulled up. This trouble has been prevalent only during seasons of frequent rainfall when the soil remains wet and soggy for several days at a time.

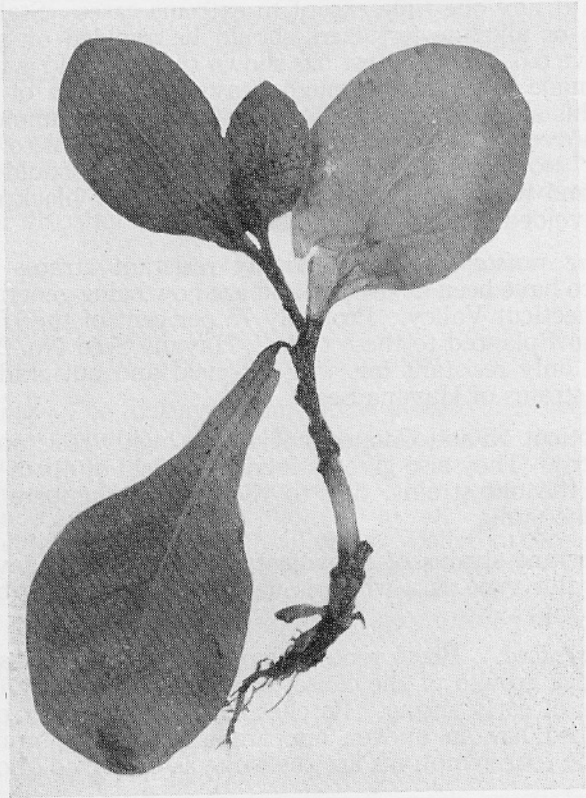

Figure 26. Soft stalk rot of transplant. Note blackened area of stalk extending into bases of leaves.

This type of rot is caused by the same species of fungi[1] that cause damping-off and bed rot in the seedbeds. This leads us to believe that the trouble starts while the plants are still in the seedbeds. However, these same species of fungi also live in the field soil and may sometimes cause infections from that source.

Dry stalk-rot, sometimes called "wire stem" causes the young stalks to shrivel but the leaves sometimes remain alive for as long as a week. The shrivelled stalk is tough and wiry, and does not disintegrate into a mushy wet rot. It is caused by another one of the fungi[2] which sometimes cause bed rot.

[1] We have usually found *Pythium debaryanum* and *P. aphanidermatum* but there may be others.
[2] *Rhizoctonia*.

Control. Since at least some of the infection starts in the beds, one obvious control measure is to keep the beds as free as possible from disease by sterilizing the soil, by aeration, by keeping the stand thin, by avoiding too moist conditions and by keeping the plants sprayed as directed under "Mildew" and "Bed Rot".

Succulent, tender, fast-growing plants appear to be more subject to attack than those which are hardened. Plants of the first pulling from the beds are more susceptible than the later pullings. The use of well hardened and disease-free plants should do much to keep stalk rot under control. It might prove profitable to discard the first pulling and use only plants from the later pullings. Forcing the plants too much in the seedbeds should be avoided since it makes them tender and more susceptible to fungus attack.

Sore Shin

Sore shin, 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. Occasionally, however, under favorable conditions, it may take a serious toll and even necessitate replanting of entire fields.

Symptoms. The characteristic symptom most commonly observed is a brown or black, sunken, rotten canker at the base of the stalk when the plants in the field are half grown or larger (Figure 27). The canker may be only on one side or may entirely girdle the stalk at, or just below, the surface of the soil. In other cases, 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.

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 in this State is Rhizoctonia, which has been mentioned previously as causing bed rot and wire stem.

It has been observed frequently that the most severe cases of sore shin are 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 this disease. 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.

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 seedbed is the focus of infection, all measures previously outlined for controlling bed rot should be practiced. This offers the best means of preventing sore shin. If it is practicable, plants from beds that have bed rot should not be used. If this is not possible, the plants should be carefully inspected when pulled and all which show the smallest brown stem lesions should be discarded. Even with such precautions, all diseased plants will probably not be eliminated. Frequent restocking shortly after setting is advisable but late restocking is hardly worthwhile. Heavy, wet soils and fields known to produce sore shin should be avoided.

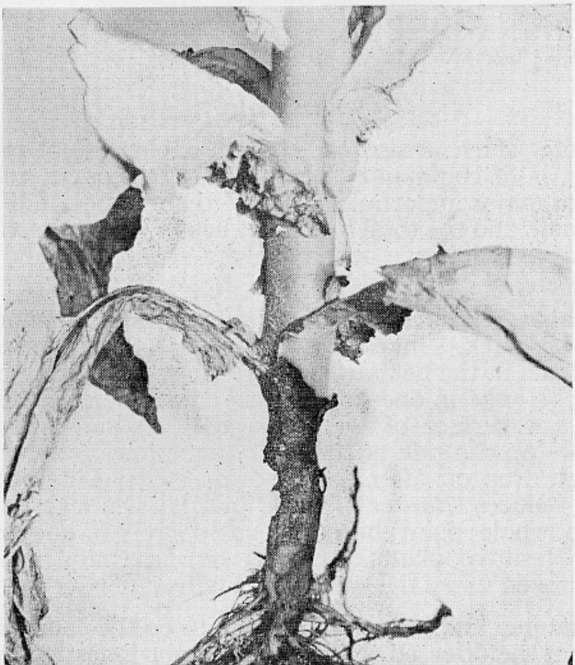

Figure 27. Sore shin.

Hollow Stalk or Bacterial Soft Rot

This is a disease of long standing in Connecticut. It belongs strictly to wet years and may not appear anywhere in dry seasons.

Symptoms. In general, hollow stalk appears first at about the time of topping. The characteristic symptom is the decay of the pith, which in wet weather is reduced quickly to a dark colored, watery jelly. With the recurrence of dry weather, the rotten pith dries and shrivels, leaving the stalk hollow; hence, the popular name of the disease. The progress of the rot does not stop at the pith. From there, it passes by natural channels into the bases of the leaves, causing them to droop and hang down (Figure 28), or to fall off, leaving the stalk bare. Even if the stalks are harvested in the early stages, the leaves do not cure well in the shed.

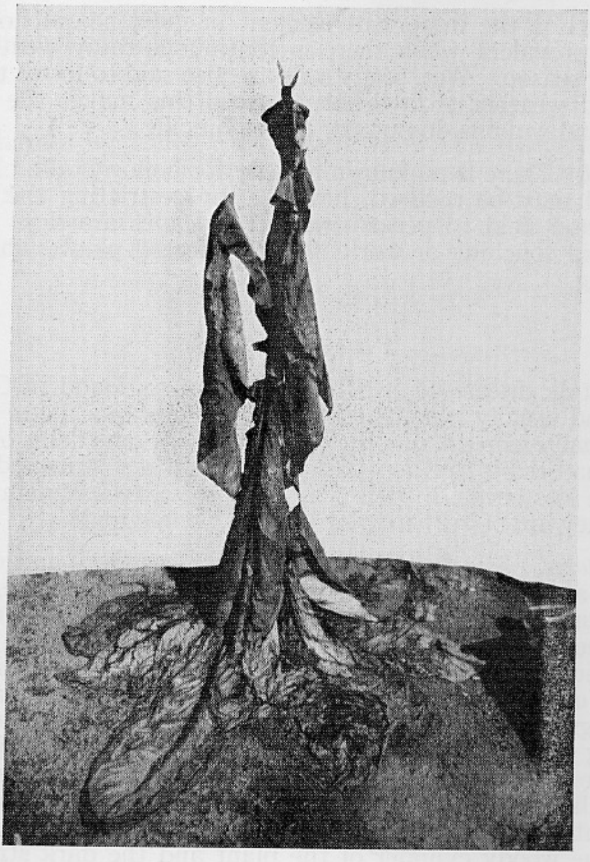

Figure 28. Hollow stalk or bacterial soft rot.

The rot usually starts in the pith where the top has been broken out. During very wet years or in exceptionally damp locations, it may start in the leaves in the field and rot out the midribs or produce large holes in fleshy leaves. During such years it may cause considerable loss in shade tobacco by rotting the leaves kept too long in the baskets or it may rot the midribs and cause the leaves to drop from the lath.

The rot is caused by invasion of the pith by parasitic bacteria.[1] Finding the succulent pith a favorable food, these bacteria multiply and spread with incredible rapidity, causing complete collapse of the

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[1]*Bacillus aroideae.*

interior of the stalks and the bases of the leaves within a few days. They are spread from plant to plant on the hands of workmen and gain access to the pith through the fresh wounds caused by breaking out tops or suckers. Broken midribs or other injuries give them access to the leaves.

Moisture is the important element in incidence of hollow stalk. It is most prevalent when there is continuous rainy weather during the topping season. Wet, soggy soils are also said to foster the disease. Hot, humid weather is favorable because this makes the pith more succulent and wounds do not dry out as quickly.

Control. There is no known remedy for hollow stalk. The spread in the field may be reduced, however, by restricting the operations in an affected field to periods when the leaves are dry. Workmen should avoid touching or working with affected plants while topping or suckering.

Fusarium Wilt

This stalk disease of field tobacco was first found in Connecticut in 1943, and usually is confined to a few plants in a field. It appears to be gradually increasing in prevalence and in some fields of Broadleaf and Havana Seed is causing considerable damage. Infected plants are a complete loss because, even if some of the leaves remain alive until harvest, they are of very inferior quality when cured.

