TOBACCO PRODUCTION

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Contents

Growth Through Agricultural Progress

This Agriculture Information Bulletin presents additional information from that formerly contained in Farmers' Bulletin 523, "Tobacco Curing," and Farmers' Bulletin 571, "Tobacco Culture."

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TOBACCO PRODUCTION

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The tobacco plant will grow on a wide range of soils from southern Canada to the Tropics. Different areas provide soils and climate for different types of tobacco leaf that possess certain well-recognized characteristics. As a result, the tobacco industry looks to these well-defined areas to obtain supplies of various kinds of leaf necessary to meet consumer demand or to fill export needs. As a rule it is not profitable to establish new areas of tobacco production. The cured leaf may not be quite acceptable as to type and it may be difficult to interest dealers and manufacturers in the new areas. Moreover, marketing facilities may not be available.

The character of the soil is a dominant factor in tobacco production. Tobacco will not thrive in an excessively wet or a waterlogged soil. The plant nutrient level of the soil is usually controlled to obtain different kinds of leaf acceptable to the consumer. Through a long evolutionary process that began in colonial times, various areas have been selected or developed to produce certain types of tobacco. The acreage planted to each of these different tobacco types occupies, as a rule, only a small area of land that is potentially adapted to each type. Usually tobacco growers in these areas possess the necessary know-how, equipment, and facilities; if necessary, they can readily increase their acreage to meet any increased demand at profitable prices.

TYPES OF LEAF TOBACCO

Tobacco types are not used interchangeably to any extent in the manufacture of tobacco products. For example, such cigarette tobaccos as flue-cured and burley are not generally used in the manufacture of cigars. Leaf for cigarettes, smoking, chewing, and snuff blends is grouped as flue-cured, fire-cured, and air-cured. Leaf for cigar types is known as filler, binder, and wrapper.

The U.S. Department of Agriculture has established an official system of classification for tobacco. Each class and type is designated by number, and the grades of leaf within the type are indicated by a series of symbols covering the principal characteristics and quality of the product (table 1). The type names establish use-value relationships that are well recognized by the trade (fig. 1).

GENERAL CULTURAL PRACTICES

Practices for seedbed culture are much the same for all areas, with modifications to take care of differences in soil and climate. Field preparation and fertilizer applications are carried out much the same as those for other crops in the same area. Transplanting tobacco is similar in each area—some areas may use more mechanical equipment, but even so, transplanting and cultivation of tobacco are tedious chores in producing the crop.

Because these practices are similar in all areas and for all types of tobacco, they will not be discussed with the specific cultural requirements for each tobacco type.

Seedbed Culture

A prime requisite for successful tobacco culture is a good supply of well-developed healthy seedlings at the proper time for trans-

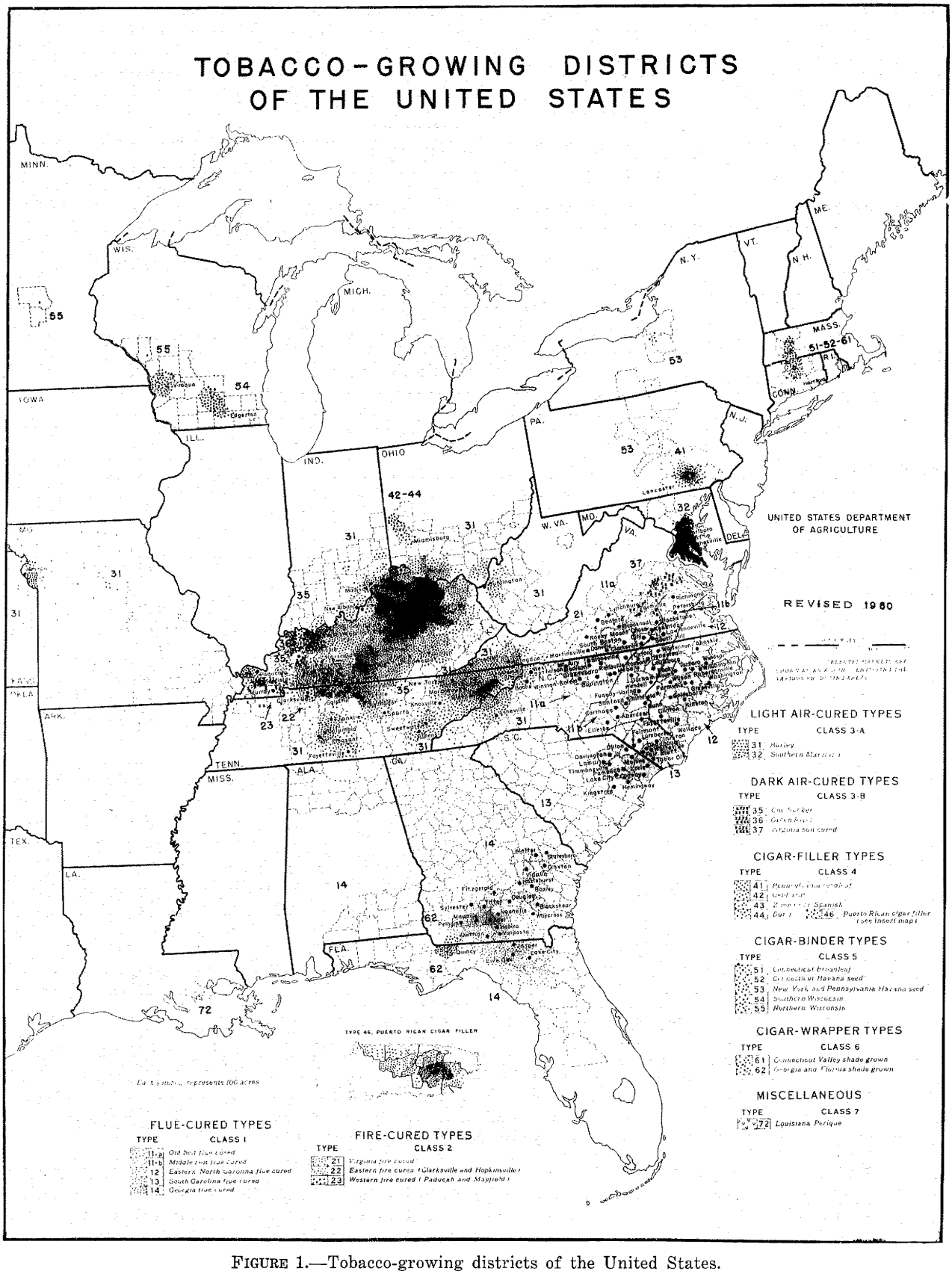

FIGURE 1.—Tobacco-growing districts of the United States.

TABLE 1.—*Classes and types of tobacco established by the U.S. Department of Agriculture*

Type of curing and class	Type	Type name or locality
Flue-cured, Class 1	11A	Old Belt — Virginia and North Carolina.
	11B	Middle Belt — Virginia and North Carolina.
	12	Eastern North Carolina.
	13	Border Belt — southeastern North Carolina and South Carolina.
	14	Georgia and Florida.
Fire-cured, Class 2	21	Virginia.
	22	Eastern — Kentucky and Tennessee.
	23	Western — Kentucky and Tennessee.
Air-cured:		
Class 3A (light air-cured)	31	Burley.
	32	Maryland.
Class 3B (dark air-cured)	35	One-Sucker.
	36	Green River.
	37	Virginia Sun-Cured.
Class 4 (cigar filler)	41	Pennsylvania Seedleaf, or Broadleaf.
	42	Gebhardt.
	43	Zimmer Spanish.
	44	Little Dutch.
	46	Puerto Rico.
Class 5 (cigar binder)	51	Connecticut Broadleaf.
	52	Connecticut Havana Seed.
	53	New York and Pennsylvania Havana Seed.
	54	Southern Wisconsin.
	55	Northern Wisconsin.
Class 6 (cigar wrapper)	61	Connecticut Valley Shade-Grown.
	62	Georgia and Florida Shade-Grown.
Miscellaneous, Class 7	72	Louisiana Perique.
	77	Domestic aromatic.

planting. It is becoming more difficult to produce these seedlings, as weeds, diseases, and insects are more prevalent and the soil is less fertile. Suitable wooded sites are scarce, and soils in open fields often are low in moisture, fertility, and organic matter content and have little protection from chilling winds.

Location

It is desirable to locate the tobacco seedbed near windbreaks and where water is available. It has been the custom since colonial days to locate the tobacco seedbed on virgin soil in the woods if such an area is available. If the soil structure can be maintained, a permanent site is often prepared. A fertile soil with good drainage and with a southern or eastern exposure is best. The bed should be some distance from tobacco curing barns, and it should be so situated that drainage from old tobacco beds or fields does not contaminate it. In the burley area, a preferred location for the seedbed is on a bluegrass sod of several years' duration. An animal-tight fence around the bed will keep out stray dogs or other animals.

All forest or excessive growth should be removed from the site of the seedbed. The area is then disked or plowed to a depth of 4 to 8 inches. In some areas, especially Pennsylvania, a liberal application of manure is plowed under in the fall. The soil is raked, pulverized, and leveled prior to sterilization.

Construction

The seedbed, often referred to as a plantbed, may be any convenient size and shape. It is difficult to control diseases, however, if a bed is more than 3 yards wide. With this width or less, a board can be placed on the walls of the seedbed as a walkway for weeding or drawing of plants. Use of a walkway in wide beds prevents contamination of the soil by soilborne disease organisms. Some beds are only a yard wide.

In most areas boards set on edge to a height of 6 to 10 inches surround the seedbed and form a coldframe. Tobacco growers often use logs or poles, rather than boards, to surround the bed. Wires or strings are stretched over the frame to support the tobacco cloth—a special cotton cloth of 24 by 28 threads per square inch for southern areas and 28 by 32 threads for northern areas. The cloth protects the seedlings from cold and insects. It also controls soil drying as it shades the area and restricts air movement. Light mulches of weedfree straw or pine needles are often used as extra covers; extra cloth or plastic covers are sometimes used if it is extremely cold.

In the Florida-Georgia area, elevated shade, as in field culture, and a second cover at a height of 1 or 2 feet usually cover seedbeds for shade-grown tobacco seedlings. In Puerto Rico and for perique tobacco in Louisiana, the seedbed is left uncovered except for the first 10 or 12 days, when the beds are protected with loose brush or palm fronds laid directly on the ground.

There has been some planting of seedbeds in southern Florida where plants are grown on a large scale, as much as 30 to 50 acres in one seedbed. Plants grown for sale in these areas are ready for planting in Georgia, South Carolina, and other areas early in the season if suitable varieties are grown and time of planting is regulated. The seedbed locations are usually on newly cleared palmetto land and are prepared so that the soil can be drained or watered with suitable pumping equipment. Often the seeds are mixed with the fertilizer and drilled simultaneously on slightly ridged seedbeds that are a tractor width. The same tractor equipment sprays for insects and diseases. No covers or sterilizations are commonly used on such beds. There has been some difficulty from diseases such as black shank and virus being carried on these plants grown in some of the Florida areas.

In such cold areas as Pennsylvania, Wisconsin, New York, Connecticut, and Massachusetts, glass sash or cloth usually covers the seedbeds. Plastic materials are sometimes substituted for glass, but they are not so durable; however, plastic is lighter and more easily handled. If glass is used as a cover, the sash, which is usually 3 by 6 feet, determines the width of the seedbed.

Sterilization

Control of weeds, diseases, and insects is very important in growing young tobacco plants. Some method of soil sterilization is usually practiced.[1] If this is not done, hand weeding is necessary. When the competing weeds are removed by hand, tobacco mosaic and other diseases are often spread, owing to handling of tobacco plants and walking on the seedbed area. Sterilization may be carried out in the fall or spring; if adequate precautions are taken to avoid recontamination of the seedbed, fall is the preferable time.

One of the oldest methods of soil sterilization is to burn brush, wood, or other material on the prepared seedbed area. The effectiveness of burning material as a sterilizer depends on how well the method is carried out. To conserve fuel, poles or a length of woven-wire fencing on which the fuel is heaped can be used. After the fuel is ignited, the burning material is moved along the bed area as rapidly as the soil becomes sufficiently heated to sterilize it to a depth of 2 or 3 inches.

If the necessary equipment is available—a steam boiler—steam sterilization will reduce to a minimum the hazards from weeds, diseases, and insects. Steam is forced into the soil either by an inverted pan or through buried tile.

In many areas chemical disinfectants are used. Methyl bromide, calcium cyanamide, and urea are the chemicals commonly applied to seedbeds. Treatment of calicum cyanamide alone at 1 pound or calcium cyanamide at one-half pound and urea at 1 pound per square yard of seedbed area are used on light soils of North Carolina, South Carolina, Georgia, and Florida. Calcium cyanamide alone gives good weed control, but the combination of chemicals controls both weeds and diseases. The treatments should be applied 60 to 90 days before seeding. Cyanamide and the cyanamide and urea treatments have not given the same results on silt loam soils, such as occur in the burley and cigar-filler tobacco areas.

[1] See Farmers' Bulletin 2023, "Tobacco Diseases and Their Control," for detailed instructions on soil sterilization.

If compatible, certain chemicals to control insects may be added to the seedbed at the time it is chemically disinfected or treated for weed control. Seedlings in plantbeds are commonly attacked by flea beetles, larvae of the green June beetle, and aphids; and occasionally by cutworms, mole crickets, slugs, snails, vegetable weevils, grasshoppers, and the larvae of midges or crane flies. For control of these pests, see table 6, pp. 49 and 50.

Methyl bromide gas, applied when the soil temperature is at least 50° F. and preferably 60° or above, controls most soilborne diseases, weeds, and insects. A tight cover of polyethylene plastic with edges tightly sealed around the bed is necessary to prevent escapement of gas. Methyl bromide is available in 1-pound cans under pressure; the recommended rate is 9 pounds per 100 square yards of seedbed area.

Methyl bromide is a poisonous gas, and the detailed precautions furnished with the material should be closely observed.

Fertilizer Rates

After the seedbed is prepared and sterilized, fertilizer for the various types of tobacco is broadcast at the approximate rates shown in table 2 and worked in the surface 2 inches. The soil should not be stirred deeper than 2 inches, as weed seed not killed by sterilization may be brought to the surface. Additional fertilizer may be needed for the seedlings, as explained under management of seedbeds (p. 6).

Seeding

Recleaned seed with a germination of 70 to 80 percent is the best insurance for a good stand. If seed with lower germination has to be used, it should be sown at a higher rate. The rate of seeding is important—if it is sown too thickly, the plants will be delicate and spindling; if sown very thin, the plants will be short and thickset and poorly suited for transplanting (fig. 2).

The seed is usually mixed at the rate of 1 ounce (4 level measuring tablespoons equal 1 ounce of tobacco seed) to 1 bushel of inert material. Inert materials are usually sifted wood ashes, land plaster, sand, bonemeal, or other light-colored material that will show distribution of seeding. A measured amount of the seed mixture is sown in each portion of the area so that even distribution is accomplished. Each part of the seedbed should be gone over three times to insure even distribution. If the seed is mixed with fertilizer, the mixture should be seeded immediately to avoid injury to seed germination.

Trampling or rolling covers the seed (fig. 3). The seed should be barely covered with soil. Table 3 gives the approximate seeding time for each tobacco type and the size of seedbed an ounce of tobacco seed will cover and the acreage the seed will supply.