Symptoms. The first symptom of wilt is fading and drooping of the leaves along one side of the plant. The affected leaves die gradually and turn brown while the leaves on the opposite side of the stalk remain green. The top of the stalk develops a curvature toward the diseased side; hence, the disease is sometimes called "crook-neck". The stalk of the plant remains green up to a very late stage. When the outer green cortex on the affected side is peeled off, however, the underlying woody part is found to be dark brown or black, although that on the healthy side of the stalk remains white. The dark discoloration on the affected parts not only runs up to the top of the stalk but out into the midveins of the leaves as dark streaks. The dark color of the woody cylinder of the plant and the dark streaks in the midveins are the sure signs by which Fusarium wilt can be distinguished from any other tobacco disease that occurs in Connecticut. In late stages, the outside of the affected bark also turns black and in very severe cases the entire plant dies.

Wilt is caused by the penetration of a parasitic fungus[1] which enters the roots from the soil and grows up to the top of the plant through the water-carrying ducts (xylem).

Hot weather favors the disease, which accounts for the fact that it first appears in fields here in July and August. This is also the reason for its greater destructiveness in southern tobacco states and

[1]*Fusarium oxysporum* var. *nicotinianae*. See Conn. Agr. Exp. Sta. Bul. 478, p. 111, for a more complete description of the disease.

makes it more unlikely that it will ever be a major disease in Connecticut.

Control. No method of control is known. Resistant varieties have been developed in southern states where the disease is more important. If it should ever assume dangerous proportions here, this line of attack would be most hopeful but, at present, control operations do not seem necessary.

Mosaic or Calico

Other names by which the growers know this disease are "mongrel", "brindle", "gray top" and "rust", descriptive of specific symptoms. In most fields it is not a major disease, affecting only a few plants, but in some fields and during some seasons it causes serious losses, particularly to the quality of the crop.

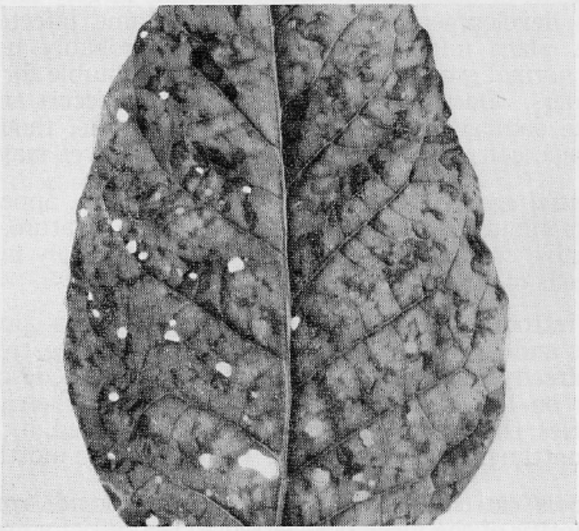

Figure 29. Mosaic disease on leaf.

Symptoms. The mottled appearance of the leaves, with splotched areas of greenish yellow between other areas of normal green, is familiar to all growers (Figure 29). Symptoms show all gradations of intensity. Sometimes the differences in shade of color are barely noticeable; at the other extreme, the light chlorotic areas of the leaf may be bright yellow to almost white, therefore standing out very sharply in contrast. Also, the pattern or mosaic, formed by the irregular alternating chlorotic and normal parts, is so extremely varied as to defy description.

In severe cases young leaves may become distorted or "puffed" and are inclined to be abnormally narrow. Plants affected early become dwarfed, do not make normal growth and are practically worthless when mature. Late infestations, with only a few of the top leaves showing the symptoms, frequently not severe, are commonly known as "gray top" by growers.

There are other symptoms, however, which growers do not always realize are manifestations of the same disease. This is particularly true of the necrotic or dead spots of various shapes and colors that develop in the leaf tissue. These are of two general types and have been called white rust and red rust. The white rust, also called fleck, is marked by numerous small white spots peppered over the leaf. In the red rust type the spots are larger, more irregular and of a reddish brown color. This spotting may be so severe as to cause death of the whole leaf. The red rust type usually appears on the upper leaves of the plant. Burning of the top leaves usually results from the spread of mosaic while topping. Since such leaves often show no mosaic mottling, the grower is not aware of the connection.

The extent of damage to a plant depends largely on the stage of the plant's development at the time it became infected with the disease. A plant infected in the seedbed probably never attains sufficiently normal growth for its leaves to be suitable for cigar wrappers or binders. On the other hand, if infection occurs at the time of topping, the damage may be practically negligible, though, even at this late stage, considerable "burn" of the top leaves may result.

The causal agent. Mosaic is caused by a virus, appearing in the plant sap as minute rod-like particles of a protein nature, which have the remarkable characteristic of being able to multiply indefinitely in the living cells of all parts of the tobacco plant.

When introduced into a tobacco plant, the virus spreads rapidly to the roots and to the newly developing leaves, but extremely slowly to leaves already fully grown. The rust symptoms described above will appear on leaves that were growing rapidly when infection occurred; leaves that were very small when attacked by the disease will show mottling. All new growth will likewise be mottled.

Mosaic is extremely infectious and will spread from the most minute quantity of the virus transferred to the cell of a growing plant. From this point, it quickly spreads in the sap to the roots and to the growing point of the plant. Once a plant is infected, it never recovers, since it has no way of eliminating the virus. When the infected plants are established in the field, the virus may be spread around on hands, clothing, tools, etc., during any cultural operations.

In cured or dried leaves the virus remains infective almost indefinitely. Its longevity is probably the most important fact to be kept in mind in connection with the prevention of mosaic. It will even survive in manufactured tobacco, such as cigars, cigarettes and chewing tobacco.

Control. No spray or dust is effective in controlling mosaic. Control measures should aim, first, at preventing the introduction of the disease into the bed or field in the spring and, secondly, at removing infected plants which may spread it from plant to plant in the field.

The following preventive measures have been found useful and are offered as suggestions to growers whose crops are troubled with mosaic.

1. Tobacco refuse from curing sheds, sorting rooms or other sources should be kept entirely away from the seedbeds. Sometimes tools or bed sash, which have been stored in sheds without being carefully cleaned, may carry bits of diseased leaves to the beds.

2. If the stalks of a preceding crop are to be used on tobacco land for fertilizer, they should be plowed under the surface as thoroughly and early as possible to give them every opportunity to decay. If results from this practice in previous years have been bad or if stalks are from an infected crop, it is better to use them on land intended for crops other than tobacco.

3. Men who are weeding, pulling, setting, or handling the crop in any way, should be discouraged from using tobacco. This applies to the use of the leaf in any form, but particularly in chewing and pipe tobacco.

4. Plants should never be set from a bed known to contain the disease. Plants infected with mosaic are difficult to detect in the seedbed. If only a few are found, it is quite certain that there are many other diseased ones which have not been "spotted".

5. Just after the plants start in the field, "rogue" out any diseased ones. About once a week, while the plants are small, a workman should systematically inspect each row, pull up every calico plant and put it in a basket. This should be done before cultivating or performing other operations which might spread the disease. The person who rogues should avoid touching any healthy plant, otherwise he may spread more disease than he removes. The basket of diseased plants should be dumped far from any growing tobacco. The workman should wash his hands thoroughly before handling healthy plants again.

6. If rogueing has not been successful, avoid spreading the virus from diseased to healthy plants during field operations, even at the time of topping and suckering. If there are several men working, one of them may handle all the diseased plants ahead of the others and not touch the healthy ones. This measure is of less importance than the preceding ones, since the direct damage at this stage is not great.

7. A field that tends to have mosaic every year should be planted to other crops for one or more years.

8. Fall plowing is helpful because it allows the crop residues and the virus to rot before the next crop is planted.

Mosaic resistant varieties. Satisfactory resistant strains have been developed in several types of tobacco in different states. None of the resistant strains, which we have developed in our Connecticut types, are yet ready for distribution but, from present indications, this will soon be the final solution of the mosaic problem.

Frenching

Frenching is a rare disease of long standing in Connecticut. Although a severely affected plant is a total loss, the disease does not usually cause serious trouble. Only a small percentage of plants in the field is likely to be affected and these are confined to certain definite areas. If frenching occurs during succeeding years, the location in the field is likely to be the same. Often it disappears entirely after one season. It occasionally appears in the seedbeds.

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 of 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. 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 numbers set very close together. This appearance may be intensified by abnormal branching of the stalk.

Cause. The cause of frenching has not been definitely proved. It is not associated with any fungus, bacterium, insect or other foreign organism. It cannot be transmitted from a diseased to a healthy plant; that is, it is non-infectious.

Control. No method of control is known. Growing of tobacco on fields where the disease has occurred frequently should be avoided. The soil reaction should be kept below 6.0 pH. If frenching does not become more prevalent in Connecticut than it is at present, control operations are hardly warranted.

Malnutrition Disorders

There are nine food elements which the tobacco plant absorbs from the soil: nitrogen, potash, phosphorus, magnesium, calcium, iron, sulfur, manganese 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 these differ from those of the others, with the possible exception of sulfur. Symptoms resulting from deficiency of iron, sulfur and boron never appear in the field because these elements are never sufficiently scarce in Connecticut soils to induce visible symptoms.

Abnormal conditions may also be brought about by absorption of an excess amount of some of the food elements. Moreover, there are 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.

All these disturbances are called malnutrition diseases. Some of the common ones are described below. Frenching possibly should also be included in this group.