TABLE 2.—*Rates of commercial fertilizer for seedbeds planted to different types of tobacco*

Tobacco type	Fertilizer mixture [1]				Rate per square yard
	N	P_2O_5	K_2O	MgO	
	Percent	*Percent*	*Percent*	*Percent*	*Pounds*
Flue-cured	4–6	9–10	3–4	1	1–1½
Fire-cured	4	12	8	.....	½
Air-cured:					
Burley	4	12	8	.....	½
Maryland	7	7	7	1	½–1
Dark air-cured	4	12	8	.....	½
Cigar filler	4–6	8	4–12	.....	1
Binder and sun-grown cigar wrapper	8	4	8	.....	1
Shade-grown cigar wrapper	8	4–8	8	.....	½– ¾
Perique [2]	.....	.....	.....	.....	.....
Aromatic	4	9	3	.....	1

[1] A minimum of chlorine.

[2] Fertilizer consists of nitrate of soda alone or mixed with ammonium sulfate, which may be applied prior to seeding or as a topdressing to the seedlings.

FIGURE 2.—Plantbed in southern Georgia, showing excellent stand of tobacco plants about ready for transplanting.

Management

Close attention to the condition of the seedlings to determine their need for supplementary water and fertilizers is a prime requisite of good seedbed management. During early growth seedlings should be protected from extremely cold temperatures by extra covers. As a rule extra early seeding is not recommended; germination may take place during a warm period, but the seedlings may be killed when it becomes extremely cold later.

FIGURE 3.—Rolling seedbed after sowing seed, to firm soil and to cover the seed lightly.

Supplementary water to assure a good plant stand is especially important. Seedbeds, especially those covered with glass or plastic, require careful attention. The beds should be maintained in a moist, but not wet, condition and should never be allowed to become dry. This is especially important immediately before and after germination. Sufficient ventilation must be given, and the temperatures within the beds must not be allowed to become too high, as the plants are likely to "burn" (fig. 4). Tobacco cloth or light canvas laid over glass-covered beds is an efficient aid in preventing burning and to check radiation at night.

If plants are yellow or grow slowly, growth may be stimulated by making one or more applications of supplemental fertilizer. For a nitrogen deficiency, 5 pounds of nitrate of soda dissolved in 50 gallons of water or the soda in a pelleted form should be applied to each 100 square yards of seedbed. Where potash starvation becomes evident, nitrate of potash is applied at the same rate to correct slow and abnormal growth. After application, the fertilizer material must be washed immediately from the leaves of the seedlings to prevent burning.

TABLE 3.—*Approximate seeding time and seedbed area and acreage that can be planted from an ounce of seed of various tobacco types*

Tobacco type	Seeding time	One ounce of seed for [1] —	
		Seedbed	Field transplants
		Square yards	*Acres*
Flue-cured	Late December to March	200	3–4
Fire-cured	February and March	200	4–6
Air-cured:			
Burley	Late February and early March	300	2–3
Maryland	February and March	300	3–4
Dark air-cured	February and early March	200	4–6
Cigar filler	Middle March to middle April	100	3–4
Binder and sun-grown wrapper	Middle March to middle April [2]	100	3–4
Shade-grown wrapper	Middle March to middle April for Connecticut; late December to early January for Florida-Georgia area.	100	3–4
Puerto Rico	August and early September	100	3–4
Perique	Late December and early January	200	4–6
Aromatic	Middle March to April first	200–300	1–2

[1] This rate is ample if seed with a germination rate of 70 to 80 percent is used and if the seedbed is sterilized and well prepared; however, more seedbed area is usually planted to insure an adequate supply of seedlings for transplanting.

[2] If grown under glass, allow at least 6 to 8 weeks from seed germination to transplanting; if grown under cloth, allow 8 to 10 weeks in areas of the latitude of Pennsylvania and farther north.

Diseases and insects must be controlled in the seedbed to avoid destruction or delay of plants in reaching transplanting size and to avoid carrying diseases and pests to the field. See sections on tobacco diseases (p. 41) and insects (p. 47) for control measures. Weeds must also be kept down by handpulling.

Plants are transplanting size when they have 4 to 6 fair-sized leaves and are 5 to 6 inches high (fig. 5). Larger plants, 6 to 9 inches high, are desirable if horse- or tractor-drawn machine transplanters are used. About 7 to 10 days before transplanting, the seedlings should be hardened off by removing the covers—during the day at first, and off entirely later if favorable weather prevails.

The soil should be thoroughly moistened before pulling the plants from the beds, to avoid excessive breakage of the roots. This is especially important when dry weather prevails. The plants should be pulled individually from the bed and placed in baskets or small boxes in which they can be transported to the field. In this way the roots can be kept moist until transplanted.

Field Preparation and Fertilizer Application

Thorough preparation of the soil aids the transplanted seedlings to gain an early start in growth, which often determines the success or failure of the crop. Details of preparation vary, depending on the soil and the previous cropping. Where cover crops are grown, they should be plowed under early, to insure decomposition, compaction, and pulverization before transplanting. Diskings prior to planting will reduce competing weed populations. In the final preparation of the field, the soil is plowed, disked, and harrowed.

Tobacco is produced to best advantage with a controlled nutrient level. Rates of fertilizer applications vary, depending upon the tobacco type, the cropping system, amount of manure applied, the soil, and the prevailing and expected weather. Fertilizer practices are discussed under the sections on cultural practices of each tobacco type.

The method of fertilizer application is important for the survival and subsequent growth of the tobacco plant. The feeding roots of the tobacco plant, particularly in the early-growth stages, develop in a limited zone of soil around

FIGURE 4.—Tobacco plantbed in Pennsylvania: Small plants (left) grown under cloth, as shown in background; larger plants (right) grown under glass, showing glass partly removed.

the plant. An ideal distribution is to place the fertilizer in two bands at a distance of 3 to 4 inches on each side of the plant and deep enough in the soil so that the fertilizer is below the roots when the seedlings are transplanted.

Some transplanting machines are so designed that the fertilizer is placed at the same time the plants are set. Broadcast applications are often used when the fertilizer rate is high, but such applications cannot be expected to give the most efficient recovery of the fertilizer by the tobacco crop. If the rate of fertilizer application is more than 750 pounds per acre and banding equipment is not available, side applications of the rest of the fertilizer over 750 pounds should be applied as soon as possible after transplanting and not later than 21 days.

The sources of the several ingredients in the fertilizer mixture are numerous and varied. There are essentially three forms of nitrogen—nitrate, ammonia, and complex organic. The nitrate is the most available form for plant growth and at the same time the most leachable.

If conditions for nitrification are favorable, the ammonia form possibly approaches the nitrate form in availability to plants, and may be somewhat less subject to leaching. The complex organic forms—mixtures of cottonseed meal, castor pomace, soybean meal, fish meal, and similar materials—are not immediately available to plants, but are eventually so; in addition, they are least readily lost immediately after application by leaching.

To combine the above strong points of all three forms of nitrogen under varying weather conditions, it is generally recommended that nitrogen be derived from mixed sources when tobacco is grown on leachable soils such as sandy loams. Silt loam soils do not need the complex organic forms of nitrogen.

Precipitated bone, bonemeal, superphosphate, treble superphosphate, and dicalcium phosphate

are satisfactory sources of phosphorus (P_2O_5). The potassium (K_2O) may be derived from carbonate, high-grade sulfate, sulfate of potash-magnesia, vegetable potash, nitrate of potash, or cottonhull ashes, provided the chlorine content of the mixed fertilizer is held to a minimum. A 2-percent chlorine content is permissible for flue-cured tobacco. If the tobacco byproducts are used as a source of potassium (K_2O), these should be sterilized to kill any disease-producing organisms that might be present.

The choice of the sources of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) in the fertilizer mixture should be such as to supply the required amounts of calcium, magnesium, sulfur, and chlorine. Fertilization with the micro-elements—boron, copper, manganese, and zinc—is not necessary except in rare instances.

Transplanting and Cultivation

Setting small tobacco plants from the seedbed requires care in order that the roots are so placed in the soil that the plants start to grow promptly. Healthy well-grown plants of uniform size should be drawn from the seedbed. If the transplants are held for any length of time they should be placed in small packages provided with ample aeration to avoid heating. If they are held overnight, the plants should be placed upright in the growing position to avoid crooking the stems. The entire plant, especially the roots, should be kept moist at all times.

If possible, transplanting should be done on a cloudy or rainy day or in the afternoon, so as to avoid excessive wilting (fig. 6). Under dry weather conditions, enough water should be added to avoid immediate and excessive wilting. It requires several days for the plants to recover from the shock due to transplanting. As soon as practicable all plants that have died should be replaced by healthy ones freshly drawn from the seedbed. The field should be gone over at least three times in the first 2 weeks to obtain as uniform a stand as possible.

If a horse- or tractor-drawn transplanting machine is used, the distance of setting, the amount of water, and the packing of the soil around the plants are automatically regulated

FIGURE 5.—Plantbed, showing tobacco plants of transplanting size. A board supported by the sideboards provides a walkway for drawing the plants and thus prevents walking on plants and spreading soilborne disease organisms. Also shown are the boxes used to transport the plants to the field.

FIGURE 6.—Dropping tobacco plants and handsetting them in southern Maryland after a rain; this method is typical for all tobacco areas. Under these conditions no supplementary water is added. Note the slight ridge and cross marking.

and adjusted (figs. 7 and 8). Some of these machines have fertilizer attachments. A single-row transplanter can set as much as 2 to 3 acres a day; a two-row tractor-drawn type can double this acreage. If the crop is small—1 acre or less—machines usually cannot be profitably used. Under these conditions a hand transplanter gives satisfactory results.

The hand-setting method can be used in all areas following a rain. It is a common practice to mark the points at which the plants are to be set by some simple device to obtain uniform plant spacing and to allow for more uniform growth.

The plant is set in a hole 4 to 6 inches deep made by the hand transplanter, dibble, wooden peg, or some other suitable implement (fig. 9). Unless the soil is already thoroughly wet when the plant is placed in the hole, some soil should fall or be placed on the roots. The depression is then filled with water, which tends to settle the soil firmly around the roots. The surrounding soil is then drawn over the roots and around the stalk of the plant to maintain the plant in an erect position; covering the terminal bud with soil should be avoided.

The recommended spacing and the usual time of transplanting for the various types of tobacco are given in table 4.

Cultivation should begin as soon as the plants start to grow—usually 7 to 14 days after transplanting—and continue as long as the size of the plants permit. The first cultivation is fairly deep, after which the cultivations are frequent and shallow to maintain a loose, fine mulch about the plants and to keep down weeds (fig. 10). One or two hoeings are desirable, to break the crust around the young plants. Most tobacco rows are ridged in southern areas, with slight ridges to level culture used in other areas.

Topping and Suckering

Most tobaccos, except some shade-grown tobacco and aromatic tobacco, are topped. For burley, Maryland, and flue-cured tobaccos the tops are broken when the plants begin to flower or about 2, 3, or more weeks before harvest (fig. 11). For fire-cured, dark air-cured, and cigar-filler and binder types, the plants may be topped as soon as they have sufficient leaves and before flowering. The number of leaves left on the plants depends on the type of tobacco grown, the soil fertility, prevailing and expected

FIGURE 7.—Transplanting with tractor-drawn equipment: *A*, Single-row, power-lift transplanter used in setting burley tobacco in eastern Tennessee; *B*, two-row transplanter used in setting cigar filler plants in Pennsylvania.

FIGURE 8.—Transplanting tobacco with a single-row, horse-drawn machine in southern Maryland.

weather, and the vigor of the individual stand. Topped tobacco does not blow down so readily as untopped during rainstorms with accompanying wind.

After topping, suckers that develop in the leaf axil should be removed at least once—a day or two before harvest—to obtain higher yields and better quality leaf (fig. 12). If possible, suckers should be removed at another earlier period—before they become so tough that they tear and break the leaves when the suckers are removed. Fire-cured and dark air-cured types are usually suckered at weekly or 10-day intervals.

Suckering is a time-consuming and laborious operation. Growers have sought to lower these labor costs by using some growth-regulating materials such as maleic hydrazide (MH–30) or oil treatments. Although these materials control suckers, they produce side effects that prove undesirable; consequently, such materials are not recommended at present (1961).

FIGURE 9.—Transplanting tobacco in North Carolina with a hand transplanter that adds water as plant is set.

FIGURE 10.—Cultivating tobacco to break up soil crusting and to destroy competing weed growth.

TABLE 4.—*Usual time of transplanting and the spacing in the field for various types of tobacco*

Type and area	Transplanting time	Spacing	
		Between rows	Between plants in row
		Inches	*Inches*
Flue-cured:			
In Florida	March	48	18 to 24
In Georgia and South Carolina	Early April	48	18 to 24
In North Carolina and Virginia	May and early June	48	18 to 24
Fire-cured:			
In Kentucky and Tennessee	Late May or early June	42	42
In Virginia	do	42	36
Air-cured:			
Burley	Late May to early June	42	14 to 18
Maryland	Late May to late June	34 to 42	30 to 34
Dark air-cured	Late May to early June	42	29 to 42
Filler:			
In Pennsylvania	June 1 to June 20	36 to 40	24 to 28
In Ohio	do	36 to 40	24 to 28
In Puerto Rico	Late October to early January	36 to 42	15 to 18
Binder and sun-grown wrapper:			
Connecticut Havana Seed	June 1 to June 20	36 to 40	17 to 20
Connecticut Broadleaf	do	42 to 45	20 to 27
Wisconsin Havana Seed	Latter half of June	34 to 38	18 to 24
Shade-grown:			
In Connecticut	Latter half of May	36 to 40	12 to 15
In Florida and Georgia	Early part of March	48 to 54	10 to 14
Perique	do	60	36 to 42
Aromatic	Late May to early June	15 to 20	3 to 6

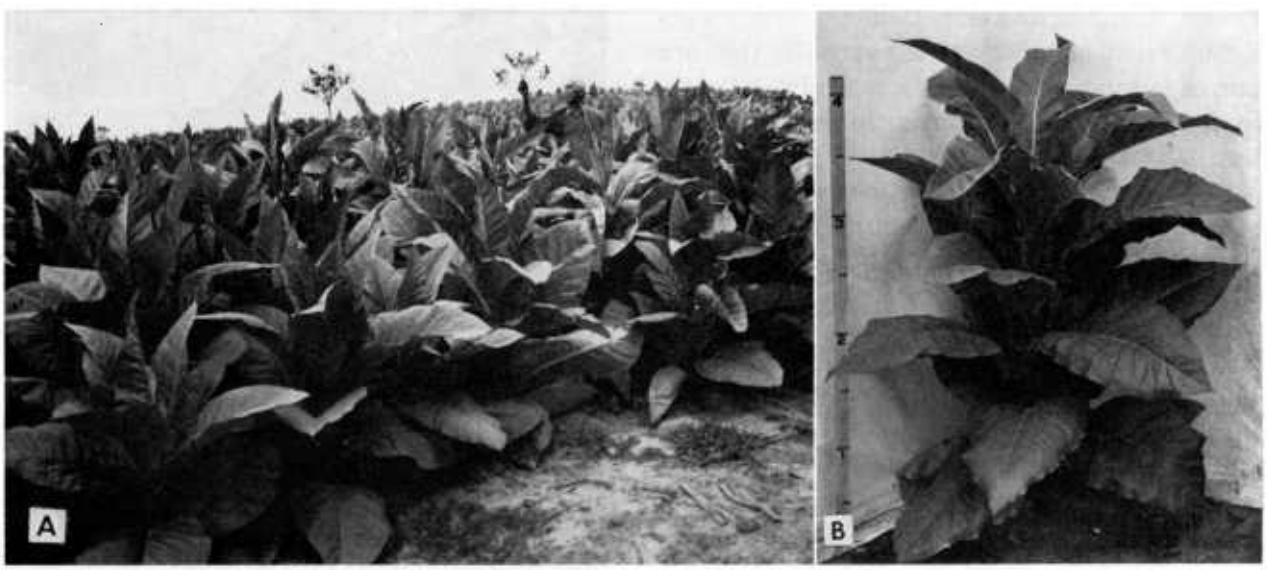

FIGURE 11.—*A*, A field of Maryland tobacco topped and suckered preparatory to harvesting. Two selected plants were not topped and will be used as a source of seed for another crop, as the field is adequately isolated from other tobacco fields. *B*, Mature plant topped and suckered prior to harvesting.