Magnesia Hunger or Sand Drown

Magnesia leaches from very sandy soils, especially during seasons of excessive rainfall. When the soil supply becomes so low that the roots cannot absorb enough to meet the physiological requirements of the plant (0.4 per cent MgO), the leaves develop chlorotic symptoms known popularly as "sand drown". The color between the veins fades out to light yellow or almost white, contrasting strongly with the dark green pattern of the vein system (Figure 30). The leaves do not

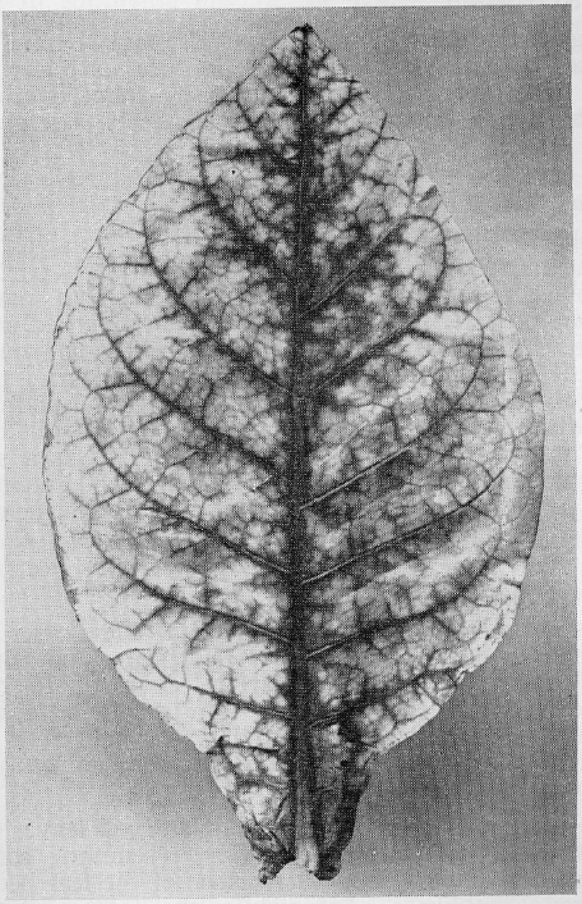

Figure 30. Magnesia hunger. Blanched leaf with green network of veins.

become hobbly or recurved downward at the margins, as is the case in potash hunger, but remain smooth and feel thick and stiff between the fingers. The lower leaves are affected first but later the symptoms may travel up the plant, even to the top leaves in extreme cases. In very advanced stages, the yellow areas between the veins may die and turn brown. The most serious damage, however, comes from the checked growth of the plants and the lifeless character of the cured leaves.

If "sand drown" is observed early in the season, it may be remedied by applying 75 pounds of magnesia, preferably in magnesium sulfate, to the acre and working it into the soil. Magnesia hunger is rarely found if sufficient magnesia has been included in the fertilizer.

Nitrogen Starvation

Nitrogen starvation causes the entire plant to turn pale and in severe cases to remain smaller and produce narrower leaves than normally. This trouble is well known by tobacco growers and is remedied by nitrate applications in the bed or by side dressing in the field.

Phosphorus Deficiency

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 not so often seen; it is most likely to occur in new fields during the first year or two of tobacco culture. When symptoms of phosphorus deficiency are found while the plants are young, the trouble can be overcome by applying "ammo-phos" (200 pounds to the acre) as a side dressing thoroughly worked into the soil. Application of 500 pounds of superphosphate per acre in the fall is a good practice on fields known to be short in available phosphorus.

Potash Deficiency

This is not a very common trouble but a few cases are brought to our attention almost every year. Shortage of potash in the soil produces characteristic symptoms on the leaves of the plants. The most severe cases that the writer has seen in this State were in seedbeds, 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 field.

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 severe, the only symptoms are yellowing and sharp downward recurving of the leaf tips.

The cured leaves do not come into "case" in the shed so quickly as those which have sufficient potash. They are dry, harsh, non-elastic, and have poor fire-holding capacity.

When this disorder occurs in the beds, the plants should be thoroughly sprinkled with a solution of nitrate of potash made by adding 2 pounds of this material to a barrel of water. After the solution 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. The remedy in the field consists in supplying any of the potash materials commonly used in the fertilizer mixture. The trouble in the field, however, is rarely observed until it is too late to undertake remedial measures for the current year.

Manganese Poisoning

All tobacco leaves normally contain a small amount of manganese, usually less than 0.25 per cent of manganese oxide (Mn_3O_4). 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.

Dead-blossom Leaf Spot

This is a disease that frequently causes considerable loss in shade fields but is rarely seen in the open field. It causes losses in two ways: (1) the large dead spots on the leaves make them useless for cigar wrappers, (2) blossom rot leaves carried into the sheds are a source of pole rot (see "Pole Rot" on page 79).

Symptoms. After the blossoms mature, the corollas, or pink trumpet-like parts, drop off. Many of them do not fall to the ground but stay on the leaves where they are held by the sticky nature of the surface hairs. As they dry out or rot, especially in wet weather, large dead spots develop under and around the fallen corollas (Figure 31). The spot starts first as a small darkened area just under the dead corolla but spreads rapidly and is soon an inch or more in diameter, becoming brown and dry or bleached to gray in the sunshine. The corolla may become black with fungous spores and remains tightly attached to the leaf. In wet weather the spot may spread until it involves half or more of the leaf. Frequently, it rots the midrib so that the leaf hangs limp and yellow. If it runs down the rib to the stalk, it often causes brown cankers several inches long. When the canker spreads around the stalk, all the leaves above the canker become yellow and soon die.

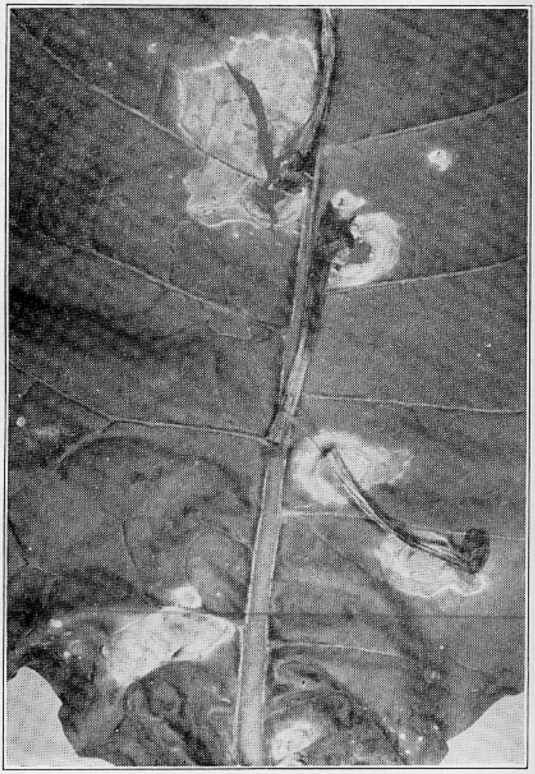

Figure 31. Dead blossom rot on shade leaf.

Cause. This leaf spot and decay are caused by two species of parasitic fungi.[1] The symptoms are about the same, regardless of which of the two parasites is present. The fungous spores at this season of the year are blown about in the air in countless numbers and fall on all parts of the tobacco plants. On the surfaces of healthy leaves and stalks the spores soon die even though they may germinate in wet weather. They are not able to infect the leaves or stalks. But on the corollas the story is quite different since these organs seem to furnish the natural medium for their growth. The germ tubes enter and spread with amazing rapidity in the flower tissues. The corollas that fall on the leaves are masses of fungous growth with a stepped-up vigor that enables the fungous threads to penetrate the leaf tissues

[1]*Sclerotinia sclerotiorum* and *Botrytis cinerea.* These are the same species of fungi that cause pole rot.

and spread swiftly. When the rot starts to spread in the leaf, nothing stops it except the coming of dry weather. Then it stops abruptly and there is a sharp definite margin to the spot. It often resumes its spread when wet weather again occurs. Sometimes the spots or cankers start where the leaf or stalk is broken or bruised but the vast majority of the spots start from the fallen blossoms.

Control. No practical method of stopping the development of the spots in the field has been found. If the blossoms could be kept off, there would be no trouble, but topping and suckering are not considered good practice for other reasons. Those who raise tall, late flowering strains like Connecticut 15 have very little trouble because most of the valuable leaves are harvested before the blossoms begin to drop.

Pole Rot[1]

Disease, spoilage, or decay of tobacco while it is curing on the poles in the sheds is called pole rot. Other common names are sweat, pole sweat, shed burn, stalk rot, stem rot, slimy stalk, hollow stalk and rattle box. During bad years losses of more than a million dollars for the tobacco region are not uncommon. During exceptionally good curing years, losses may be almost negligible but a crop is never cured without some loss.

Symptoms. In the green or early yellow stage, the leaves or large patches of them first swell and become discolored and clammy to touch. Drops of water may stand out on them. This soon develops into a darker soft rot and the leaves have no strength but pull apart when handled. They give off an odor of decaying vegetable matter. The midribs swell and, as they weaken in advanced stages, the leaves drop easily off the stalks. When the leaves are dried, they do not come into case easily and the affected parts are brittle and shatter with handling during a damp. On the sorting bench, the leaf blades pull away from the midribs when the leaf is opened (Figure 32). The midribs themselves disintegrate, leaving intact only the vascular strands, like ravelled cords.

On the stalks, there are different symptoms. The stalks may become slimy and wet and the outer part may slip easily off the woody cylinder ("slimy stalk"). Such stalks frequently become covered with a mouse-gray, felt-like mold, which sends off dusty clouds of spores when the stalk is handled. Other stalks become hollow and, when they are dry, little hard black pellets are found inside which rattle around like a rattle box if the stalk is shaken. The leaves on such stalks are prematurely cured, off-color, thin and papery and of inferior quality generally.

In another type of rot (freckle rot) the leaves become peppered with small darker spots of the size and distribution of freckles on the face. This type is not so damaging and seldom causes complete breakdown of the tissues.

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[1]For a more complete discussion, see Conn. Agr. Exp. Sta. Bul. 517, "Pole Rot of Tobacco", 1948.

Cause. Pole rot in all its forms is caused by the attack of parasitic fungi.[1] Wet weather and moisture in the sheds are not the primary causal agents of rot. They merely *create a condition* which is necessary for the attack and growth of the parasitic fungi. These fungi frequently attack the plants while they are still in the field, making incipient cankers in injured tissues around wounds caused by topping, suckering and accidental bruises. In shade tobacco they cause the previously described dead-blossom leaf spot and the introduction of such infested leaves is commonly the start of rot in shade sheds.