FLUE-CURED TOBACCOS

Flue-cured is the most extensively grown type of tobacco. It owes its popularity to the ever-increasing demand for this type as a principal constitutent of blended cigarettes. The use of cigarette filters has accentuated the demand for a full-bodied tobacco rich in aroma and flavor. Flue-cured tobacco is also used in smoking mixtures and for chewing tobacco, and it is exported. The better grades are bright yellow; the color is due largely to the soil on which the tobacco is grown, the varieties planted, the fertilizers used, and the curing method.

Flue-cured tobacco is grown in the southern part of Virginia, middle and eastern North Carolina, eastern South Carolina, southeastern Georgia, and northern Florida.

Varieties

All older varieties and many of those currently grown are strains of Orinoco (fig. 13). Most of these varieties do not bear the Orinoco name. Pryor is an old variety that is still grown. Sometimes the variety name is changed and it is often difficult, if not impossible, to know if the altered designation represents a distinct and new variety. Yellow Mammoth, which is a Pryor, White Stem Orinoco, Bonanza, Virginia Bright, Jamaica, and Gold Dollar, which is a selection from Jamaica, are old varieties that are grown to some extent. Hicks, a strain of Orinoco, is one of the more currently popular varieties.

Resistant strains of the Orinoco type have been developed and are grown to control losses from certain diseases. The disease-resistant Orinoco strains were crossed and backcrossed with disease-resistant varieties and other introduced foreign and domestic tobaccos. The 400 and 402 groups, including Yellow Special, show some tolerance to several diseases: Black root rot, root knot, nematode root rot, bacterial wilt, southern stem rot, and leaf spots. Virginia 45 is resistant to black root rot and mosaic. Where only black shank is a problem, Oxford 1 and selections from this variety and related varieties—Oxford 1-181, Vesta 5, S.C. 58, N.C. 73, N.C. 75, and N.C. 95—may be grown and produce leaf of acceptable quality. N.C. 75 also shows high resistance to black root rot, is moderately resistant to fusarium wilt, and is tolerant to brown spot.

N.C. 95, released for planting in 1961, is the first flue-cured variety carrying resistance to the common root-knot nematode; in addition, it is highly resistant to black shank and to fusarium wilt and is moderately resistant to bacterial wilt. Oxford 26 and Dixie Bright 28 are resistant to bacterial (Granville) wilt. Dixie Bright 101, Coker 187, and Coker 187-Hicks are resistant to bacterial and fusarium wilts and black shank, and can be grown where these diseases are a problem.

Soil Selection and Management

Flue-cured tobacco is produced on a variety of soils—preferably sandy loams—such as the Granville, Durham, Norfolk, Marlboro, Ruston, Appling, Cecil, Portsmouth, and Tifton series. These soils of the Coastal Plain and Piedmont

FIGURE 12.—Connecticut Broadleaf is topped and suckered as it approaches maturity.

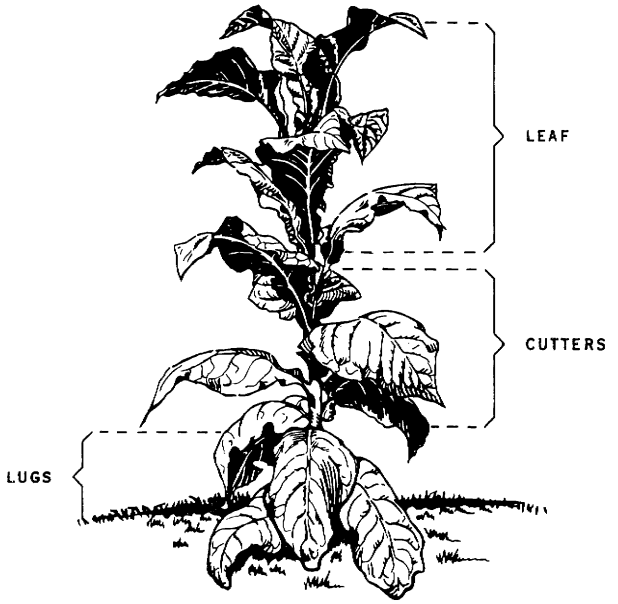

FIGURE 13.—Orinoco tobacco plant—a typical flue-cured type—showing approximate division of leaves used for the flue-cured grades: Lugs, cutters, and leaf.

regions are sandy and fine sandy loams underlain by varying mixtures of gravel, loose sand—either coarse or fine—sandy or fine sandy clay, and sometimes even clay subsoils. A gravel and sand subsoil is not desirable, because heavy rains leach out fertilizers and water is not held in this soil layer. On the other hand, tight clay subsoils may cause waterlogging.

A systematic crop rotation is not commonly practiced in the flue-cured areas. The use of legumes in the rotation is not recommended, especially if the legume crop immediately precedes the tobacco crop. Manure is seldom used on flue-cured tobacco soils; if it is supplied, only small amounts are applied. High quality flue-cured tobacco can only be produced with suitable control of the nutrition level, and excessive and varying amounts of manure and legume growth make it difficult to control the nitrogen requirements.

Some use of crops other than legumes is often desirable, especially if tobacco diseases are troublesome. A small-grain crop, particularly oats, provides a suitable crop to follow flue-cured tobacco, if the crop is adapted to the area. A small-grain crop gives protection from water and wind erosion during winter without favoring any of the prevalent tobacco diseases. Redtop following a small-grain crop is recommended for some areas. The small-grain crops often present difficulties in preparing a suitable soil condition for transplanting tobacco if they are plowed under late in spring. These crops, as well as grass and weed cover, may cause a carryover of insects that may infest transplanted seedlings.

Sometimes natural weed growth, such as horseweed and ragweed, volunteers after the harvesting of small grain. If bacterial wilt is present, however, ragweed may carry over this disease. Crabgrass and lambsquarters also are undesirable, as they favor root knot and nematode root rot. In some instances pure stands of annual lespedeza depress tobacco growth when the lespedeza is turned under.

Fertilization

It has been previously pointed out that tobacco is produced to best advantage with a controlled nutrient level. As flue-cured tobacco is grown on relatively infertile, sandy loam soil, a complete fertilizer is needed to establish the desired nutrient level. This type requires the following approximate percentages of fertilizer constituents:

Constituent:	*Percent*
Nitrogen (N)	3
Phosphorus (P_2O_5)	9
Potassium (K_2O)	10
Chlorine (Cl)	2
Calcium (CaO)	6
Magnesium (MgO)	2
Sulfur (SO_3)	8

Most soils will require an application of such a mixture at the rate of 800 to 1,200 pounds per acre. If higher analysis fertilizer is used, the rate of application is lower. Excessive quantities of nitrogen are to be avoided.

Fertilizer applied in bands (as suggested on p. 8) at the time of transplanting consistently produces the best results. If the fertilizer is applied to only one side of the plant, it frequently produces one-sided growth effects. If banding equipment is not available, a portion of the fertilizer should be applied broadcast before transplanting and the rest applied as a side application not later than 21 days after transplanting.

It is seldom necessary or desirable to lime soils for flue-cured tobacco. Occasionally, a

very light application of finely ground magnesium limestone may be used to adjust the soil acidity and at the same time supply magnesium and calcium.

Topping and Harvesting

Flue-cured tobacco is topped when the flower buds begin to show. Usually 15 to 20 leaves are left on the plant, the number depending on the fertility of the soil, the variety grown, and the vigor of the plant.

Harvesting should not take place until the leaf is thoroughly ripe. It will show numerous small patches of light-yellow color, and the green parts should be light green. As the leaves ripen, they are removed (primed or picked) first from the bottom of each plant (fig. 14). Two or three leaves are removed at each picking, which takes place at approximately weekly intervals. To harvest all the leaves, the field will be gone over five to eight times.

The leaves should undergo some wilting prior to stringing, in order to avoid breakage. They are then carried to a central location, usually near the curing barn, where the leaves are strung and hung on a stick (fig. 15). The string is usually attached by a single loop to one end of a 4½-foot stick that is placed in a suitable holder. The string is then passed once around the butt end of a small bunch of leaves—usually two large to four small—and twisted so that the leaves hang to one side of the stick. The string crosses the stick diagonally and the second bunch of leaves is then looped with the string and swings from the opposite side of the stick. The process is repeated until the stick carries about 30 bundles of leaves, with the end of the string fastened to the opposite end of the stick.

Curing

Flue curing takes its name from the fact that the barn is provided with a system of large pipes or flues that carry off the fuel gases throughout the curing period. Smoke or other fumes that may impart objectionable odors should not come in contact with the tobacco. Supplementary heat is used throughout the cure, which is completed within a few days.

Barn Construction and Fuel

Barns used in curing flue-cured, or bright, tobacco are usually built square with inside dimensions of 17, 21, or 25 feet. These dimensions provide 4, 5, or 6 sets of tier poles spaced

FIGURE 14.—Harvesting flue-cured tobacco in North Carolina by the picking, or priming, method.

FIGURE 15.—Stringing or tying flue-cured tobacco on sticks. Two large to four small leaves in bunches are looped alternately on each side of the stick, and no needle is used.

50 inches apart, center to center. The ground tier poles are placed 6 to 7 feet above the ground with a vertical distance between tiers of 2 feet center to center. The total height of the barn to the plate is 16 to 20 feet. Additional tier poles may be attached to the rafters forming the roof. The tier poles should run at right angles to the flues.

Barns were formerly built of logs, but frame structures have replaced many log barns. When log barns are used, the cracks are either chinked with mud or closed with lime mortar. In frame barns, all cracks are covered with thin board strips, or preferably, the walls are of two thicknesses of boards with builder's paper between the walls. Hollow concrete or clay-block fire-resistant barns are coming into use. They provide greater safety from fire hazards and their construction lasts longer than wooden structures; however, some form of insulation is required to provide efficient heat utilization.

Openings around the bottom of the barn and small windows that can be opened in the gable ends near the roof provide ventilation. Many barns contain so many cracks and crevices, especially about the roof, that they require no special ventilators, but such barns are poorly adapted to flue curing. Figure 16 shows a good type of barn, fitted with an improved roof ventilator and ventilator openings in the foundation.

The heating system consists of a series of sheet-iron flues leading from small furnaces placed at one end of the barn. The arrangement of the flues is comparatively simple, but is modified in different sections of the flue-curing belt.

FIGURE 16.—Barn used for flue curing of tobacco is fitted with a good roof ventilator and ports in the foundation.

One of the best arrangements for larger sized barns is that shown in figure 17.

The furnaces are built of stone or brick and are usually about 18 inches wide, 15 to 20 inches high—inside measurement—and 5 to 10 feet or more long, and project a short way outside the building. The flues, 10 to 12 inches in diameter, are made in sections similar to ordinary stovepipe. They are fitted into the ends of the furnaces and extend across the barn, where they turn at right angles and continue toward the center, then turn at right angles. The pipes should incline slightly upward throughout their length, and pass out through the barn wall at a point 1 to 2 feet higher than the mouth of the furnace. Smokestacks are fitted to the outer ends of the flues and should extend above the roof.

This arrangement of flues may be modified; for instance, the two flues may be united at *C,C* (fig. 17), with a single arm returning to the side of the barn from which the furnaces enter. This arrangement gives three lengths of pipe across the barn instead of four. In the smaller barns a single furnace is placed in the center of one end and a single flue leads across the barn; then branches at right angles, with the branches returning along the side walls. In any arrangement, the flues should be placed at least 18 inches from the walls of the barn.

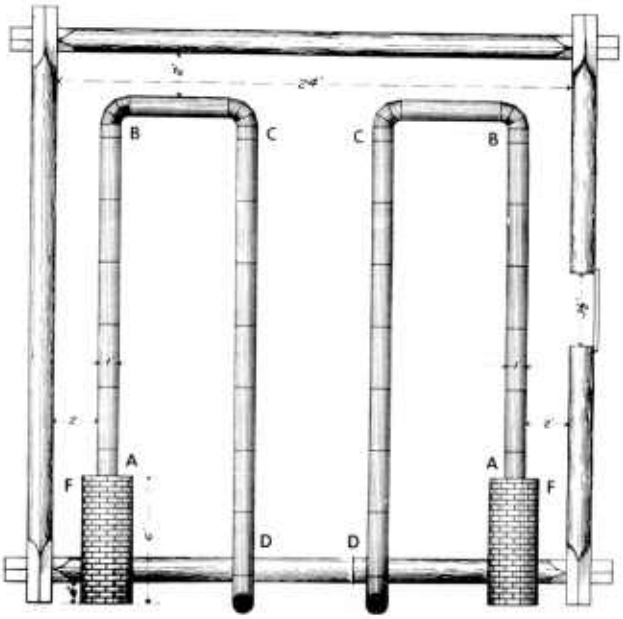

FIGURE 17.—Floor plan of furnaces and flues in a flue-curing barn: *A,A*, Fire joints at furnaces *(F,F)*; *B,B*, and *C,C*, flue elbows; *D,D*, points (1 to 2 feet higher than at *A,A*) where flues pass outside to smokestacks. Instead of elbows at *C,C*, a T-joint could unite the two stacks into one outgoing flue.

Formerly, wood was commonly used as fuel in flue-curing tobacco, as it was generally available on the farm and if purchased it was not expensive. Since wood has become scarce, fuel oil and coal are replacing wood. Both oil and coal burners are adapted to thermostat or other means of automatic control; these controls greatly reduce the need for supervision and thereby save in the use of skilled labor. Furthermore, such automatic controls provide more uniform curing conditions, which is almost impossible with any system of manual firing. Several types of oil burners are used, and automatic stokers, such as those used for house heating, stoke coal-burning furnaces (fig. 18).

Special care is required in the operation and maintenance of oil burners that liberate the products of their combustion within the barn. Smoking or improperly operating burners will contaminate the tobacco, making it unsuitable for the usual manufacturing purposes.

Under prevailing conditions (1961), coal burned in furnaces with automatic stokers is the cheapest fuel for curing.

Conditions Affecting Cure

A number of formulas or rules are in use in curing bright tobacco. The differences are

FIGURE 18.—Flue-curing tobacco barn, with stoker.

due partly to differences in the tobacco when harvested and partly on how the temperatures in the barn are maintained. One factor that is seldom considered is the humidity; the principal use of artificial heat is to regulate the humidity, which is affected by the quantity of water in the tobacco and by the prevailing weather conditions.

The capacity of the air for holding moisture and, consequently, its drying capacity, depends principally on its temperature. If the air is already saturated, it has no drying power until its temperature is raised. Therefore, for tobacco drying, the temperature of the air in the barn must be higher in warm weather than in cool and also higher in rainy or wet seasons than in dry weather. At the beginning of the curing period the barn temperature is maintained only a few degrees above that prevailing outside; at the end of the process, a temperature of 170° F. or more is reached.

Another important factor in controlling the humidity in the barn is proper ventilation. Few growers fully appreciate its importance. In order that warm moist air in the barn be constantly replaced by less humid air outside, the barn should have means for controlling ventilation. Some barns that are poorly built allow for some natural ventilation caused by the higher temperatures inside. Frequently, this natural ventilation is insufficient and at the critical moment of curing excessive moisture may badly damage the tobacco by discoloration. On the other hand, it may be desirable to check the rate of drying; therefore, barns should be provided with top and bottom ventilators that can be readily opened or closed.

Changes in Composition and Properties of Leaf

The value of flue-cured (bright) tobacco is to a large extent dependent on its color. Color is the index used to indicate important associated changes. In flue curing, the principal changes in composition is brought about before the leaf is killed. Flue-cured tobacco at the time of harvesting is riper than most tobaccos cured without the use of heat. Partly on this account and also because of the character of the soil, variety, and fertilizer with which the tobacco is grown, the leaf is richer in starch matter and poorer in coloring than other tobaccos. Flue curing hastens and shortens the first stage of air curing—the yellowing. In the next stages, drying is completed as quickly as possible without scorching the leaf or changing the color.

Management

For flue curing, it is desirable that the barn be completely filled with tobacco in 1 day. A thermometer is hung on the lower tier, near the center of the barn. Small fires are started in the furnaces, and a moderate temperature maintained until the leaf is thoroughly yellowed. This stage requires 24 to 36 hours. The temperature should start at 80° to 90° F., and gradually rise to 110° to 120° at the end of this stage. The change from green to yellow, along with other necessary changes, takes place chiefly while the leaf is still living. At temperatures above 120° the leaf is rapidly killed, so this temperature limit must not be exceeded during the yellowing process. Care must be taken to avoid drying the leaf too rapidly at the beginning. As the leaf begins to yellow, the humidity must be decreased by slowly raising the temperature and gradually increasing the ventilation.

The second period is the critical one—commonly spoken of as "fixing the color." During this stage, moisture must be removed as fast as it is given off by the leaf. Plenty of ventilation is essential. If the leaf contains too much moisture when the yellowing is completed, splotches of red or brown will soon appear on the surface. This trouble, caused by insufficient ventilation toward the end of the yellowing, is known as sponging.

Sometimes it is too late to correct excess moisture in the second stage, but more ventilation may prove beneficial. If the heat is increased too rapidly while the leaf is still full of sap, a greenish-black color will develop—known as scalding, or blistering. Best results are obtained in this stage if the temperature is gradually increased until 130° to 135° F. is reached. Some growers follow the practice of raising the temperature rapidly to 125° or more and then quickly lowering it and opening the door and ventilators of the barn, repeating the process several times. This method is simply another way of removing excess moisture. It is not necessary if the barn is properly provided with ventilators.

To complete the process, the temperature is maintained at 130° to 140° F. until the leaf is completely dried out, which will require 30 to 36 hours after the completion of the yellowing process. All danger from sponging or scalding will be past. The fourth stage is the drying of the stems. The ventilators should be nearly closed and the temperature raised to 165° to 170° at the rate of 5° an hour. The 165° to 170° temperature is maintained until the stems are completely dried out. Some growers raise the temperature to 190° to 200°, but this greatly increases the danger of burning up the barn and contents, an accident by no means rare. These high temperatures cause the leaf to take on a reddish cast, and the process is known as scorching.

When the tobacco is to be taken down, the barn is left open the preceding night and the floor may be sprinkled, if necessary, so that the leaf may absorb enough moisture to bring it into condition for handling (fig. 19). If the leaf can be folded in the hand without breaking, it is in proper condition to be taken down without injury.

Sorting and Handling

When taken down, flue-cured, or bright, tobacco is placed in bulks in shingle fashion without being removed from the sticks. At the end of a week to 10 days, the bulk is torn down and rebuilt, to avoid injury to tobacco from mold. In rebuilding, all the butts point outward and the tips overlap in the center of the bulk. This treatment improves the color of the leaf and assists in bleaching out the green remaining after the curing. It frequently happens that leaves showing a decided greenish cast will come from the bulk with a clear lemon-yellow color, if the green has not been set by too rapid drying in the first stage of the curing.

The tobacco is carefully sorted by the grower into different lots or grades for marketing. As a rule the different primings are handled separately and only a few lots made of each. The early priming, or lugs group, may be separated

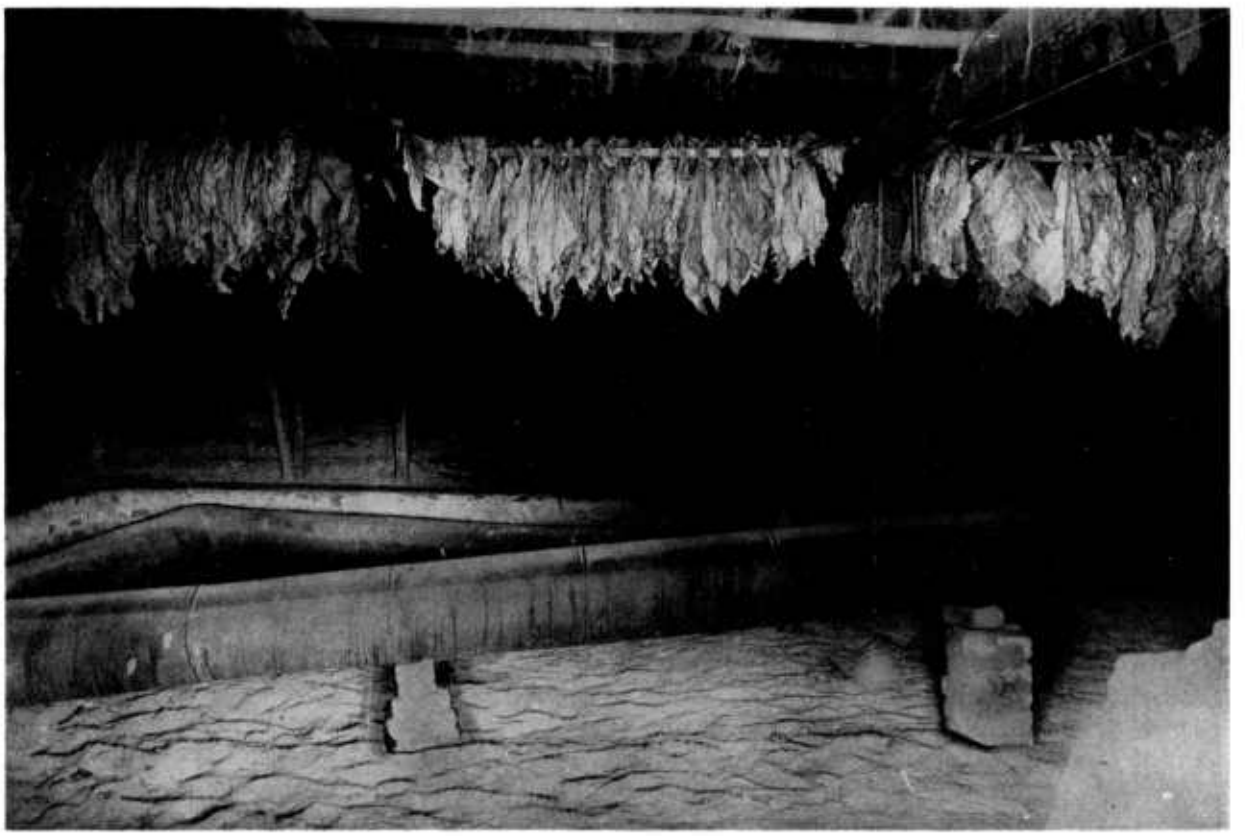

FIGURE 19.—Flue-curing tobacco barn interior, showing flues and cured leaf just before its removal after curing.

into lots commonly called trash lugs, sand lugs, and good lugs. The intermediate primings, or cutters group, are usually divided into best leaf and second leaf lots. The late primings, or leaf group, are separated into tips and green tips. Although the lots are separated mainly by time of picking, color, and extent of injury, the quality—thickness, elasticity, and texture—of the leaf is also important in determining in which lot it is to be placed. Also, the lots may be further subdivided according to quality and color. The most desirable colors, in descending order, are lemon, orange, red, dark red, and green.

In addition to the main three groups, a subgroup, known as wrappers, is made up of almost perfect leaves selected from the leaf and the cutter groups. By the time the grower has sorted his entire crop of flue-cured tobacco, he will have 6 to 10 grades for the market. Different growers may have a different set of grades of leaf after sorting. In general, the lots made up from leaves of the lower part of the plant are used in the manufacture of cigarettes, and those lots made up from the upper part are used in smoking and chewing tobaccos.

The care and skill used in grading greatly influence the price obtained on the market. Grading requires experience and ability on the part of the grower to classify rapidly the colors and to determine accurately the other equally important characters of the leaves.

The graded leaves are carefully tied into hands or bundles, which are hung on sticks for 12 to 36 hours before they are marketed.

FIRE-CURED TOBACCOS

Fire-cured types are similar to a kind grown in colonial times. Fire-cured tobacco is dark colored, with a heavy body and distinctive flavor imparted by the smoke of open fires used in curing. It is used for the production of snuff, plug, wrapper, and to a limited extent for Italian cigars. Formerly, much of it was exported, but in recent years the foreign demand has been declining.

Most of the fire-cured tobacco is grown in 20 counties of central Virginia and in western Kentucky and northern Tennessee.

The varieties grown for fire curing resemble those grown for dark air curing. Kentucky 151, a mosaic-resistant variety, and Madole are popular in the Kentucky-Tennessee area, and Brownleaf is the principal variety grown in Virginia.

Soil Selection and Fertilizers

Fire-cured tobacco is produced on heavy loam soils containing a high percentage of clay with more or less silt loam. This crop is grown in a rotation with other crops and usually follows a grass or legume sod mixture.

Plowing should be early enough in the spring to permit decomposition and compaction of the soil before it is prepared for transplanting the tobacco plants. Fertilizer mixtures of 4–12–8, 5–10–10, or 5–10–15 are applied at the rate of 750 to 1,000 pounds per acre. The application is usually drilled or broadcast before the plants are set out. Manure is often used when available.

Topping and Harvesting

Topping commonly takes place as soon as the plant has developed 10 to 15 leaves, so as to encourage the growth of larger, thicker, and darker colored leaves (fig. 20). It is a common practice to remove and discard 3 or 4 bottom leaves and to remove the terminal bud. Low topping as practiced with fire-cured tobacco stimulates more active development of the suckers that develop following topping. These suckers must be removed as often as they appear, usually at weekly intervals.

When mature, the leaves are a mottled color, caused by small yellow patches in the leaf, and they are thick and heavy. This stage is commonly reached 30 to 40 days after topping.

Harvesting should not take place immediately after a heavy rain, as the gum that accumulates on the leaf in dry weather and which improves the quality is washed off and does not build up again for 2 or 3 days. The first step in harvesting is to split the stalk with a sharp knife from the top downward, in such a manner as not to cut off or injure any of the leaves, to within a few inches of a point where the stalk is cut off near the ground level. When severed, the plants are either placed on the ground or hung astride a stick before placing the tobacco on the ground

to wilt. All plants are placed astride a 4½-foot tobacco stick before they are hung in the curing barn.

Curing

The smoke from open hardwood fires imparts a characteristic odor and taste to fire-cured tobacco and improves its keeping qualities. The fire-curing procedures have changed somewhat, owing to the scarcity of fuel. As a consequence, there is less firing, and hardwood sawdust is in general use as part of the fuel.

Barn Construction

The old type of barn used for fire curing was built of logs and the cracks chinked with mud. These barns were small but were generally high enough to contain five sets of tier poles. In recent years the log barns have been partly replaced by modern frame buildings of much larger size. These buildings have large doors opening into a passageway through the building, thus allowing a loaded wagon to be drawn directly beneath the tier poles. The poles are arranged at intervals of 3 feet 10 inches horizontally and 3 feet vertically. The first tier is 8 to 9 feet above the ground. Figure 21 shows a type of barn in use in Kentucky and Tennessee.

Management

Usually no heat is required during the first stages of yellowing fire-cured tobacco, for it would dry out the leaf too rapidly. Drying should be gradual, to allow proper colors to develop and to bring about other important changes. From 3 to 5 days after the tobacco has been placed in the barn, slow fires are started on the floor and the temperature is maintained at 90°to 95° F. at the height of the first tier near the middle of the barn until yellowing has been completed. Thereafter, the temperature may be slowly increased until 125° or 130° is reached and should be held at this point until the leaf tissue is almost dried out. Usually, the fires are

FIGURE 20.—Low topping and close suckering of plants that are typical of fire-cured tobacco.

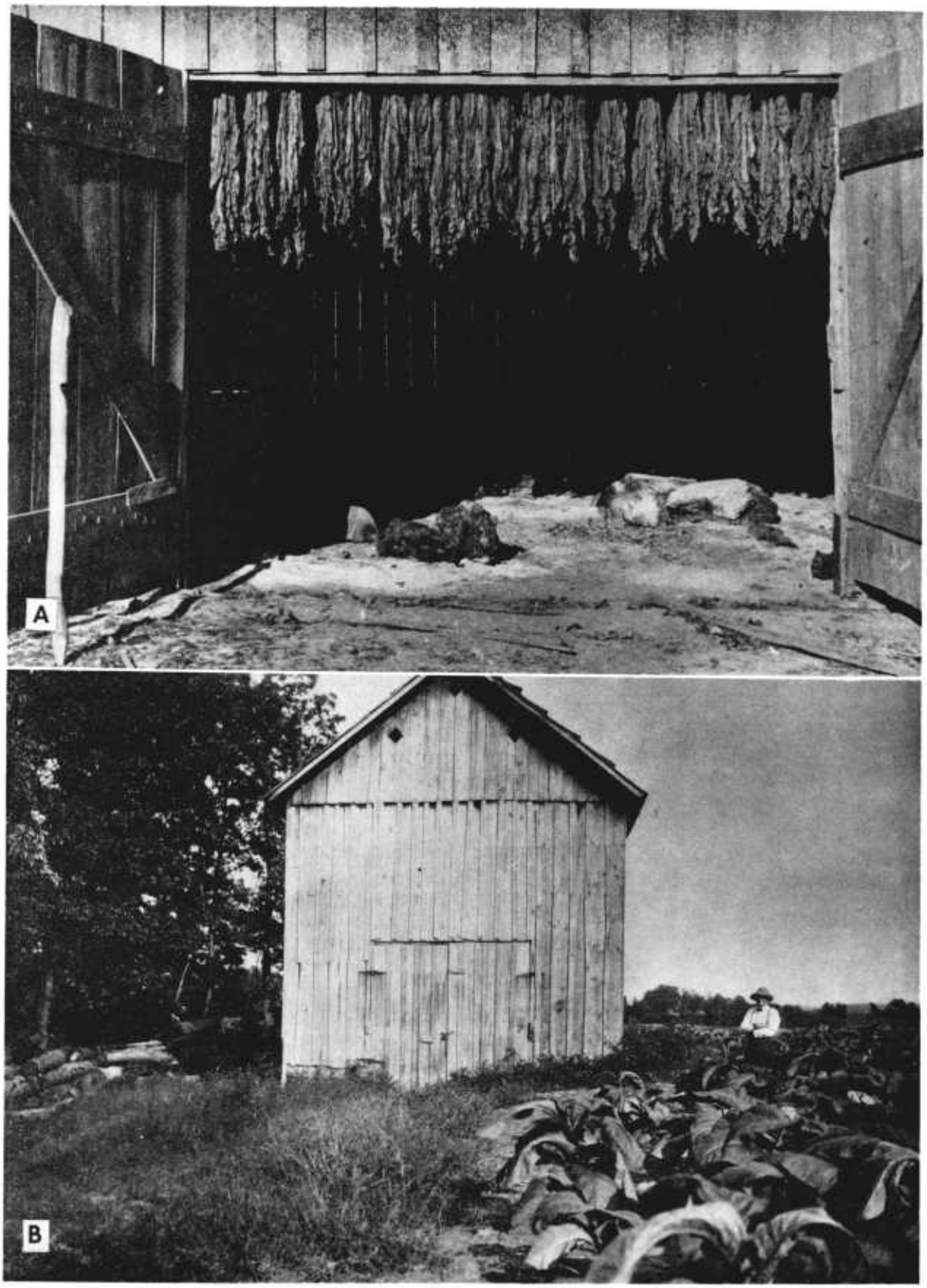

FIGURE 21.—Type of barn used in fire-cured districts of Kentucky and Tennessee: *A*, Fire-cured leaf hanging in barn with remnants of fire on the ground; *B*, exterior view of the barn.

kept burning for 3 to 5 days; in some sections, it may be longer.