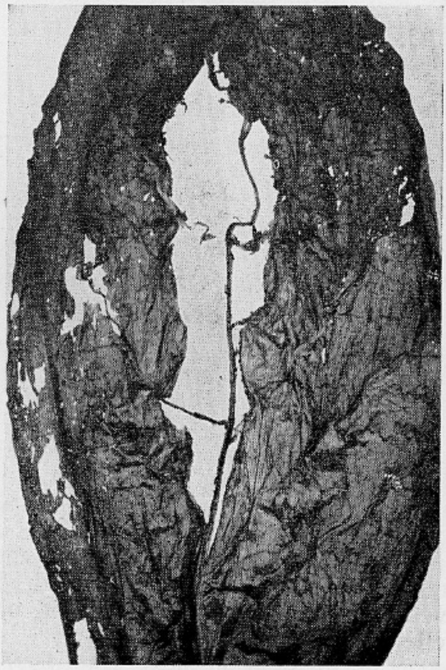

Figure 32. Pole rot or vein rot on cured leaf.

Tobacco leaves in the field always have great numbers of spores of these fungi on their surfaces. The numerous breaks and bruises incident to harvesting furnish ideal infection courts for these spores. One of the main advantages of "green firing" mentioned on page 51 is to dry out these wounds before rot can get started. Too, these spores are blown about in the air and enter the shed through cracks and ventilators. If they find the surfaces of the plants moist, they germinate and start new infection.

[1]*Sclerotinia sclerotiorum*, *Botrytis cinerea* and *Alternaria tenuis* are the three species that we have found causing rot in Connecticut. Most of our destructive rot is caused by the first two mentioned. Alternaria causes only the freckle rot type.

Control. No method of destroying the spores or causal fungi in the sheds nor preventing the spores from entering the sheds has been found. Since they will always be there, the obvious method of preventing rot is to create conditions in the shed that will stop their growth. Fortunately, these fungi have one weak point where they can be attacked: they are very dependent on moisture. There must be much moisture in the air or on the surface of the leaves to allow their spores to germinate. Too, as soon as the water content inside the leaves is sufficiently reduced, growth and spread of the parasite stops.

The whole purpose of fire curing is to reduce the moisture inside the sheds as completely and quickly as is consistent with development of good quality in the cured leaves. Raising the shed temperature above that of the outside air and maintaining air currents are the two means of removing moisture. This is the only workable method of combating pole rot that has been developed. Principles of curing tobacco with the aid of artificial heat are discussed under "Curing" on page 49.

INSECTS[1]

There are more than 20 species of insects that feed on tobacco in Connecticut. Four of them, cutworms, wireworms, flea beetles and aphids are of major importance and cause trouble every year. Hornworms and grasshoppers are present every year but are rarely serious. Thrips, springtails, seed corn maggots and Japanese beetles occur some years but their damage is not widespread. Stalk borers, corn root webworms, budworms, crane fly maggots and tarnished plant bugs are only occasional and their damage is usually negligible.

By using the key below, the grower should be able to identify the principal insects which he is likely to find in the seedbed or in the field.

KEY TO DAMAGE BY INSECTS ON TOBACCO

I. Insects causing injury to plants in seedbeds

1. Very small seedling in two- or four-leaf stage, defoliated. Tiny, purple, jumping insects, just visible to the naked eye. *Garden Springtail*
2. Large holes eaten in the leaves, or whole seedlings devoured or cut off at soil surface. Large dark-colored worms which feed at night and curl up under the surface of the soil or at the sides of beds during the day. *Cutworms*
3. Foliage of larger plants (middle or late May) have numerous "shot holes" eaten by small, black, active, jumping beetles, 1/16 inch long. *Potato Flea Beetle*
4. Small green insects on the undersides of leaves. No damage to plant apparent. *Aphids*

II. Insects causing injury to young plants in the field

1. Young stalks tunneled out, causing plants to wilt and die, usually within a few days after transplanting. Hard, yellowish-brown, shiny, slender worms, ½ to 1 inch long, in stalks or in soil near plants. *Wireworms*

[1]For more complete information see Conn. Agr. Exp. Sta. Bul. 379, "Insects Pests of Growing Tobacco in Connecticut", 1935, and Circular 179, "Control of Tobacco Insects", 1951.

2. Injury similar to that mentioned above. Soft-bodied white maggots ¼ inch long present. *Seed Corn Maggots*
3. Young plants cut off at soil surface. Fat, dark-colored worms curled up in soil nearby. *Cutworms*

III. Insects causing injury to larger, more mature plants in field in July or August

1. Growing point or buds attacked before leaves unfold.
   - (a) Unfolding leaves distorted and curly but with no large holes. Brown mottled bug, ¼ inch long, flying away when disturbed. *Tarnished Plant Bug*
   - (b) Unfolding leaves ragged and misshapen with irregular, large holes. Small rusty brown worms, when young; or green, slender worms with paler stripes lengthwise on sides, up to 1½ inches long, when mature. *Tobacco Budworms*
2. Mature leaves damaged.
   - (a) Main veins silvery above and peppered with minute black specks. Brown, slender, sucking insects, 1/25 inch long. *Tobacco Thrips*
   - (b) Numerous little "shot holes" eaten by small, black, active, jumping beetles, 1/16 of an inch long. *Flea Beetles*
   - (c) Large round holes between veins eaten by large, variously colored (never black) hoppers with prominent hindlegs. *Grasshoppers*
   - (d) Holes much as above, or all of leaf tissue except larger veins eaten by dirty gray or brown, fat worms. *Cutworms*
   - (e) Large holes, or extensive areas without regard to veins, eaten away by large green caterpillars up to 4 inches long, with prominent horn-like appendage at posterior end. *Hornworms*
3. "Honeydew" on leaves, white cast skins of small insects present. Small green insects on the under surfaces of leaves. *Aphids*
4. Seed pods bored and entered by pale green, slender worms with lighter lengthwise stripes, up to 1½ inches in length. *Tobacco Budworms*

Methods of control are presented in the pest control charts on pages 104 to 108. Short descriptions of the insects are given below.

Flea Beetles

The potato flea beetle is one of the most serious pests of tobacco in Connecticut. The beetles are black, oval in outline, and about 1/16 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 (Figure 33). 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.

Although there is only one generation of flea beetles a year, there are two distinct feeding periods. Early in the spring, beetles that have hibernated over the winter may attack plants in beds, and later the newly set plants in the field. Apparently the beetles do not breed in tobacco fields, but usually lay their eggs in potato fields. The larvae develop by feeding on the potato roots. Adults begin to emerge about the second week in July, and damage to tobacco increases until early in August.

Control. For many years 1 per cent rotenone dust was the standard remedy for this pest. This material is still highly effective. DDT dust is also very effective, and is preferred by many growers because it also helps control aphids and other insects.

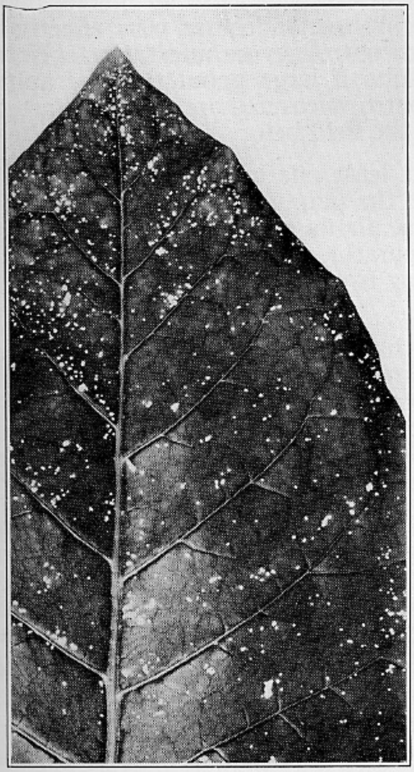

Figure 33. Flea beetle injury.

Consult pest control chart for beds, section 11, and chart for fields, sections 5 and 8, for schedule of treatments.

Aphids

The green peach aphid (*Myzus persicae* S.) has occurred on tobacco in small numbers for many years. In 1946, this aphid became a major pest and by 1948 was by far the worst pest of shade tobacco. The infestation declined in 1949 and 1950, but aphids remain a serious problem.

The damage caused by aphids on tobacco is most evident on the cured leaf. The presence of "honeydew" makes the leaves sticky and off-color. The white cast skins adhering to the leaf reduce the grade drastically. Infested leaves are papery and lifeless when cured.

The exact source of infestation on tobacco in Connecticut is not known. At least a few of the serious infestations could be traced to infested plants in the seedbed. Plants are infested in the field by winged aphids migrating from weeds or cultivated vegetables growing in the vicinity.

Control. Several insecticides are very effective in killing aphids, and can be used to control severe infestations. However, less damage to the tobacco results if large populations of aphids are prevented. For this reason, control measures are usually started in the plant bed and carried out in the field before the plants are heavily infested.

In the beds at least one application of parathion spray or dust should be made on the plants. This treatment should be at least 10 days before the first plants are to be removed. For a spray, ½ to 1 pound 15 per cent parathion wettable powder in 100 gallons of water is required. If dusting is preferred, a 1 per cent parathion dust may be used.

In the field it has been shown conclusively that DDT dust will kill many aphids and that dusted plants are not infested again for some time. The young plants may be dusted with 10 per cent DDT dust at the rate of 10 pounds to the acre. This also controls flea beetles and repeated dustings should keep the plants free of aphids until the plants grow too large for treatment with row-crop dusters.

Aphid control on large plants requires treatment by means of mist blowers or aircraft. The use of about 0.2 pound of parathion per acre in the form of wettable powder has given good results. This may be applied in from 3 to 5 gallons of water by aircraft or 10 to 15 gallons of water by mist blower. Usually only one or two such applications are required. The final application should be made at least a week before the first priming.