During the first stages of curing—when the tobacco is still full of sap—too much heat must be guarded against, or parts of the leaf will be discolored by scalding. Until the leaf is almost dried out, house-burn must be guarded against (see p. 39). If necessary, the fires should be started earlier, when more ventilation is required.

After curing is complete, slow fires should be started during periods of wet weather to prevent injury from molds and too much darkening of the leaf color.

Stripping and Sorting

Frequently, the tobacco is improved by bulking it down without removing it from the sticks, as described for flue-cured tobacco (p. 20).

Fire-cured tobacco is thoroughly cured by late fall or early winter. When it has become pliable by the absorption of moisture during a damp period, it is the usual practice to remove the plants from the sticks and strip the leaves from the stalk and tie them into hands. Tobacco in condition for winter handling will not keep through the spring. If warm weather sets in, tobacco will usually mold unless reordered by hanging the hands across a stick to dry out. If hands of fire-cured tobacco are taken down and packed after warm weather has set in, it will keep indefinitely.

Fire-cured tobacco is usually sorted into three principal grades—trash, lugs, and leaf. The better grades are used in the manufacture of snuff and the rest for Italian cigars. The leaf grade is subdivided, based on size and color. Each grade is then tied into a neat hand or bundle containing six to eight or more leaves.

In Virginia, fire-cured tobacco is auctioned loose, and this method is gaining ground in Kentucky and Tennessee. In these districts in former years, the general practice was to pack, or "prize," the leaf in hogsheads.

AIR-CURED TOBACCOS

Nearly all the cigar tobaccos, the immense quantities of burley and dark air-cured manufacturing tobaccos grown in Kentucky and adjoining States, the Maryland type, the Virginia sun-cured types, and shade-grown tobacco are air-cured. That is, they are cured without the use of artificial heat except, in some cases, during periods of wet weather. The tobacco is placed in the barn in the ripened state, usually after it is wilted, and curing is controlled by regulating the ventilation of the building.

Burley Tobacco

Burley tobacco, a light air-cured type, ranks next to flue-cured tobacco in the acreage grown in the United States. It is used in the popular cigarette blends and is also a major constituent of many widely used pipe-smoking mixtures and chewing tobaccos. This type possesses exceptionally large absorptive capacity. The liquid flavoring materials used in the manufacture of plug, cigarette, and other tobacco products are usually added to the burley portion of the blend.

Burley tobacco is relatively light in color and body when grown under proper conditions. It is differentiated from all other tobaccos grown in the United States by the light-green or creamy color of the stalk and leaf midribs. When approaching maturity, the leaf blade also develops a light yellowish-green appearance (figs. 22, 23, 24). The cured leaf is porous, lacking in gum, and fine in texture, and when properly grown and cured it varies from a straw to brown color.

The burley type is grown most extensively in the bluegrass region of Kentucky. The largest acreages outside of Kentucky are in Tennessee, Virginia, western North Carolina, and Ohio.

Varieties

The original White Burley variety appears to have been a broadleaf, drooping type, and was especially adapted for use in the manufacture of plug chewing tobacco. The use of the word "white" before the type or variety name "burley" is not current usage. When the demand arose for light-colored, light-bodied leaf, adapted to the manufacture of cigarettes and smoking mixtures, a plant was selected to give such a product. Such selections were usually taller

FIGURE 22.—Color contrasts of tobacco when grown in Maryland: Burley (*B*) as contrasted with Maryland Broadleaf (*A, C, D*).

growing forms with more erect-growing leaves, and were commonly known as standup varieties. Some of the most popular varieties that have been extensively grown are Judy's Pride, Kelley, Halley, and Pepper.

These early varieties were all highly susceptible to black root rot, which could often be controlled by growing tobacco following crops that did not carry the disease—such as bluegrass—or by avoiding the use of lime immediately preceding tobacco. To control the root rot, resistant varieties were developed; the most widely grown are Kentucky 16, Kentucky 41A, and Burley 2.

Where black shank is a problem, Burley 11A and Burley 11B, released in 1954, have shown resistance to this disease, as well as good resistance to black root rot and to fusarium wilt. In 1960, Burley 37, an improved black-shank-resistant variety, was released; it is also highly resistant to wildfire and to black root rot. In 1955, Burley 21 was released; it combines resistance to wildfire, mosaic, and black root rot (see fig. 24). These varieties all give good yields of good quality cured leaf.

Soil Selection and Management

Burley tobacco is grown largely on diversified farms in combination with livestock, and, consequently, pasture usually occupies a considerable portion of the farm acreage. The tobacco crop, as a rule, occupies only a small part of the farm acreage in any one year. It is possible, therefore, for the grower to select and, by wise planning, to provide high-fertility areas to grow the tobacco by a judicious use of manure and fertilizer applications to assure the highest returns. It is never desirable to grow tobacco on the same area year after year, as such a practice destroys tilth and fertility and often lends itself to a building up of destructive tobacco diseases, such as black root rot, fusarium wilt, and black shank.

Burley is grown principally on silt loam soils of limestone origin, such as Maury in the inner bluegrass region; Decatur, Dewey, Fullerton, associated colluvial soils, and numerous others in the bordering areas. The silt loam soils on which burley is grown often lack good drainage, unless they are handled with proper care.

Burley tobacco grows best on virgin soil or a heavy bluegrass sod that has been standing for

FIGURE 23.—Growth habit and light color of leaf midribs of Burley 2 tobacco when grown under Tennessee conditions.

6 or more years. Sod supplies the good soil tilth and physical conditions that produce high-quality leaf. In recent years some farmers grow burley tobacco in continuous culture, using a legume cover crop during the winter, or they grow the tobacco in short rotations, using the black root-rot-resistant varieties. Such systems of management often produce leaf lacking in quality and also cause a gradual decline in soil tilth and fertility accompanied by soil loss by erosion. With the appearance of black shank, which is becoming quite generally distributed in the burley area, serious losses are likely to occur where continuous culture or short rotations are employed even with the use of existing resistant varieties.

Fertilizers

Fertilizer applications for burley vary, depending upon the cropping system, amount of manure applied, the soil, and the prevailing and expected weather. The sources from which nitrogen, phosphoric acid, and potash are derived are largely determined by their availability to the tobacco plant and the relative costs. The inorganic forms of nitrogen are satisfactory sources of nitrogen, although mixed sources of nitrogen are desirable. Phosphoric acid is commonly derived from superphosphate and treble superphosphate. Potash may be derived from any available source, provided it is relatively free of chlorine. Sulfate of potash is widely used for burley tobacco. Fertilizer grades recommended by the States in the burley area are 4–8–12, 4–12–8, 3–9–18, 5–10–15, and 6–6–18. Side or top dressings of 8–0–24 are recommended in some States.

It appears that excessive nitrogen fertilization is not so readily manifest as dark color in the cured leaf of burley as it is often evident in the case of flue-cured varieties. However, the nitrogen must be regulated and should be held to a minimum at which profitable yields may be obtained and, at the same time, produce the quality, especially the nicotine content, that is

FIGURE 24.—Standup habit of leaf growth and light color of leaf midribs of Burley 21 tobacco when grown under Tennessee conditions.

acceptable to the manufacturer. The total amount of nitrogen should be about 100 pounds per acre, usually applied before transplanting. If 10 tons per acre of a good grade of farm manure is applied, it can be estimated that it supplied 50 pounds of nitrogen; an additional 50 pounds of nitrogen should be applied as fertilizer. If no manure is applied and a nonlegume cover crop was grown before the tobacco crop, approximately 100 pounds of nitrogen fertilizer should be applied.

The phosphoric acid requirements are high on the low-phosphate soils typical of most of the burley area. However, on the high-phosphate soils found in some areas of the bluegrass regions of central Kentucky and middle Tennessee, additions of phosphoric acid does not always give any response in growth. Low-phosphate soils should receive 100 to 150 pounds per acre.

The representative silt loam soils on which burley tobacco is produced usually contain considerable potash that often appears not to be available to the tobacco plant. This potash nonavailability becomes more acute on soils of poor physical condition and is often aggravated by continuous cropping to tobacco or by alfalfa plantings of long duration. When the crop is grown on newly cleared land, after old bluegrass sod, or after heavy manure applications, the availability of the native and added potash will result in a crop of acceptable quality. The amount of potash to be recommended will, therefore, be governed by the cropping history and quantity of farm manure used, and may range from 120 to 250 pounds per acre. The use of muriate of potash as a source of potash is not recommended.

The amount and sources of calcium, magnesium, and sulfur for best results in growing burley tobacco are not known. However, materials used from generally available sources for mixing fertilizers supplying nitrogen, phosphoric acid, and potash commonly furnish adequate amounts of these elements. To date, it appears that it is not necessary to supply any of the micronutrients—boron, copper, manganese, or zinc—in burley tobacco fertilizers.

Additions of lime on burley tobacco soils should be held to a minimum. The soil should be moderately acid and should only be limed to avoid excess acidity. Any additions of lime should be made immediately after the tobacco crop.

Topping and Harvesting

Burley tobacco is topped after the plant is in flower; as a rule, 18 to 22 leaves are left on the plant. The height that the plant is topped depends upon the variety grown, the fertility level, the vigor of the individual plant, and the prevailing and the expected weather.

It is always desirable to permit the plant to reach maturity before harvesting, which is usually about 3 weeks after topping takes place. At maturity, plants assume a lighter shade of green, and by experience the grower acquires the necessary know-how as to when to harvest. The entire plant is harvested by cutting the stalk near the ground level, so as to save as many of the lower leaves as possible. The cigarette grades, which as a rule command the highest prices, are usually found among the lower and middle leaves.

As the plants are cut they are at once speared onto the stick, one end of which is forced into the ground at an angle, often in such a position that it rests on the stubble of a severed plant (fig. 25). The sticks bearing the plants are left in this position until the plants are wilted. They are then taken to the curing barn. When the weather is excessively hot, with a bright sun, it is necessary to move the cut tobacco promptly to the curing barn to avoid sunburning of the wilted leaves.

The harvested tobacco should not remain in the field overnight, as rain often washes soil onto the leaves touching the ground, and it is difficult to remove the soil after curing. A removable metal spearhead, which is sharpened, is used to force the required number of plants onto each stick. The number of plants (5 to 8) placed on each 4½-foot stick varies with the average size of the individual plants. Recently, some growers have harvested the leaves as they ripen by picking (priming). It appears that only one or two pickings are profitable before the plant with the remaining leaves is stalk-cut.

Maryland Tobacco

Maryland tobacco is grown in southern Maryland—Anne Arundel, Calvert, Charles, Prince Georges, and St. Marys Counties—and has

FIGURE 25.—After cutting, burley tobacco is speared onto a stick, one end of which has been forced into the ground. Wilting is hastened by this exposure.

been grown in this same general area since colonial times. It is a minor type as far as total number of pounds produced, but it occupies a favorable position as an export type. The principal use in recent years is for the manufacture of blended cigarettes.

Desirable grades of the Maryland leaf are thin, of good length; light in body and color; of a dry, chaffy character; low in alkaloids; and possess, as a rule, good burning qualities.

Varieties

The varieties commonly cultivated in southern Maryland represent some of the oldest commercial varieties in existence in the United States. They resemble, and possibly furnished, the parent types from which the broadleaf, or seedleaf, group of cigar tobaccos extensively grown in other areas, originated. The Maryland varieties may be divided broadly into two groups—narrowleaf and broadleaf—but there are numerous intermediate varieties.

The numerous strains or subvarieties usually bear the name of some local grower who has established a reputation for producing good tobacco. Among some of the popular varieties are Robinson's Medium Broadleaf, Wilson's Broadleaf, and Catterton Broadleaf.

Soil Selection and Management

Maryland tobacco is preferably grown on sandy loam, fine sandy loam, and very fine sandy loam soils. Sometimes fairly heavy loams are used, but such soils do not produce the best quality leaf. The Collington and Sassafras series are preferred to those belonging to the Leonardtown soil series. The preferred soils are light-brown loamy sand or light sandy loam to a depth of 8 to12 inches, with a yellowish or reddish-brown crumbly or friable sandy clay or heavy sandy loam subsoil that affords good but not excessive drainage. Where the subsoil is derived from green sand, as in the Collington series, it has a greenish tinge. The mineral green sand is relatively rich in potash and some other elements essential for the growth of tobacco.

In recent years, growing tobacco continuously for several years on those locations that give profitable returns has become a common practice in southern Maryland. A fall seeding of wheat or a combination of wheat and hairy vetch is generally grown as a winter cover crop. Where sufficient suitable land is available to the grower, growing tobacco continuously on one plot cannot be considered as ideal, since it often destroys soil tilth, exhausts soil fertility, and builds up parasites that may reduce yields,

lower tobacco quality, or destroy all or part of the crop.

If the farm enterprise is somewhat diversified, so that pasture and hay are grown for livestock production, a 2- or 4-year rotation can be set up with wheat, grasses, and legumes, followed by tobacco. The tobacco crop also does especially well on land that has been permitted to develop a growth of natural vegetation, sometimes spoken of as rested land, for one and preferably more years. During the early days of tobacco culture in Maryland, it was recognized that best results were obtained when the crop was grown on newly cleared land. At the present time, when newly cleared land is almost nonexistent, the growth of tobacco after a natural vegetation cover of a few years becomes a good substitute for newly cleared land and usually results in the production of high-quality leaf.

Fertilizers

Under prevailing conditions, a 4–8–12 fertilizer derived from sources relatively free of chlorine is commonly used. For best results it should contain approximately 2 percent magnesia. In addition, the mixture should carry around 6 percent calcium and 8 percent sulfur. If a higher potash application is desired, a 3–9–15 mixture is used. These mixtures are usually applied at the rate of 750 to 1,200 pounds per acre. Although the use of lime is quite common for tobacco in Maryland, it may not always give desirable results. Judicious use of farm manures, with adjustment in the rate of application of mixed fertilizer to avoid excessive applications of nitrogen, can often be used advantageously.

Topping and Harvesting

After the plant has flowered, Maryland tobacco is usually topped and 16 to 20 leaves are left. Harvesting should occur when the plants are mature, before there is much loss of the lower leaves, or about 2 weeks after topping.

Maryland tobacco is harvested much like burley. When harvest takes place late in the fall when the weather is cool, the sticks with the harvested tobacco are often left standing on end overnight or longer (fig. 26). The tobacco is then hauled to the curing barn early in the morning when the standing tobacco in the field is wet with dew. When the tobacco is harvested in midsummer and the weather is hot with a bright sun, it should not remain in the field for any length of time as the leaves sunburn readily.

FIGURE 26.—Harvesting tobacco by cutting the stalk and spearing the plants on the stick: One man cuts while two others spear the plants and pile the tobacco for hauling to the curing barn.

Dark Air-Cured Tobacco

Dark air-cured tobacco is grown in the same areas as fire-cured and burley types in Kentucky and Tennessee and in Virginia. It is not uncommon to find two or more types growing in different areas on one farm. Virginia sun-cured, grown in a few counties immediately north of Richmond, was originally exposed on scaffolds in the sun in the process of curing; however, in recent times, it is air-cured in the same manner as burley, Maryland, and cigar tobaccos.

The Green River, One-Sucker, and Virginia sun-cured types are used in the domestic manufacture of chewing and smoking tobacco products or for export.

Types and Varieties

Green River is grown in the northern and western parts of Kentucky around Owensboro and Henderson. Varieties of the Pryor group, related to Orinoco, are used to produce this type.