If isolated spots of infested plants are found during priming, hand treatment with tetraethyl pyrophosphate dust may be made.

See pest control charts for schedule of treatments.

Cutworms

Several species of cutworms may damage tobacco. Infestation may occur in seedbeds, newly set plants may be cut off just above the ground, or established plants may be damaged by cutworms feeding on the buds or leaves. The larvae that infest tobacco in the spring have hatched from eggs laid late in the preceding fall and have lived through the winter as partly grown caterpillars. Most of the cutworms feed only at night, and spend the day hiding just under the surface of the soil, usually near a tobacco plant.

Control. Cutworms are most easily controlled *before* plants are set in the field. In the beds, steam sterilization should kill all cutworms but some may migrate into the beds after steaming. Beds not sterilized may be infested by cutworms. Usually the young plants are partly grown before damage becomes apparent.

In the field the older method was to apply poisoned bait made of 50 pounds wheat bran, and 1 pound of Paris green mixed dry and then moistened. The bait should be broadcast late in the day at the rate of about 25 pounds to the acre before the plants are set. Heavy rain falling before the cutworms have had a chance to feed destroys the value of the bait.

More recent methods and materials are given in section 3 and 4 of the pest control chart for fields, page 107.

DDT dust as used for control of flea beetles should control cutworms on established plants.

Wireworms

Wireworms are hard, shiny, yellow or brown larvae that feed on the roots and stems of plants. Their most serious damage is in killing or stunting newly set plants. Wireworms are larvae of the click beetles seen so commonly around tobacco fields in May and June. Eggs which are laid in the soil hatch into very small larvae. Two to four years may be required for these to complete their growth. Therefore, fields infested one season may also be infested for one or two years afterwards.

Control. There are two practical methods of control for wireworms: (1) fumigation of the soil, and (2) soil treatment with insecticides.

Fumigation is usually used when control of nematodes is required. Either ethylene dibromide or "D-D" mixture may be used as for nematode control. Occasionally fumigation is not effective on wireworms because it is done late in the fall or early in the spring when the wireworms are too deep in the soil to be reached by the fumigant.

Soil treatment with insecticides may be made while the land is being prepared for planting. Four pounds of chlordane per acre may be applied to the surface of the soil in either dust or spray form and disked in immediately. In terms of the usual formulation, 8 pounds of 50 per cent chlordane wettable powder or 40 pounds of 10 per cent dust are required per acre. Results are usually better if the material is applied at least two weeks before setting the plants. One treatment should be effective for at least three years.

Good protection from wireworm damage can be obtained by addition of chlordane to the setting water. The suggested rate is 4 ounces of 50 per cent wettable powder to 50 gallons of water. Agitation is necessary to keep the powder from settling. This method may not be effective in succeeding years, but is especially useful in re-setting fields.

Hornworms[1]

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 fully grown (Figure 34). A slender, curved, soft horn-shaped protuberance on the back near the posterior end is responsible for the popular name of hornworm. These pests 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. 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. During some seasons hardly one hornworm 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.

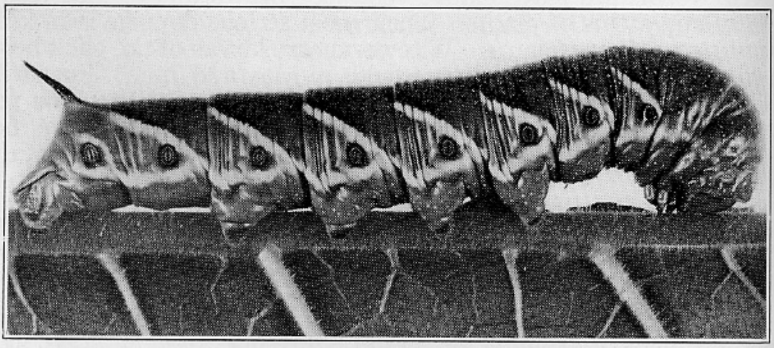

Figure 34. Hornworm.

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, they may frequently 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.

Control. When the worms are not numerous, growers usually depend on hand picking for control. In years when they become

[1]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.

numerous, the fields may be dusted with rhothane (see pest control chart for fields, section 9).

Grasshoppers

Grasshoppers of several species[1] feed upon the leaves of tobacco, leaving large, rounded, smooth-edged holes an inch or two in diameter, mostly between the veins. Damage is usually worst around the edges of the field, especially when adjacent to grass or hay fields. Serious infestations sometimes occur in the interior of fields, especially in new fields which were in grass the previous year.

Control. Grasshoppers may be controlled by scattering a poison bran bait between the rows as for cutworms. This should not be allowed to fall on the leaves because it will poison them and cause large dead spots.

This bait is spread on the ground at the rate of 10 to 20 pounds to the acre. It is usually necessary to treat only the edges of the fields. See pest control chart for fields, section 9.

Japanese Beetle

The Japanese beetle is about half an inch long, bright green in color, with copper-colored wing covers. Two white spots on the tip of the upper abdomen show beyond the ends of the wing-covers. These beetles feed on a variety of plants, including fruit trees and ornamental plants. Tobacco is not one of the preferred hosts. However, Japanese beetles emerging from tobacco land which was in grass the preceding season may damage the crop. Beetles may also migrate into tobacco from grassland nearby.

Japanese beetles emerge in July and most of their damage is done then. They breed in turf, where the larvae spend the winter.

Japanese beetles are killed readily by DDT, parathion or lindane dusts or sprays. If the infestation occurs at the time flea beetles are present, DDT will control both pests. If treatment is needed for aphids, parathion should work. If special applications are needed, either 10 per cent DDT, 1 per cent parathion, or 1½ per cent lindane dust may be used.

Budworm[2]

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[3] burrow through the

[1]The red-legged grasshopper, *Melanoplus femur-rubrum* DeG., is most common but is 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.

[2]*Chloridea virescens* Fabr.

[3]Rusty brown when first hatched, they change to pale green with stripes when ½ inch long.

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 (Figure 35). As the caterpillars grow, they feed on the more mature leaves. At the end of two or three weeks they are about 1½ 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, spindled-shaped pupae. In the spring the moths emerge and deposit eggs singly on the underside of the leaves. They may be controlled by the same method as flea beetles.

Figure 35. Bud leaves injured by budworm.

Tarnished Plant Bug[1]

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 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 tobacco plants but migrates 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.

The remedy is the same as for flea beetles.

[1]*Lygus pratensis* Linn.

Thrips[1]

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 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 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 yellow in the larval stage, brown in the adult, slender, and about 1/25 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. 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.

The usual treatment for flea beetles or aphids should be effective against thrips.

Seed Corn Maggot[2]

During some years the ravages of this insect have 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.

Since there is no practical way to forecast an outbreak of this pest, it is difficult to apply any preventive measures. At present, the only remedy is to reset the infested field, using 4 ounces of 50 per cent chlordane wettable powder in 50 gallons of setting water to try to prevent reinfestation.

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[1]*Frankliniella fusca* Hinds.
[2]*Hylemyia cilicrura* Rond.

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. The mature worm is about 1½ 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.

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

APPENDIX

Construction of a Shade Tent

The object of growing tobacco under cheese cloth is to produce thinner, smoother leaves with smaller veins, which are more suitable for fine cigar wrappers (Figure 36). 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 supplanted by wires. Today all tents in the Valley are almost uniform in pattern. The wires over which the cloth is stretched are stapled to posts which are set 33 feet apart each way. Originally chestnut poles were used but now they are made of red cedar or other species treated chemically to prevent rotting. These posts are in straight, exact rows, in either direction, the cross rows being exactly at right angles with the long rows. Poles of a length of 12 feet, and a minimum top diameter of 4 or 5 inches, are now in use. These posts last five to ten years at least and when once set are not changed. The poles are set 3 to 3½ 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, 1½ 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.

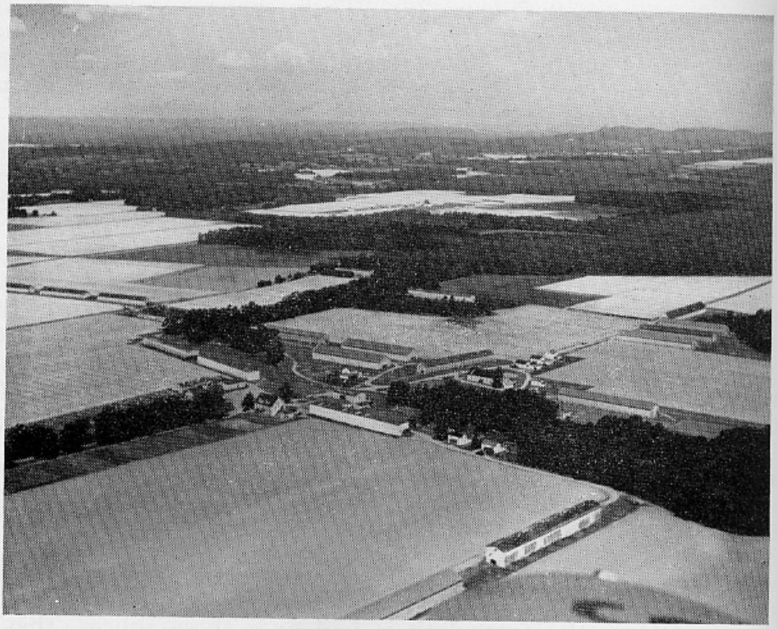

Figure 36. Aerial view of shade plantation. (*Photograph courtesy of The Hartman Tobacco Company.*)

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 yards long. It is purchased in bales of 400 to 450 pounds, four strips in a bale. One bale will cover about 1⅛ acres. The type of cloth used has eight threads one way and ten the other. Groups of re-enforcing closer strands are spaced about 18 inches apart the long way, and 14 inches the short way. 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 wooden skewers or 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 nine 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.

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 17th 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 passed 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 19th century, the increasing popularity of cigars and the introduction of 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 that 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 3. Study of this table shows that wars, booms and economic depressions have a direct influence on the acres planted as well as on the price received. Starting with a relatively high rate of production and price during the Civil War, there followed a long period of reduced acreage during the depressed 1870's. The more prosperous 1880's saw a big increase in acreage, but this was followed by the long depression of the 1890's.

A steady climb in acreage and price began with the new century, was accelerated by the First World War, culminating in 1921 with 31,000 acres, the highest ever attained in this State. High prices and the inflation after the war kept production at a high level until the depression of the 'thirties. The Second World War sent production and price up to another high level from which the industry is just now receding.

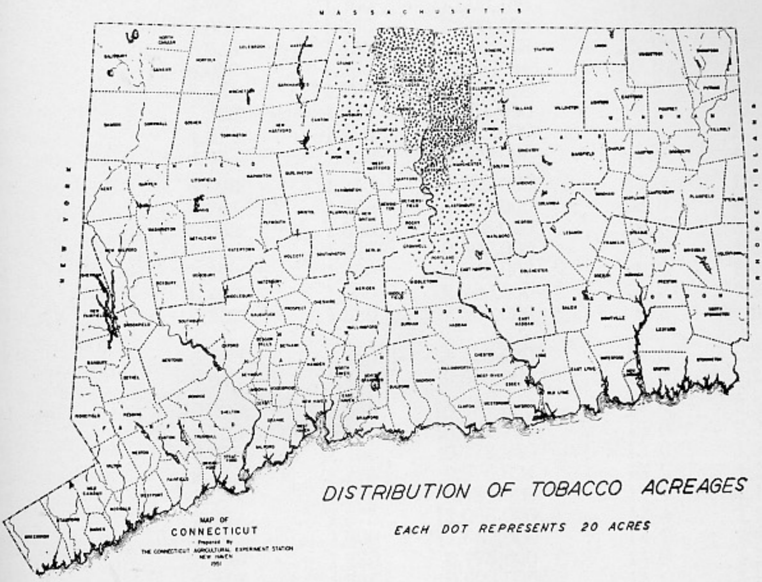

Figure 37. Map of Connecticut showing where tobacco is grown.

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 handmade 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 in the mid 'thirties to 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 (Figure 37). 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 prices and depression, the acreage shrank first in the towns at the greatest distance from the river. Even disregarding these fluctuations, the last hundred years have seen a steady tendency towards concentration of the industry along the banks of the river. The distribution by towns in the State is shown in Table 6.

TABLE 3. COMBINED PRODUCTION OF ALL TYPES OF TOBACCO IN CONNECTICUT (1839–1952)[1]

Year	Acres	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
1839	......	......	537,649[2]	....	....
1849	......	......	1,405,920[2]	....	....
1859	......	......	9,266,448[2]	....	....
1862	5,769	1,300	7,500,166	14.0	$1,050,023
1863	6,000	1,250	7,500,166	25.0	1,775,041
1864	6,828	1,450	9,900,218	25.0	2,475,054
1865	6,050	1,350	8,167,681	30.0	2,450,304
1866	6,534	1,200	7,840,974	13.6	1,063,275
1867	5,263	1,266	6,664,000	16.5	1,097,937
1868	4,871	1,450	7,063,000	18.6	1,313,802
1869	4,482	1,450	6,500,000	21.4	1,390,650
1870	5,996	1,250	7,495,000	20.3	1,520,530
1871	4,761	1,700	8,094,000	22.5	1,819,694
1872	5,052	1,650	8,336,000	26.6	2,215,058
1873	5,220	1,647	8,600,000	21.2	1,821,363
1874	7,224	1,250	9,030,000	28.9	2,605,591
1875	6,600	1,500	9,900,000	19.2	1,898,867
1876	6,203	1,220	7,568,000	8.3	631,245
1877	......	......	....	....	....
1878	5,800	1,400	8,120,000	11.0	891,417
1879	6,900	1,400	9,660,000	12.0	1,159,200
1880	10,070	1,538	15,487,660	15.0	2,323,149
1881	8,753	1,572	13,763,759	16.0	2,202,201
1882	8,665	1,128	9,772,269	13.0	1,270,396
1883	8,145	1,176	9,576,824	13.5	1,292,871
1884	8,064	1,176	9,481,000	12.4	1,175,644
1885	7,661	1,575	12,066,000	12.4	1,496,193
1886	7,292	1,600	11,667,000	14.0	1,633,380
1887	6,198	1,480	9,173,000	14.3	1,311,745
1888	6,136	1,565	9,603,000	13.0	1,248,369
1889	6,331	1,402	8,874,924	12.5	1,009,366
1890	6,394	1,600	10,230,400	16.0	1,636,864
1891	6,458	1,620	10,461,960	19.5	2,040,082
1892	7,104	1,600	11,366,400	21.0	2,386,944
1893	7,459	1,429	10,658,911	14.0	1,492,248
1894	6,713	1,516	10,176,908	16.0	1,628,305
1895	6,579	1,509	9,928,000	16.5	1,638,120
1896	6,579	1,550	10,197,450	13.0	1,325,668
1897	6,908	1,100	7,598,800	....	....
1898	6,563	1,250	8,203,750	....	....
1899	10,119	1,673	16,930,770	18.0	3,047,539
1900	10,948	1,684	18,435,765	15.0	2,833,041
1901	11,782	1,586	18,682,319	15.0	2,756,221
1902	12,725	1,712	21,785,200	16.0	3,485,632
1903	13,234	1,600	21,174,400	15.5	3,282,032
1904	12,705	1,685	21,407,925	22.6	4,838,191
1905	13,340	1,725	23,011,500	17.0	3,911,955
1906	14,140	1,735	24,532,900	18.0	4,415,922
1907	14,400	1,510	21,744,000	11.5	2,501,000
1908	13,824	1,680	23,224,320	17.0	3,948,134
1909	16,000	1,752	28,110,000	16.5	4,638,000

[1]Compiled from the Annual Reports of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

[2]All New England.

TABLE 3.—Continued

Year	Acres	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
1910	16,000	1,730	27,680,000	16.5	$4,567,000
1911	17,000	1,625	27,625,000	20.5	5,663,000
1912	17,500	1,700	29,750,000	24.1	7,170,000
1913	18,400	1,550	28,520,000	21.0	5,989,000
1914	20,200	1,770	35,754,000	18.5	6,614,000
1915	22,200	1,350	29,970,000	17.0	5,095,000
1916	22,200	1,630	36,186,000	27.0	9,770,000
1917	24,000	1,400	33,600,000	38.4	12,902,000
1918	25,000	1,500	37,500,000	44.0	16,500,000
1919	28,000	1,535	42,980,000	48.1	20,673,000
1920	30,000	1,365	40,950,000	45.7	18,714,000
1921	30,800	1,440	44,352,000	31.3	13,882,000
1922	28,000	1,065	29,820,000	40.5	12,077,000
1923	29,000	1,410	40,890,000	47.5	19,423,000
1924	28,900	1,368	39,535,000	29.3	11,584,000
1925	30,000	1,352	40,560,000	26.5	10,748,000
1926	22,400	1,340	30,016,000	36.7	11,016,000
1927	24,200	1,223	29,597,000	36.2	10,714,000
1928	25,000	1,190	29,750,000	37.0	11,008,000
1929	20,800	1,370	28,496,000	48.1	13,707,000
1930	23,400	1,385	32,409,000	37.1	12,024,000
1931	22,600	1,351	30,536,000	23.0	7,017,000
1932	18,500	1,468	27,158,000	27.9	4,782,000
1933	13,800	1,366	18,858,000	22.9	4,323,000
1934	10,600	1,462	15,495,000	35.2	5,450,000
1935	12,400	1,429	17,715,000	19.1	6,383,000
1936	14,500	1,459	21,151,000	38.0	8,032,000
1937	17,200	1,293	22,240,000	34.0	7,564,000
1938	16,700	971	16,223,000	21.6	3,512,000
1939	17,300	1,443	23,958,000	35.1	8,755,000
1940	16,300	1,318	21,487,000	34.6	7,438,000
1941	16,600	1,379	22,890,000	44.5	10,177,000
1942	15,000	1,312	19,680,000	57.0	11,209,000
1943	14,200	1,412	20,051,000	79.2	15,885,000
1944	16,500	1,447	23,869,000	89.0	21,243,000
1945	17,800	1,355	24,126,000	101.3	24,451,000
1946	19,700	1,372	27,029,000	117.5	31,752,000
1947	20,500	1,302	26,692,000	125.2	33,422,000
1948	20,000	1,297	25,944,000	128.0	33,255,000
1949	19,600	1,356	26,568,000	99.0	26,314,000
1950	19,200	1,435	27,552,000	89.4	24,638,000
1951	16,500	1,355	22,353,000	92.2	20,604,000
1952	16,900[1]	1,428	24,138,000	....	....

[1]Planted acreage.