One-Sucker is grown in the area centering around Logan County, Ky., and in adjacent areas in Tennessee.

Sun-cured varieties are Narrowleaf Orinoco, Lizard Tail, and related strains.

Soils and Fertilizers

Green River and One-Sucker tobaccos are grown on relatively heavy silt loams that contain a high percentage of clay and silt; these soils are not especially adapted for growing burley. Sun-cured tobacco is grown on sandy loam with a relatively tight clay subsoil.

Fertilizer mixtures for dark air-cured tobaccos may be 4–12–8, 5–10–10, or 5–10–15, applied at the rate of 500 to 1,000 pounds per acre. The soils on which this tobacco type is grown are, as a rule, low in phosphate. Manures are used when available, and the crop is generally grown in rotation with other crops, usually after a grass-and-legume sod mixture.

Topping and Harvesting

Dark air-cured tobacco is customarily topped lower than for other types—sometimes as low as 10 leaves per plant (fig. 27). If the season and soil fertility appear to justify higher topping, the plants may be allowed to develop around 15 leaves.

FIGURE 27.—Field view of low topping and close suckering of One-Sucker, a dark air-cured type.

Usually 4 to 6 weeks after topping, the leaves will have attained their maximum size and will show mottled yellow areas with considerable thickening of the leaf, which becomes brittle when turgid. In harvesting, it is customary to split the stalk to within 6 to 8 inches of the point where it is severed near the ground level. The stalk is then placed astride a tobacco stick to permit hanging in the barn to cure.

Cigar Tobaccos

The bulk of the cigar tobacco crop is grown in Massachusetts, Connecticut, New York, Pennsylvania, Puerto Rico, Wisconsin, Ohio, Florida, and Georgia. The finest grades of wrapper leaf are grown in the Connecticut Valley and in a few counties of western Florida and southern Georgia. Wisconsin is known as a cigar-binder State. New York, Pennsylvania, Ohio, and Puerto Rico produce mainly filler grades. All cigar tobaccos are air-cured. In curing the wrapper types, however, some supplemental heat is used.

Leaf from three distinct varietal groups of tobacco is used in the manufacture of cigars. These varieties are Broadleaf, or Seedleaf; Havana Seed; and Cuban—each with numerous local strains. Another variety—Little Dutch—is grown to a limited extent in Ohio for filler and is a narrowleaf type.

Connecticut Broadleaf, sometimes designated as Seedleaf, is grown in Connecticut for binder and sometimes for wrappers. Broadleaf strains are also grown in Pennsylvania and Ohio, where they are given the name of the State where grown. These strains are used in cigar binder and filler production. These strains may be further identified as John Williams Connecticut Broadleaf, Swarr–Hibshman Pennsylvania Broadleaf, and similar designations.

The Havana Seed group is grown extensively in the northern cigar-tobacco-producing districts and is used in the production of wrapper, binder, and filler for cigars and for scrap chewing tobacco. The so-called Spanish varieties, formerly grown in Wisconsin and Ohio for binder and filler, were known as Comstock and Zimmer Spanish, but appear to be strains of Havana Seed. In recent years numerous varieties of Havana Seed have been developed for resistance to disease and these carry a number.

Cigar Filler

Cigar-filler leaf is produced mainly in the Lancaster (Pennsylvania) and Miami Valley (Ohio) districts in continental United States and in the uplands in the vicinity of San Lorenzo, Cayey, Aibonito, Comerio, Caguas, and Utuado and the coastal area around Isabela in Puerto Rico. The Puerto Rico tobacco is blended with continental filler types in cigar manufacture, and most of the coastal tobacco is prepared as roll-chewing tobacco.

Hand hoeing is held to a minimum for filler tobacco in Ohio and Pennsylvania; a mechanical hoeing device consisting of a pair of three-pronged shovel-toothed rakes mounted on swivel arms are attached to the tractor cultivators.

In Puerto Rico, the tobacco is grown on steep slopes laid out in areas bounded by shallow ditches (fig. 28). These ditches are characteristic of Puerto Rican tobacco culture. Often oxen are used in preparing the soil. Weed control and good growing conditions are usually maintained by two cultivations by hand hoes (fig. 29).

FIGURE 28.—Puerto Rico cigar-filler tobacco growing on steep slopes; field also shows mode of ditching to carry off excess water.

Types and Varieties. — Swarr-Hibshman, Greider, Heilman, Red Rose, Slaughter, and Zanders are Pennsylvania Broadleaf varieties that are commonly grown in Pennsylvania. Zimmer Spanish and selections from it are the principal varieties grown on upland soils, and Ohio Seedleaf, or Broadleaf, and often called Gebhardt, is grown on the bottoms of Miami Valley

FIGURE 29.—Cultivation of Puerto Rico cigar filler with hand hoes.

area of Ohio. Little Dutch is grown to a limited extent in Ohio.

Virginia 12, sometimes called V–12, is the principal variety grown on the uplands in Puerto Rico (fig. 30, *A*). The main variety used in the coastal area resembles the Cuban variety that is grown in the Connecticut area under shade (fig. 30, *B*).

Soils and Fertilizers. — In the continental United States, the soils that produce filler leaf are strikingly different than those on which binder and wrapper leaf are produced. Soils for filler leaf tobacco contain more silt and retain larger percentages of water. These soils are also well adapted to general farming, and tobacco is commonly grown in rotation with other crops. Duffield, Hagerstown, and Dunmore silt loams, derived from limestone, are used in Pennsylvania. Miami and Crosby silt loams and Brookston silty clay loam are the principal soil types used in Ohio. Underdrainage of these soils is sometimes poor and often requires the use of tile.

In Puerto Rico, cigar-filler tobacco is grown on Mucara, Juncos, Cayagua, and related Brown soils and on the Utuado and Jayuya soils derived from granite in the uplands. The coastal tobacco is grown on soils derived from limestone, such as Bayomon, Coto, and Maleya.

In Pennsylvania and Ohio, stable manure is used liberally—at the rate of 10 tons or more per acre. As a supplement, 4–8–12 fertilizer is applied at the rate of 1,000 to 1,500 pounds per acre. The chlorine content of these plant nutrients should be held to the lowest minimum possible.

In Puerto Rico, the crop is fertilized with 500 pounds per acre of 6–8–10 fertilizer at transplanting time, with a similar amount applied 30 days after transplanting.

Topping and Harvesting.—In Ohio and Pennsylvania the plants are topped 2 to 3 weeks before harvest and before any blossoms are evident. Only 12 to 14 leaves should be left. Harvest is carried out when the plants are fully ripe, as indicated by the paler green color, mottled appearance, increased thickness, and increased brittleness of the leaves. During clear weather and when the plants are dry of dew, the plants are cut off near the ground by long-handled, specially designed shears and allowed to fall on the ground to wilt. It is customary to use wagons fitted with racks to haul the tobacco to the curing barn.

In Puerto Rico, harvest in the uplands begins

FIGURE 30.—Puerto Rico cigar-filler tobacco: A, Virginia 12 variety grown principally in the uplands; *B*, variety similar to Cuban tobaccos grown in the coastal areas.

around 35 days after transplanting. Topping may begin before harvesting and continues during the picking of the lower leaves. The lower 3 or 4 leaves are removed first. Later pickings consist of 3 or 4 leaves or more and continue until all the leaves are removed from the stalks. These are either wrapped in burlap sheets or placed in wooden trays covered with burlap and carried to the curing barn. Here they are strung by means of a needle and the strings are then tied to some form of stick or even to the tier poles of the barn.

Coastal tobacco is topped at 12 to 14 leaves. It is harvested when the leaves are a light-green color. The entire plant is cut, and, after wilting, two plants are tied together by fiber from *Sanseviera* leaves and then hung over a stick for curing.

Cigar Binder and Sun-Grown Wrapper

Tobacco grown in the Connecticut-Massachusetts area, southern and southwestern Wisconsin, and to a limited extent in Pennsylvania, Minnesota, and New York supplies most of the cigar-binder leaf and sun-grown wrapper.

Presprouted seed is sometimes planted in seedbeds to hasten time of transplanting in the field in northern areas, where the growing season is short.

Soils and Fertilizers.—In the Connecticut-Massachusetts area, wrapper and binder leaf are produced on very fine sandy loams belonging to the Agawam, Enfield, and Manchester series. The subsoil is well-drained sandy loam or very fine sandy loam. The soils for binder leaf produced in Wisconsin, New York, Pennsylvania, and Minnesota are fine sandy loams, light clay loams, and dark prairie loams.

When stable manure is available it is plowed under, preferably in the fall. Manure is not used so extensively as formerly in the Connecticut-Massachusetts area. In Wisconsin, it is used at a liberal rate—about 15 tons per acre.

The actual quantity of mixed fertilizers to be supplied vary somewhat with the character of the soil. Usually an application of 2,500 pounds per acre of 8–4–8 mixture that also contains 2 to 4 percent magnesia will supply the necessary nutrients. Where manure is used liberally, about 1,000 pounds per acre of 3–9–18 is sufficient.

The fertilizer is usually applied broadcast before transplanting. If the rainfall during the growing season becomes excessive, as it may in Connecticut, 200 pounds of nitrate of soda or 100 pounds of ammonium nitrate per acre is applied immediately after a heavy rain.

A moderately acid soil aids in the control of black root rot disease, but sometimes, when the soil shows a pH value of 5 or lower, 500 to 1,000 pounds per acre of ground limestone containing a high percentage of magnesia may be advantageous. In most cases lime in any form should be used judiciously, to avoid undesirable flakiness of the tobacco ash, interference with potash availability, and disease complications where the soil reaction becomes too alkaline.

Topping and Harvesting.—Topping of cigar-binder tobaccos usually takes place at about 2 to 3 weeks before harvest. When the plants begin to flower, the tops are broken off and about 15 leaves are left on the plant. The number of leaves left is determined by the grower, based on his experience as to the fertility of the soil, variety grown, and vigor of the individual plant. Suckers should be removed at least once before harvest.

Plants of cigar-binder tobacco are harvested when the middle leaves are judged to be "ripe," as indicated by the development of a lighter shade of green. At this stage, the lower leaves of the plant will tend to be more or less overripe and the top leaves will show varying stages of maturity. The stalk of the plant is cut near the ground with a special hatchet, knife, or long-handled shears (fig. 31). The plant is allowed to wilt after it is placed on the ground carefully to hold breakage of leaves to a minimum. On hot, clear days, the plant must be handled and speared promptly to avoid sunburning. Five or six plants are strung on a 4-foot lath by means of a removable steel spear. The opposite end of the lath must be solidly supported against the soil or spearing horse. The laths carrying the plants should be placed upon a rack, to avoid excessive bruising and breakage of the leaves, and hauled to the curing barn.

Shade-Grown Cigar Wrapper

Cigar wrapper of the best quality is grown under artificial shade in parts of Connecticut and Massachusetts; Gadsden County, Fla.; and Decatur County, Ga. The artificial shade results in a thinner, smoother leaf with small veins suitable for fine cigar wrapper. The con-

FIGURE 31.—Tobacco in Pennsylvania is harvested by cutting the stalks near the ground with long-handled shears.

ditions prevailing under the shade tent increase humidity, which reduces evaporation and wind movement.

Types and Varieties.—The Cuban variety, with numerous strains, is quite different from the Broadleaf and Havana Seed. It was originally developed from imported seed for the production of cigar-wrapper leaf under artificial shade in Connecticut and Massachusetts. Numerous disease-resistant varieties have been developed, including Fowler Special, Connecticut 15, and Connecticut 49 (fig. 32).

FIGURE 32.—Connecticut 15 grown under shade in Connecticut.

In the Florida-Georgia area, variety 301 has replaced Big Cuban and Round Tip varieties and was selected for its resistance to the black shank disease. A more recent selection, Rg, is now grown extensively. In 1954, Dixie Shade was released; it is resistant to black shank and tolerant to nematodes.

Soils and Fertilizers. — Shade wrapper is grown on fine sandy loams to sandy loams, with well-drained subsoils, in Florida and Georgia. In the Connecticut area, the tobacco is produced chiefly on Merrimac coarse sandy loam.

The same amount of fertilizer—2,500 pounds per acre of 8–4–8 mixture—as for sun-grown wrapper is used in the Connecticut area. In the Florida-Georgia area, more nitrogen and potash are used than in Connecticut, or 2,500 pounds of 10–8–12. Manure is used when available, with adjustments made in the amount and kind of mixed fertilizers applied.

Artificial Shade.—Shade consists of a wire frame about 8 feet high, supported by stout posts, substantially anchored by suitable bracing around all sides of the field. Cloth shading is attached over the top and sides (fig. 33). The cloth is a specially prepared coarse, loosely woven material containing 8 threads one way and 10 the other to the inch. It is reinforced with closer woven strands spaced at regular intervals.

Tobacco cloth comes in strips 400 inches wide and 125 feet long. The cloth is stretched and securely fastened by sewing it to the supporting wires. The cloth is placed on the frame in the spring before transplanting and it is removed after the crop is harvested. The cloth is used for the top for only one season, but the old cloth is doubled and used on the sides of the tent for the next season.

Topping and Harvesting. — The plant is topped as soon as flower buds appear. Often shade tobacco is grown without topping. Very little suckering occurs, as the plants are spaced so closely under the shade.

The priming method—picking leaves as they ripen—is used in harvesting all shade-grown tobacco. The degree of ripeness at harvest is not so advanced as for stalk-cut tobacco. However, the proper degree of ripeness is very important, as the texture, body, color, and elasticity qualities of the cured leaf depend on proper development. Usually the first picking

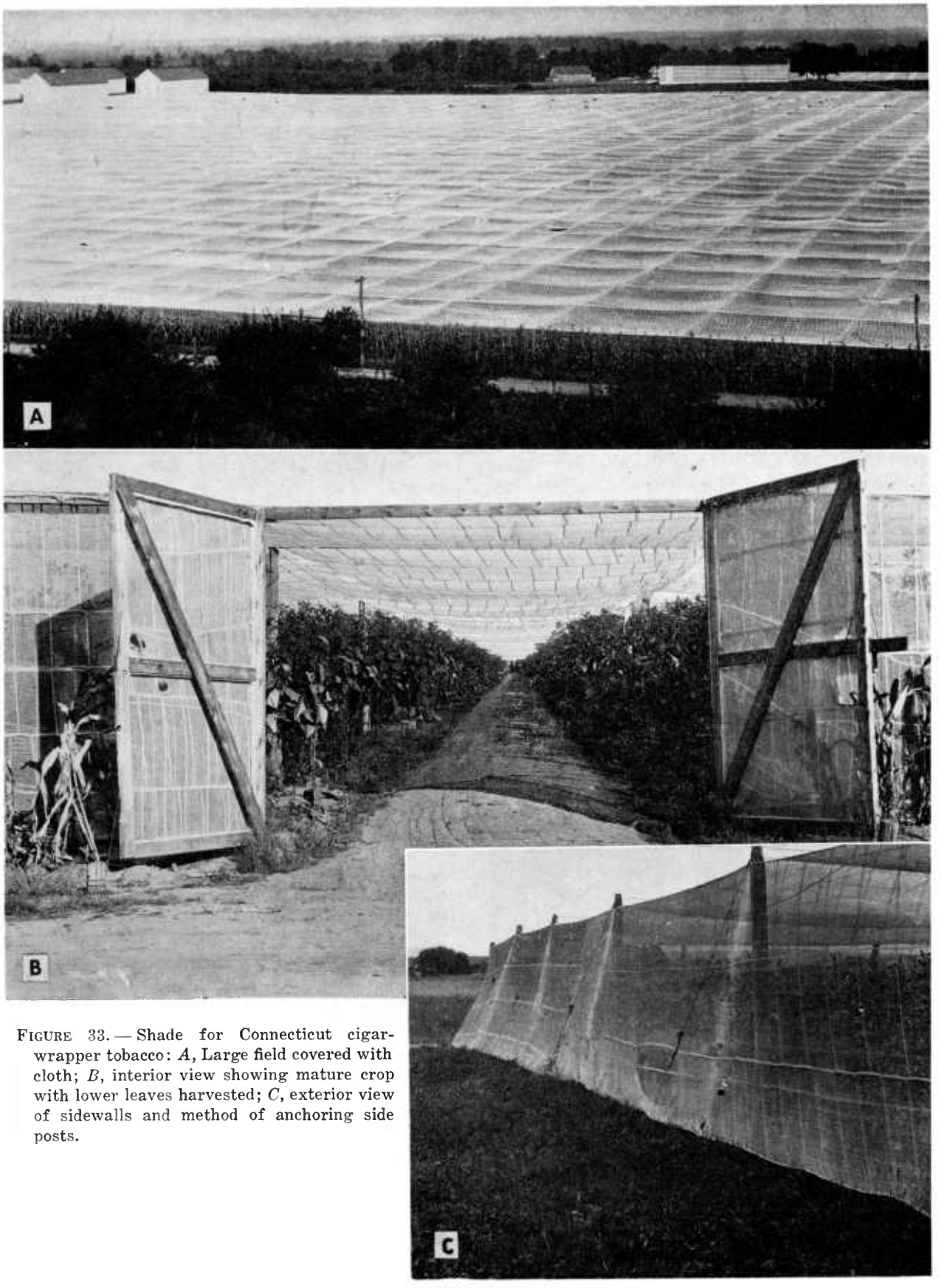

FIGURE 33. — Shade for Connecticut cigar-wrapper tobacco: *A*, Large field covered with cloth; *B*, interior view showing mature crop with lower leaves harvested; *C*, exterior view of sidewalls and method of anchoring side posts.

of three or four lowermost leaves is made at the time the flower head forms; subsequent pickings of three or four leaves are usually harvested at weekly intervals, progressing up the plant until all the leaves are harvested. The weather and other growing conditions will influence the exact interval between primings. At least five pickings should be made.

As the leaves are taken from the plant they are systematically stacked with the topside up in piles in the row. These piles are placed in canvas-lined baskets, to avoid bruising, and hauled to the curing barn. Here, a large needle threaded with a string is passed through the stem about 1 inch from the base of the leaves and the leaves paired so that the underside of each pair are against each other. The lath to which the string is attached has a saw notch at each end so that the string is fastened by drawing it into the notch with suitable winding to hold it firmly in place (fig. 34). Each lath should carry 20 to 22 pairs of leaves. In recent years special stringing machines are in general use. The machines string the leaves, which are fed to the machines by hand.

Curing

Barn Construction

To build a good tobacco barn for air curing, it should be as nearly airtight as possible and it should provide a good system of ventilation. The site should be thoroughly drained and sufficiently removed from other buildings to allow free access of air. For convenience in harvesting the barn should be near the tobacco field. The barn is usually 30 to 40 feet wide and any convenient length up to 300 feet; but shorter barn lengths are preferable.

The interior consists of a pole framework to be used to support the laths bearing the tobacco. Spaces between the poles are called tiers. Many barns are built four tiers high, but curing can be better controlled if the building is only three tiers high. Tobacco should not hang within 5 feet of the ground, so the first tier of poles should be at least 8 to 10 feet from the ground and the other tiers 4 to 5 feet apart for tobacco cured on the stalk (fig. 35). In the shade-grown areas, the tier poles are usually double the number for stalk-cut tobacco, or only 2½ feet apart, as the leaves are picked from the stalk at harvest.

FIGURE 34.—Preparation of leaves of Connecticut shade wrapper for curing: *A*, Lath showing method of attaching string; *B*, arrangement of leaves on string with pairs face to face and back to back.

FIGURE 35.—Hanging Maryland tobacco—one of the tobaccos cured on the stalk—in the curing barn.

The posts, plates, and beams used for the frame of the barn should be of stout timbers securely braced to carry the enormous weight of the green tobacco and to withstand heavy winds. Usually, the posts, frames, and girders are set up across the barn at intervals of about 16 feet, the same as at the ends, thus dividing the framework into sections known as bents. The girders on the ends and on bents are usually removable, as they carry the lower tier of poles. The upper tiers should be well braced. The tier poles on which the tobacco is hung are usually about 16 feet long and should be stout enough to carry at least 800 pounds.

The boards for the sides and ends of the barn should be of uniform width—10 or 12 inches—and all cracks should be battened with thin strips so as to make the structure as nearly weatherproof as possible. In the northern areas at least every third board should be hung on hinges either at top or sides to be used as a ventilator (fig. 36). If the boards are put on horizontally, those used for ventilators should be hung from the upper edge (fig. 37). A horizontal bottom ventilator should be provided along the entire length of the sides to admit air near the ground. Very few barns provide ventilation in the roof, such as is shown in figure 37, but it is a desirable feature if artificial heat is applied in unfavorable weather. In the Florida-Georgia district, ventilators are often openings 2½ to 3 feet wide and 10 feet long, placed at intervals of about 8 feet, and hinged at the top. The openings are about 4 to 5 feet from the ground.

The barn usually has a driveway extending through it. Doors are provided at each end of sufficient size to allow a truck or team to be driven through.

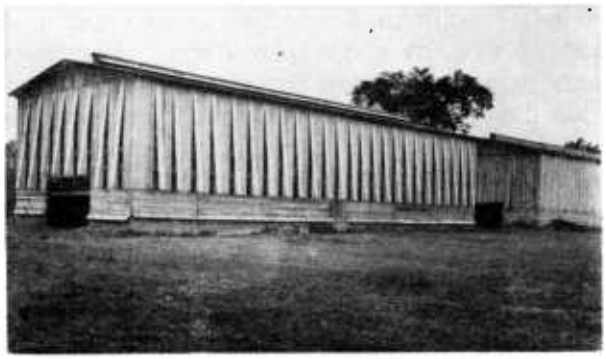

FIGURE 36.—This barn for curing cigar tobacco has vertical ventilators on sides and horizontal ventilators on peak of the roof and near the foundation.

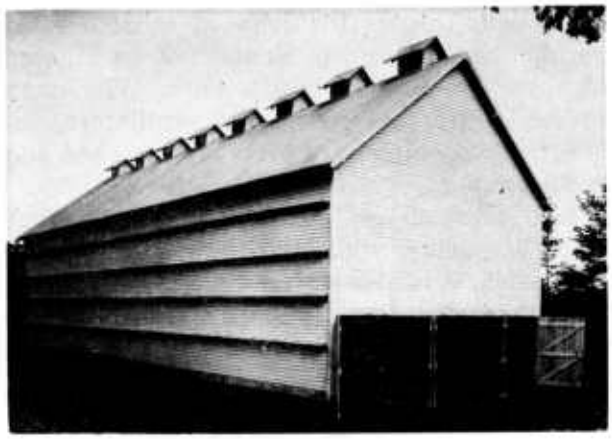

FIGURE 37.—Burley tobacco is cured in this barn, which shows horizontal ventilators and ventilators along peak of roof.

Air Curing

Air curing gives satisfactory results only when weather conditions are favorable. At the time the tobacco is hung in the barn water is evaporating from the surface of the leaves. This evaporation continues until the surrounding space is saturated with moisture. Hence, the evaporation from the fresh leaves will soon cease unless the moisture is removed by circulating the air. In moderately dry weather ventilation is all that is needed to obtain favorable curing conditions, provided the temperature is not too low. In very dry weather the evaporation from the leaves can be kept in check by having the barn built as tightly as possible and by keeping the ventilators closed during the day. If the temperature is low, curing changes are stopped, although the tobacco may continue to dry out. In this case the leaf is simply dried and not cured.

Under favorable conditions, curing for various air-cured tobaccos range from 4 to 8 weeks. The cure is finished when the midrib of the leaf is dried out so that it will snap when bent between the fingers. The tobacco stalks may still be quite green at this stage. After the cure is finished the tobacco should be prevented from coming in high case, or order, until it is taken down. Those tobaccos that were stalk-cut should be stripped and the leaves sorted as soon as possible after curing is completed.

Sunlight injures the color of tobacco after curing; hence, the sun should not be allowed to shine on the leaf in the barn. Wind may bruise the leaf near doors and ventilators, unless these openings are carefully watched and regulated.

Leaf Changes in Curing.—During the first stage of curing, while the leaf is undergoing starvation, it is also gradually losing the water it contains. One important feature of curing is to regulate properly the rate of drying. If drying is too rapid the leaf is killed prematurely and curing is stopped; if drying is too slow, curing goes too far. The rate of drying depends principally on the humidity in the barn. The fully ripe leaf is rich in starch, and an important change in the curing is the disappearance of this starch, which is consumed largely by the living part of the leaf.

If the leaf is killed by bruising, rapid drying, or too high heating there is no means of removing the starch, and the tobacco is harsh, lifeless, and "strawy." Some nitrogenous constituents also are changed during this starvation period. These are the first changes necessary for curing.

As these changes in composition occur, the green color is replaced by a lemon yellow. If, by bruising or rapid drying out, the green leaf is killed outright soon after harvesting, the green color cannot be removed by any later treatment.

The full development of the yellow color marks the end of the first period of curing. After the leaf is dead no more starch is consumed, nor are the insoluble nitrogen compounds altered further. During the second stage the color may become yellow to brown or red, depending on tobacco type. This is caused by a process of oxidation that does not take place until the cells of the leaf are dead. A supply of air and sufficient moisture are necessary to develop the brown or red color. In air curing, the principal danger is that excess moisture may cause the tobacco to cure too dark.

The tobacco leaf ordinarily loses about 75 percent of its green weight in curing, and most of this loss is in water. Thus, the tobacco from an acre yielding 1,800 pounds of cured leaf weighs, when harvested about 8 tons, including the stalks. Of the 8 tons, fully 6 tons is water. To cure tobacco successfully, most of the water must be removed at such a rate that it will allow the other important changes to take place.

Temperature and Ventilation. — The living cells of the leaf are killed by excessively low or excessively high temperatures and by loss of water. In practice, the most favorable temperatures for the first stage of air curing lie between 70° and 100° F. and the relative humidities are about 70 percent for burley and 85 percent for Maryland, dark air-cured, and cigar tobaccos. Under these conditions the leaf will gradually lose its water, but it will not become brittle, and curing will proceed smoothly. If the humidity becomes much higher, pole-sweat will develop on the leaves most advanced in curing; if the humidity falls much below these figures, the leaf will dry out too rapidly.

In the second phase, when the leaf begins to turn brown or red, the air in the barn need not be kept so moist. The leaf should be allowed to dry rather rapidly until the stems have become brittle. After curing and before it is taken down, it is desirable to prevent the tobacco from coming into very high case, that is, from becoming very moist.

Unfortunately, most growers have very limited means for controlling the temperature and humidity in the barn. If the season is too dry the tobacco "hays down"—that is, it simply dries out like hay; if too wet, it is also seriously damaged. All experienced tobacco growers are aware of the serious damage likely to result from pole-sweat, or house-burn, during very wet weather. Few, however, fully appreciate the extent of the injury in quality caused by excessively dry weather.

Artificial Heat.—During rainy or foggy weather, any given space contains the maximum or near maximum amount of water vapor that can be present at the prevailing temperature and pressure. Under these conditions evaporation of water from the tobacco is severely retarded or stops entirely. In wet weather, supplemental heat is required to reduce the humidity in the barn. If barn temperatures can be maintained 15° to 20° F. higher than that of outside air, combined with proper ventilation, the grower can control curing conditions. An insufficient quantity of supplemental heat is worse than none, and enough must be supplied to warm the barn to the top and thus drive out the moisture. When the temperature is

below 50°, heat is needed for good curing, regardless of the humidity, as tobacco cannot cure properly at low temperatures. Nearly all shade-grown tobacco is cured in part with artificial heat.

Small charcoal fires on the floor of the barn or coke in stoves usually provide supplemental heat for air curing. Moderate heat is maintained for 2 or 3 days, depending on the weather conditions. Liquid petroleum (LP) gas is now the common fuel used for curing shade-grown wrapper tobacco.

Pole-Sweat, or House-Burn.—During periods of prolonged wet weather accompanied by rather high temperatures, pole-sweat may occur after the tobacco leaf tissue dies. It is often associated with minute organisms that attack those parts of the leaf that give it toughness and stiffness, causing those parts to soften and decay. As the organisms that cause this trouble are not active at very low temperatures pole-sweat does not appear to any extent in cold weather.

Three conditions are necessary for the rapid spread of the decay: (1) Tobacco that has passed through the first stage of curing or has been killed by bruising or other injury; (2) a temperature ranging from 60° to 100° F.; and (3) a relative humidity of 90 percent or more, which checks the evaporation from the leaves. Conditions favorable to pole-sweat may exist for short periods without decay appearing, but decay will certainly develop if the conditions above continue for 24 to 48 hours.

The only practicable means for controlling the humidity in the curing barn during excessively damp weather is to use supplemental heat.

Sun Curing

In Caroline, Louisa, Hanover, and adjoining counties of Virginia, and in some fire-cured areas and in Pennsylvania, tobacco is often exposed to the sun or open air for several days immediately after harvesting. The curing then is completed in the barn without artificial heat. Sun-cured tobacco is used mainly for chewing, and exposure to the sun is thought to improve the flavor.

In sun curing, the sticks, filled with plants, are crowded rather closely together on scaffolds erected near the barn (fig. 38). After the leaves have yellowed, usually 4 to 6 days, the sticks are spread farther apart and left on the scaffold a few days longer. If there is much rain during this period, tobacco should be placed under shelter. Because of the increased cost of handling, very little tobacco is now sun-cured.

Stripping and Sorting

After air curing, leaf cured on stalks should be taken from the laths (or sticks) as soon as

FIGURE 38.—Pennsylvania cigar tobacco hung on scaffolds to wilt and to cure partially before it is transferred to the barn.

possible and the leaves stripped off. This cannot be done, however, until after damp weather has prevailed long enough for the leaf to become sufficiently pliable to be handled readily without breaking. Tobacco in this condition is said to be "in case" or "in order." Weather well adapted to bringing cured leaf into case is spoken of as a "tobacco storm." Tobacco will not come into order if the temperature is very low, even during wet weather. If the stalks have been frozen, the plants should hang until dripping stops, so as to avoid staining. In some filler districts, laths are hung in dampening cellars, to bring the tobacco in case. From the cellar the stalks are taken to a sorting room and stripped.

As the stalks with the cured leaf are taken from the laths they are usually piled in heaps on the floor on poles or boards. The tips are all turned inward and overlapped, to prevent the leaves from drying out. The heap, or bulk, may be covered with tarpaulin, mats, stalks, or other materials to prevent drying. The heaps may become heated unless stripping is done as soon as possible.

The leaves, as stripped from the stalk, are placed into grades, according to length, soundness, and type of tobacco. Each grade is tied into "hands" of 10 to 30 leaves, using a tie leaf. In filler and binder districts, the leaves are usually made into neat bundles or bales by means of a form, then wrapped with heavy paper, and tied with twine. These bundles usually weigh 30 to 60 pounds. Burley and Maryland tobaccos are usually sold loose-leaf, tied into hands. Sometimes, Maryland tobacco is sold in hogsheads containing 700 to 800 pounds of leaf.

Various air-cured types are usually sorted in the following grades with further breakdowns according to quality or color:

Burley tobacco—tied into hands of 10 to 20 leaves and bulked down—(1) flyings and (2) trash used principally for smoking tobacco; (3) lugs, (4) bright leaf, and (5) red leaf used mostly for cigarettes; and (6) tips used for plug and twist fillers.