TABLE 4. HISTORICAL RECORD OF CONNECTICUT TOBACCO BY TYPES
(Harvested in 1919–1952)[1]

Year	Acres harvested	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
		Broadleaf			
1919	16,800	1,600	26,880,000	45.1	$12,109,000
1920	17,700	1,465	25,930,000	40.0	10,365,000
1921	17,000	1,546	26,282,000	20.0	5,273,000
1922	12,800	1,120	14,336,000	30.0	4,296,000
1923	13,200	1,510	19,932,000	35.0	6,984,000
1924	14,900	1,497	22,305,000	20.0	4,461,000
1925	18,400	1,400	25,760,000	19.1	4,908,000
1926	13,200	1,400	18,480,000	26.1	4,814,000
1927	12,700	1,309	16,624,000	21.0	3,483,000
1928	12,000	1,310	15,720,000	21.0	3,303,000
1929	7,900	1,455	11,494,000	27.1	3,115,000
1930	11,800	1,550	18,290,000	25.1	4,591,000
1931	12,900	1,500	19,350,000	14.0	2,709,000
1932	9,500	1,580	15,010,000	12.0	1,801,000
1933	7,200	1,500	10,800,000	13.0	1,404,000
1934	5,200	1,700	8,840,000	17.0	1,503,000
1935	6,200	1,700	10,540,000	18.5	1,950,000
1936	7,400	1,700	12,580,000	20.5	2,579,000
1937	8,800	1,540	13,552,000	15.5	2,101,000
1938	8,000	1,130	9,040,000	15.0	786,000
1939	7,600	1,620	12,312,000	22.0	2,709,000
1940	7,900	1,540	12,166,000	21.0	2,555,000
1941	7,900	1,600	12,640,000	22.0	2,781,000
1942	6,700	1,520	10,184,000	26.0	2,648,000
1943	6,500	1,670	10,855,000	40.0	4,342,000
1944	8,000	1,670	13,360,000	39.0	5,210,000
1945	8,900	1,620	14,418,000	60.0	8,651,000
1946	9,900	1,590	15,741,000	74.0	11,648,000
1947	9,900	1,500	14,850,000	51.0	7,574,000
1948	8,900	1,560	13,884,000	60.0	8,330,000
1949	8,900	1,580	14,062,000	53.0	7,453,000
1950	10,000	1,620	16,200,000	52.0	8,424,000
1951	8,100	1,640	13,284,000	51.0	6,775,000
1952	8,800[2]	1,640	14,256,000	....	....

[1]Estimates of the Crop Reporting Service of the U. S. Department of Agriculture.

[2]Planted acres.

TABLE 4.—Continued

Year	Acres harvested	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
		Havana Seed			
1919	6,100	1,580	9,638,000	31.0	$2,988,000
1920	6,100	1,449	8,839,000	36.0	3,182,000
1921	6,200	1,500	9,300,000	23.0	2,139,000
1922	8,000	1,125	9,000,000	29.0	2,610,000
1923	8,100	1,460	11,826,000	35.0	4,139,000
1924	7,800	1,345	10,491,000	19.0	1,993,000
1925	7,500	1,380	10,350,000	17.0	1,760,000
1926	4,700	1,463	6,876,000	28.0	1,925,000
1927	5,400	1,343	7,252,000	23.0	1,668,000
1928	6,000	1,300	7,800,000	24.0	1,872,000
1929	5,500	1,510	8,305,000	30.0	2,492,000
1930	5,700	1,520	8,664,000	23.0	1,993,000
1931	5,000	1,410	7,050,000	13.0	916,000
1932	5,300	1,580	8,374,000	9.0	754,000
1933	2,800	1,480	4,144,000	10.0	414,000
1934	1,300	1,650	2,145,000	15.8	339,000
1935	1,500	1,650	2,475,000	17.7	438,000
1936	1,800	1,670	3,006,000	18.5	556,000
1937	2,400	1,570	3,768,000	17.0	641,000
1938	2,600	1,050	2,730,000	15.0	348,000
1939	3,300	1,660	5,478,000	24.0	1,315,000
1940	2,900	1,640	4,756,000	23.0	1,094,000
1941	2,800	1,680	4,704,000	24.0	1,129,000
1942	3,000	1,540	4,620,000	27.0	1,247,000
1943	2,200	1,680	3,696,000	37.0	1,368,000
1944	2,200	1,770	3,894,000	38.0	1,480,000
1945	2,200	1,550	3,410,000	57.0	1,944,000
1946	2,600	1,600	4,160,000	69.0	2,781,000
1947	3,000	1,490	4,470,000	67.0	2,995,000
1948	2,800	1,580	4,424,000	63.3	2,781,000
1949	2,500	1,570	3,925,000	39.0	1,531,000
1950	2,600	1,650	4,290,000	40.5	1,737,000
1951	1,700	1,630	2,771,000	44.5	1,233,000
1952	1,800	1,640	2,952,000	....	....

TABLE 4.—Continued

Year	Acres harvested	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
		Shade			
1919	3,900	1,180	4,602,000	105.0	$4,832,000
1920	4,700	890	4,183,000	100.0	4,183,000
1921	5,700	1,040	5,928,000	95.0	5,632,000
1922	6,300	846	5,330,000	90.0	4,797,000
1923	6,800	1,130	7,684,000	100.0	7,684,000
1924	5,500	1,050	5,775,000	85.0	4,909,000
1925	3,800	1,048	3,982,000	100.0	3,982,000
1926	4,200	1,000	4,200,000	98.0	4,116,000
1927	5,700	900	5,130,000	105.0	5,389,000
1928	6,600	858	5,663,000	100.0	5,663,000
1929	7,300	1,150	8,395,000	56.0	4,701,000
1930	6,000	1,040	6,240,000	73.0	4,555,000
1931	4,700	880	4,136,000	82.0	3,392,000
1932	3,700	1,020	3,774,000	59.0	2,227,000
1933	3,800	1,030	3,914,000	64.0	2,505,000
1934	4,100	1,100	4,510,000	80.0	3,608,000
1935	4,700	1,000	4,700,000	85.0	3,995,000
1936	5,300	1,050	5,565,000	88.0	4,897,000
1937	6,000	820	4,920,000	98.0	4,822,000
1938	6,100	730	4,453,000	60.0	2,378,000
1939	6,400	1,120	7,168,000	66.0	4,731,000
1940	5,500	830	4,565,000	83.0	3,789,000
1941	5,900	940	5,546,000	113.0	6,267,000
1942	5,300	920	4,876,000	150.0	7,314,000
1943	5,500	1,000	5,500,000	185.0	10,175,000
1944	6,300	1,050	6,615,000	220.0	14,553,000
1945	6,700	940	6,298,000	220.0	13,856,000
1946	7,200	990	7,128,000	240.0	17,323,000
1947	7,600	970	7,372,000	310.0	22,853,000
1948	8,300	920	7,636,000	290.0	22,144,000
1949	8,100	1,040	8,424,000	205.0	17,269,000
1950	6,600	1,070	7,062,000	205.0	14,477,000
1951	6,700	940	6,298,000	200.0	12,596,000
1952	6,300[1]	1,100	6,930,000	.....	....

[1]Planted acres.

TABLE 5. ACREAGE AND PRODUCTION OF SHADE TOBACCO IN ALL NEW ENGLAND (1900–1952)[1]

Year	Acres	Yield per acre (pounds)	Total production (pounds)	Farm price per pound (cents)	Total value
1900	1/3				
1901	41				
1902	720				
1903	625				
1904	33				
1905	40				
1906	40				
1907	70				
1908	200				
1909	400				
1910	1,000				
1911	1,995				
1912	1,906				
1913	1,840				
1914	2,574				
1915	3,609				
1916	4,939				
1917	5,917				
1918	6,223				
1919	4,900	1,178	5,800,000	105.0	$6,060,000
1920	6,000	899	5,400,000	100.0	5,393,000
1921	7,400	1,019	7,500,000	95.0	7,166,000
1922	8,000	849	6,800,000	90.0	6,113,000
1923	8,500	1,134	9,600,000	100.0	9,639,000
1924	6,900	1,070	7,400,000	85.0	6,277,000
1925	4,600	1,050	4,800,000	100.0	4,830,000
1926	5,300	1,004	5,300,000	97.8	5,204,000
1927	7,100	899	6,400,000	105.0	6,705,000
1928	8,000	865	6,900,000	93.0	6,439,000
1929	8,800	1,153	10,200,000	56.0	5,684,000
1930	7,400	1,040	7,700,000	73.0	5,618,000
1931	5,800	880	5,100,000	82.0	4,186,000
1932	4,500	1,016	4,600,000	59.0	2,699,000
1933	4,700	1,032	4,800,000	64.0	3,104,000
1934	5,000	1,100	5,500,000	80.0	4,400,000
1935	5,700	1,004	5,700,000	85.0	4,866,000
1936	6,400	1,055	6,800,000	88.0	5,942,000
1937	7,200	832	6,000,000	98.0	5,869,000
1938	7,300	745	4,800,000	60.0	2,910,000
1939	7,700	1,120	8,600,000	66.0	5,692,000
1940	6,400	862	5,500,000	83.0	4,581,000
1941	6,800	947	6,400,000	113.0	7,274,000
1942	6,100	925	5,600,000	150.0	8,466,000
1943	6,300	1,004	6,324,000	185.0	11,699,000
1944	7,300	1,060	7,735,000	220.0	17,017,000
1945	8,100	935	7,572,000	220.0	16,658,000
1946	8,800	1,003	8,824,000	240.0	21,178,000
1947	9,500	975	9,262,000	310.0	28,712,000
1948	10,600	924	9,798,000	290.0	28,414,000
1949	10,500	1,061	11,136,000	205.0	22,829,000
1950	8,300	1,097	9,102,000	205.0	18,659,000
1951	8,400	960	8,066,000	200.0	16,132,000
1952	7,800[2]	1,104	8,611,000	......	....

[1]Reports of the New England Crop Reporting Service.

[2]Planted acres.

TABLE 6. ACREAGE OF TOBACCO BY TOWNS AND COUNTIES IN CONNECTICUT (Broadleaf and Havana Seed in 1951 and Shade in 1950)[1]

Towns and counties	Broadleaf 1951	Havana Seed 1951	Shade 1950	Total
Bloomfield	....	33	304	337
East Granby	41	252	524	817
East Hartford	952	....	213	1,165
East Windsor	1,559	....	432	1,991
Enfield	1,060	....	270	1,330
Glastonbury	742	....	268	1,010
Granby	....	49	257	306
Manchester	291	....	130	421
Simsbury and Avon	....	13	498	511
South Windsor	2,127	....	601	2,728
Suffield	1,101	839	650	2,590
Windsor	56	202	1,578	1,836
Windsor Locks	104	56	185	345
Total Hartford County	8,033	1,444	5,910	15,387
Ellington	479	....	149	628
Somers	241	....	173	414
Vernon	131	....	....	131
Total Tolland County	851	....	322	1,173
Cromwell	....	....	40	40
Middletown	....	25	....	25
Portland	50	....	183	233
Total Middlesex County	50	25	223	298
Total Litchfield County	....	30	....	30
Total for Connecticut	8,934	1,499	6,455	16,888

[1]Survey by Department of Economics, Storrs Agr. Expt. Station, furnished by Mr. Arthur Dewey.

PEST CONTROL CHART FOR TOBACCO BEDS

Prepared by the Connecticut and Massachusetts Agricultural Experiment Stations and Extension Services

Seedbed Operation	Pests	Preventive Treatment	
(1) Location of beds	Wildfire Mosaic {Calico, Brindle}	Don't locate beds near curing barns because wildfire and mosaic overwinter there and may be carried into beds. Change location of bed if these diseases were there last year and beds are not sterilized.	
(2) Sterilizing the soil	Weed seeds Damping-off Bed rot Rootrots Wildfire Earthworms Ants Nematodes	Steam or	Fall preferably, or spring at least 10 days before seeding. Loosen soil first. Use 100 lbs. pressure 30 minutes (20 minutes for 2 pans).
		Methyl bromide or	Fall when soil temperature is over 50° F. Use 1½ lbs. to 100 sq. ft. for 24 hours or 1 lb. for 48 hours under gas-tight tarpaulin.
		Chloropicrin	Fall only. When soil temperature is above 55° F., use 1½–2 lbs. to 100 sq. ft. Water surface at once to keep fumes in.
(3) Before making beds	Wildfire	If wall boards or sash were used on infected beds last year or were stored in shed when wildfire was present, sprinkle or wash them with formaldehyde at 1 gal. in 25 gals. of water.	
(4) Preparing the soil	Weed seeds Rootrots Damping-off Wildfire	Don't work soil deeper than it was sterilized; 3 inches is enough. Avoid contaminating sterilized soil with untreated soil from outside or with trash from curing shed.	
(5) After seeding beds	Ants Earthworms Springtails	When these pests appear, apply 5% chlordane dust to soil, ½ lb. to 100 sq. ft. (six 6-ft. sash, four 8 to 9-ft. sash) with excess around edge.	

BED CHART

Seedbed Operation	Pests	Preventive Treatment
(6) After plants are up and still in 2-leaf stage	Wildfire Damping-off Green "moss" Ground molds	Spray or sprinkle bed soil heavily with 1 gal. of Bordeaux 4-4-50 (copper sulfate-lime-water) for each 100 square feet. If Bordeaux powder or neutral copper fungicide is used (Copper A, Tri-Basic Copper Sulfate, C.O.C.S., Basicop, etc.), add following amounts to 50 gals. water: if 12-14% metallic copper, 8 lbs.; 24-26%, 4 lbs.; 48-51%, 2 lbs. *Leave beds open until plants are dry.* Copper burns if not dried rapidly.
(7) 7 days later	Wildfire Damping-off Green "moss"	Repeat the copper spray. *Leave beds open until leaves are dry.*
(8) When weeding beds	Mosaic {Calico, Brindle}	Don't smoke, chew, or handle other tobacco while weeding. Wash hands in soapy water several times a day.
(9) First week in May. At least 3 days from a copper application	Blue mold Bed rot	Spray plants and soil thoroughly with Ferbam* at dilution of 1 lb. in 50 gals. of water, or Zineb** at ¾ lb. in 50 gals. Apply 1 to 2 quarts of spray to each 100 sq. ft. of bed. *Fermate, Carbam-black, Nu-leaf, Ferradow, Niagra Carbamate, etc. **Dithane Z-78, Parzate.
(10) Twice a week until fields are set and stocked over and beds destroyed	Blue mold Bed rot	Repeat treatment as in Section 9. When plants are half grown, increase strength of Ferbam to 2 lbs. in 50 gals. and Zineb to 1½ lbs.
(11) Any time after leaves are size of dime if beetle holes are found in leaves	Flea beetles	Add 1 lb. of 50% DDT wettable powder to 50 gals. of the blue mold spray, or dust plants with 5% or 10% DDT dust.
(12) If blue mold appears in beds (Emergency treatment)	Blue mold	Gas beds 3 nights in succession with PDB crystals in baskets. One basket to each sash and 2 tablespoons of crystals in each basket. Seal beds tightly while gassing. Remove baskets when sun warms bed. Then continue blue mold sprays.

BED CHART

Seedbed Operation	Pests	Preventive Treatment
(13) If wildfire appears in bed (Emergency treatment)	Wildfire	If only in isolated spots, drench each spot including 12-inch band of healthy plants around it with formaldehyde 1-50. Leave bed open. Spray remainder of bed once a week with copper spray. (See Sections 6 & 9)
		If wildfire is extensive, kill all plants by drenching with formaldehyde 1-50 and keep bed closed.
(14) At least 10 days before first pulling	Aphids	Same treatment as in Section 11 or, if aphids are plainly evident, apply 1% parathion dust, or spray with ½ lb. of 15% parathion wettable powder in 50 gals. water (*not in blue mold spray*). *Use all safety precautions when using parathion.*
(15) During plant pulling and setting	Mosaic {Calico, Brindle}	To avoid spreading mosaic, pullers and setters should not use tobacco and should wash hands in soapy water several times a day.
(16) Immediately after fields are set and stocked over	Aphids Blue mold Mosaic {Calico, Brindle}	*Kill all plants.* Sprinkling the beds heavily with formaldehyde 1-50 is a good method; leave beds closed.
(17) Storing sash and wall boards	Wildfire Mosaic {Calico, Brindle}	Do not store sash and wall boards in curing barns. If wildfire was present in the beds, treat sash and boards with formaldehyde (see Section 3) before using again.

PEST CONTROL CHART FOR TOBACCO FIELDS

Prepared by the Connecticut and Massachusetts Agricultural Experiment Stations and Extension Services

Time	Pests	Control Measures
(1) Autumn or spring 3 weeks before setting	Nematodes Brown rootrot	Fumigate soil with ethylene dibromide (Dowfume W, Soilfume, Iscobrome, Bromofume) or dichloropropene mixture (D-D, Dowfume N, Nemafume). Follow manufacturer's directions for application rate (e.g. 15 gals. ethylene dibromide 40% by weight or 20 gals. dichloropropene mixture per acre). Apply when soil temperature is 50° or above and soil is moist, not wet.
(2) After plowing and until 2 weeks before setting or No. 4	Wireworms	To each acre apply 4 lbs. actual chlordane (40 lbs. 10% dust, or in water sprays, 8 lbs. 50% wettable powder, or 4 qts. 45-48% emulsion, or 2 qts. of 72-75% emulsion) and harrow into the soil. This treatment should be effective for three years.
(3) One week before setting or No. 4	Cutworms	To each acre apply 30 lbs. of 10% toxaphene dust or 50 lbs. of 5% toxaphene bait or use 3 quarts of 40% toxaphene emulsion in a water spray. Leave on surface at least 5 days.
(4) At time of setting	Cutworms	Broadcast 50 lbs. of 5% toxaphene bait to the acre immediately after setting.
	Wireworms	Add 4 oz. of 50% chlordane wettable powder to 50 gals. of the setter water. Keep agitated during setting and empty each barrel completely.
	Wildfire Sore shin Blue mold Mosaic	Avoid setting plants from beds affected with wildfire, mosaic, blue mold or bed rot. Don't smoke, chew, or handle other tobacco while setting.
	Black rootrot	Plant rootrot resistant varieties suggested by Experiment Station. Avoid high reacting (above pH 5.6) or wet, cold fields.
(5) Soon after setting	Flea beetles	When beetles appear and damage plants, dust with 10% DDT at 10 lbs. to the acre.

FIELD CHART

Time	Pests	Control Measures
(6) In shade tents as soon as the plants have started to grow and continuing through month of June	Blue mold	Spray or dust every 4 days with Ferbam at rate of 5 lbs. to the acre or Zineb at rate of 4 lbs. High concentrations are best if good distribution is obtained.
(7) At weekly intervals until plants are a foot high	Mosaic {Calico, Brindle	Remove all mosaic plants from field as soon as first symptoms are seen. Wash hands with soapy water before touching healthy plants. (Fields that have mosaic every year should be grown to other crops 1 to 3 years.)
(8) Start June 25 to July 10	Aphids (preventive treatment) Flea beetles Tarnished plant bug Japanese beetles	Dust 2 or 3 times at 10-day intervals with 10% DDT at 10 lbs. per acre. Arrange dust outlets to cover buds and undersides of the leaves.
(9) Emergency treatments	Aphids	1 lb. parathion (15% wettable powder) per acre in 3-5 gals. of water by aircraft, or in 10-15 gals. water if mist blower is used, or apply 1% parathion dust for "spot" treatments. Use all safety precautions to protect the worker.
	Hornworms	Dust with 10% TDE (Rhothane, Diatox, etc.) at 10 lbs. per acre as needed.
	Grasshoppers	Dust with 5% chlordane at 10-20 lbs. per acre. Treatments applied to borders of fields as young hoppers become numerous may save applications to tobacco itself.
(10) Autumn	Black rootrot	If previous crop had black rootrot and soil reaction is over pH 5.6, apply 500 lbs. ammonium sulfate per acre and omit cover crop if tobacco is to be grown on this land next year.

Parathion, EPN, Netacide and TEPP are dangerous when inhaled or when they come in contact with the skin. Use of these and similar materials is not suggested unless the grower is prepared to follow safety precautions provided with each container.

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