Maryland tobacco—seconds, bright leaf, and dull leaf—for domestic cigarette manufacture and some for export.

Dark air-cured tobaccos—trash, lugs, and leaf—for domestic plug chewing, pipe tobacco, and for export.

Sun-cured tobacco—lugs and leaf—for chewing and sometimes the better leaves for wrappers.

Cigar tobaccos—binders or tops, fillers, stemming, and wrappers.

Binder and filler tobacco may be sold unassorted in the bundle or bale to buyers. It is sorted and processed by the manufacturers to suit their requirements. When grading is done on the farm in a limited way, growers separate the tobacco in bales or bundles of various lengths and place in sizing boxes with subdivisions for each grade.

Before any leaf is ready for the manufacturer, it must undergo a process of fermentation, commonly spoken of as "sweating." Carrying out this process successfully requires a thoroughly equipped plant, with facilities for controlling ventilation, temperature, and humidity. As a rule, therefore, the growers sell their leaf in the bale or bundle or in cases to the packers, who carry out the grading and fermentation processes.

PERIQUE TOBACCO

Perique tobacco is grown to a limited extent in Louisiana on the better drained soils of the St. James Parish. It represents a distinct type of tobacco, and the product resembles that grown in the coastal region of Puerto Rico.

Power machinery is used to cultivate the crop if possible, but much hand hoeing is often necessary.

The varieties grown and methods of culture resemble those used in producing the fire-cured type (p. 21). The plants are topped at 12 to 14 leaves and the suckers are removed, usually about three times.

Perique tobacco is harvested in June or July by cutting stalks near the ground level. A nail is driven at an angle in the base of the stalk so that the plants can be hung on wires stretched across the barn. The barns are well ventilated and the leaf is cured in 8 to 14 days.

The leaves are removed from the stalks and

stemmed and graded, then made into twists, or "torquettes," weighing about 1 pound each. The twists are then placed in suitable containers and allowed to process under heavy pressure. The pressure is applied and maintained by means of screws, levers with weights, or other manipulations. The boxes or casks are opened every 2 or 3 days for about 2 weeks to aerate, rearrange, and finally combine the tobacco from about three casks into two. After the 2-week period, processing under pressure is continued so that the tobacco may ferment in its own juice. Heavy pressure is maintained until the tobacco is marketed a year or so later.

AROMATIC TOBACCO

Aromatic tobacco is produced to a limited extent in the Piedmont regions of western North Carolina, Virginia, and South Carolina. Most aromatic tobacco, often referred to as Turkish or oriental tobacco, is grown in certain areas in Greece, Turkey, Bulgaria, and the U.S.S.R. in upland areas bordering on the Aegean and Black Seas. This tobacco is very important in the domestic-blended cigarette industry. When importations of oriental tobaccos were curtailed during World War II, farmers in the United States became interested in growing it. Samsun, Smyrna, Cavilla, and Xanthi are the varieties.

Aromatic tobacco does best on well-drained soils of medium natural productivity. Phosphate and potash nutrients should be raised to a medium or high level, but the nitrogen should be maintained at a relatively low level—usually an application of 20 pounds N per acre is adequate. About 100 pounds per acre of P_2O_5 and of K_2O should be added.

The plants are not topped and the leaves are harvested by priming—3 to 5 leaves are removed at 5- to 7-day intervals. Harvesting is usually completed in 5 to 6 pickings. The leaves are small and are strung on a string with a needle or on special wires. The string or wire of leaf is hung across or attached to a stick for curing. The leaf may be sun-cured for a short period before final air curing in a barn.

Owing to the large number of plants that are grown per acre and the resulting small size of the leaf to give an acceptable product, the cost of producing aromatic tobacco is too expensive with U.S. labor and equipment. In some cost-of-production surveys, the man-hours to end of harvest for a crop was estimated at 600 per acre.

DISEASES AND THEIR CONTROL

The tobacco plant is attacked by a number of diseases in the plantbed (fig. 39) and in the field (fig. 40).

Sanitation should be practiced, especially in the plantbed, as transplanting of healthy plants is the first important step in producing a good crop. Tobacco trash can be used as a fertilizer for many crops, but it should not be used on the tobacco crop—either in the plantbed or in the field.

Weeding or pulling plants from the bed should never be done immediately after handling tobacco from the previous year's crop unless the grower has thoroughly washed his hands with soap. If possible, he should also change into clean clothing.

PRECAUTIONS

Fungicides and nematocides are poisonous. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. Keep the pesticides in closed, well-labeled containers in a dry place where they will not contaminate food or feed and where children and pets cannot reach them.

Wear clean clothing; avoid repeated or prolonged contact of chemicals with the skin and inhalation of dusts and mists; and wash hands and face before eating or smoking.

When large quantities of solutions are used wear oiled leather gloves and a rubber or oil-

FIGURE 39.—*A*, Blue mold destroyed all but about 1,000 plants per 100 square yards in this unsprayed plantbed; *B*, sprayed plantbed produced 40,000 tobacco plants per 100 square yards.

cloth apron. Use care in pouring out solution not used and see that it soaks into the ground and does not stand in puddles. Pour solution where it will not wash down and contaminate water supplies. Clean thoroughly all vessels after use.

Location of the seedbed (p. 3) and soil sterilization (p. 4) are important aids in disease control. Table 5 identifies the major tobacco diseases, including malnutritional disorders (fig. 41), and gives the most effective known control measures or remedies.

The causal organisms of the diseases given in table 5 are as follows:

Disease	*Causal organism*
Anthracnose	*Colletotrichum* sp.
Bacterial wilt	*Pseudomonas solanacearum* E.F.Sm.
Blackfire	*P. angulata* (Fromme & Murray) Holland.
Black root rot	*Thielaviopsis basicola* (Berk. & Br.) Ferr.
Black shank	*Phytophthora parasitica* (Dast) var. *nicotianae* (Breda de Haan) Tucker.
Blue mold	*Peronospora tabacina* Adam.
Brown spot	*Alternaria longipes* (Ell. & Ev.) Mason.
Damping-off	*Pythium debaryanum* Hesse in spring; *Rhizoctonia solani* Kuehn. in summer; also by other species of *Pythium* and strains of soft rot bacteria.
Frogeye	*Cercospora nicotianae* Ell. & Ev.
Fusarium wilt	*Fusarium oxysporum* (Schlecht.) var. *nicotianae* J. Johnson.
Nematode root rot	*Pratylenchus* sp.
Root knot	*Meloidogyne* sp.
Sore shin	*Rhizoctonia solani* Kuehn.
Southern stem and root rot.	*Sclerotium rolfsii* Sacc.
Wildfire	*Pseudomonas tabaci* (Wolf & Foster) F. L. Stevens.

TABLE 5.—*Major tobacco diseases and malnutritional disorders and their control*[1]

PLANTBED DISEASES

Disease	General conditions	Most distinctive symptoms	Control [2]
Damping-off	Plants dying in spots	Stems at the ground surface are withered	Soil sterilization, ventilation, and regular spraying or dusting with fungicides (carbamates).
Black root rot	Growth retarded in some areas	Plants wilt during the warm part of the day; roots are decayed and black.	Soil sterilization; avoid seeding on alkaline soil; grow resistant varieties.
Blue mold	Leaves with large irregular dead areas	Underleaf surface, before the tissue dies, shows a downy mold growth.	Regular spraying or dusting with fungicides (carbamates); also gas, using heavy cover, when disease appears; streptomycin sprays or dusts.
Anthracnose	Leaves with many small whitish spots	Veins on the underside have red-brown streaks	Regular spraying or dusting with carbamate fungicides.
Wildfire	Leaves with rounded yellowish spots	Younger spots have a dead, light-colored center the size of a pinhead and a broad yellowish border.	Early and regular spraying with copper fungicides or streptomycin sprays or dusts; grow resistant varieties.
Blackfire	Leaves with dark irregular spots	Lesions tend to be angular	Do.

FIELD DISEASES

Black root rot	Retarded top growth and diseased roots.	Lesions on roots localized and black	Grow resistant varieties; avoid transplanting on alkaline soil.
Nematode root rot		Lesions on roots red brown	Rotation and soil fumigation.
Root knot		Roots swollen and knotted	Do.
Southern stem and root rot.		Light-brown stalk decay at ground surface; on decayed surface, small round bodies (sclerotia); affected plants scattered over field.	Practice crop rotation and soil fumigation.
Sore shin	Wilting of entire plants	Dark-brown stalk decay, beginning at ground surface and extending up 12 to 24 inches; no sclerotia; affected plants scattered over the field.	No effective control measures known.
Black shank		Decay begins in root and extends into stalk pith; later all roots and base of stem blacken and die; diseased plants concentrated in definite field areas.	Grow resistant varieties and practice rotation, using resistant or immune crops.
Bacterial wilt		Disease development same as with black shank; in addition, dark streaks extend up through stem wood rather than through pith.	Do.

TABLE 5.—*Major tobacco diseases and malnutritional disorders and their control* [1]—Continued

FIELD DISEASES[1]—Continued

Disease	General conditions	Most distinctive symptoms	Control [2]
Fusarium wilt	Plants that wilt on one side	Soft bark on affected side removed; solid brown layer on surface of the wood.	Grow resistant varieties and practice rotation, using resistant or immune crops; nematode control by soil fumigation reduces this wilt.
Wildfire	Leaf spots	Younger spots have a small dead center and a wide yellow border.	Use liberal potassium and low nitrogen applications; grow resistant varieties; transplant healthy plants.
Blackfire		Lesions are irregular, angular, and dark colored.	Do.
Brown spot		Spots are rounded, red brown, and dark colored.	No effective control measures known.
Frogeye		Spots are irregular; many are paperwhite with dark dots in the center.	Do.
Mosaic [3]	Leaf malformation and mottling	Green and yellow mottling that is most conspicuous on young leaves.	Sanitation and grow resistant varieties.
Etch [3]		Older leaves mottled; younger leaves showing only chlorotic spots.	Control aphids; sanitation.
Vein banding [3]		Dark-green borders along veins of older leaves	Do.
Ring spot [3]		White dead areas form concentric rings or lines that follow the veins; later leaves show no symptoms.	Avoid growing tobacco after clovers, lespedeza, and alfalfa.
Streak		Young leaves suddenly become necrotic and crumpled in appearance; later leaves show no symptons.	Avoid growing tobacco after sweetclover.
Frenching		Young leaves are chlorotic; older leaves become thick and straplike.	No effective control measures known.

MALNUTRITION DISORDERS [4]

Group	General conditions	Specific symptoms	Fertilizer element needed
Effects localized on older or lower leaves of plant, or general on whole plant.	Local, as mottling or chlorosis, with or without necrotic spotting of lower-leaves, little or no drying-up of lower leaves.	Lower leaves mottled with necrotic spots at tips and margins, which are tucked or cupped under; stalk slender in extreme cases and may show necrotic areas; if shortage becomes acute in mature plants, top leaves may be first to show symptons.	Potassium.
		Lower leaves chlorotic and typically show no spots; tips and margins turned or cupped upward; stalk slender in extreme cases.	Magnesium.
	General on whole plant; also, yellowing and drying-up or firing of lower leaves.	Plant light green; lower leaves yellow and dry to light brown; stalk short and slender if element is limiting in later growth stages.	Nitrogen.
		Plant dark green; lower leaves may yellow and dry to a greenish brown to black; stalk short and slender if element is limiting in the later growth.	Phosphorus.
Effects localized on newer or bud leaves of plant.....	Terminal bud dies; death is preceded by peculiar distortions at the tips or bases of young leaves making up bud.	Young leaves making up terminal bud first typically hooked, then die back at tips and margins so that later growth of such leaves shows a cutout appearance at tips and margins; stalk finally dies back at terminal bud.	Calcium.
		Young leaves making up terminal bud first light green at base, then more or less breakdown takes place at base of young leaf, and if later growth follows, leaf shows twisted growth; stalk finally dies back at terminal bud.	Boron.
	Terminal bud remains alive; chlorosis of newer or bud leaves, with or without necrotic spots; veins light or dark green.	Young leaves chlorotic, with necrotic spots scattered over leaf; smallest veins tend to remain green, producing a checkering effect on leaf; stalk slender.	Manganese.
		Young leaves light green, no necrotic spots; veins lighter green than intervein tissues; stalk short and slender.	Sulfur.

[1] Adapted from U.S. Dept. Agr. Farmers' Bul. 2023, "Tobacco Diseases and Their Control." The reader is referred to this publication for more detailed information on tobacco diseases.

[2] Carbamates may include ferbam (ferric dimethyl dithiocarbamate) and zineb (zinc ethylene bisdithiocarbamate). Gas may include PDB (paradichlorobenzene) applied under gastight covers at night. The heavy cover is usually removed in the morning before the sun gets warm. Streptomycin may include commercial formulations of streptomycin sulfate or nitrate, which are usually applied at 200 parts per million of the chemical. The fumigants commonly used are ethylene dibromide (Dowfume W–40) and dichloropropene-dichloropane (D–D) mixture. Read carefull precautions on page 41 before using these chemicals.

[3] Caused by a virus.

[4] Malnutrition disorders caused by lack of certain fertilizer elements decrease plant growth and may cause death of some parts of plant; affects plants in plantbeds and in the field.

FIGURE 40.—Black shank destroyed this tobacco crop as it approached maturity.

FIGURE 41.—*A*, Normal growth of plant when all elements are supplied. Tobacco plants showing effects due to malnutrition produced by the following plant nutrient shortages—*B*, nitrogen; *C*, phosphorus; *D*, potassium; *E*, boron; *F*, calcium; and *G*, magnesium.

INSECTS AND THEIR CONTROL[2]

Several species of insects attack tobacco practically at all stages of its growth. Flea beetles (fig. 42) commonly attack the plants in the plantbed and newly set plants; and hornworms (fig. 43) commonly injure plants in the field. These and other insects and the principal measures for their control are given in table 6. These recommendations apply to the 1961 season. For current recommendations and precautions, see USDA Agriculture Handbook 120, which is revised each year.[3]

The insects and related pests discussed in table 6 follow:

Common name	*Scientific name*
Changa	*Scapteriscus vicinus* Scudd.
Corn root webworm	*Crambus caliginosellus* Clem.
Crane fly	*Neolimnophila ultima* (Osten Sacken)
Cutworm:	
Black	*Agrotis ipsilon* (Hufnagel)
Dark-sided	*Euxoa messoria* (Harr.)
Dingy	*Feltia subgothica* (Haw.)
Granulate	*F. subterranea* (F.)
Spotted	*Amathes c-nigrum* (L.)
Variegated	*Peridroma saucia* (Hübner)
Grasshopper:	
American	*Schistocerca americana* (Drury)
Migratory	*Melanoplus bilituratus* (Walker)
Long-horned	*Concocephalus* sp.
Southern red-legged	*Melanoplus femurrubrum propinquus* Scudder
Green June beetle	*Cotinis nitida* (L.)
Green peach aphid	*Myzus persicae* (Sulz.)
Midge	*Smittia aterrima* (Meigen)
Seed-corn maggot	*Hylemya cilicrura* (Rond.)
Slug:	
Spotted garden	*Limax maximus* L.
Gray garden	*Deroceras reticulatum* (Müller)
Southern mole cricket	*Scapteriscus acletus* R. & H.
Suckfly	*Cyrtopeltis notatus* (Distant)
Tobacco budworm	*Heliothis virescens* (F.)
Tobacco flea beetle	*Epitrix hirtipennis* (Melsh.)
Tobacco hornworm	*Protoparce sexta* (Johan.)
Tobacco thrips	*Frankliniella fusca* (Hinds)
Tomato hornworm	*Protoparce quinquemaculata* (Haw.)
Vegetable weevil	*Listroderes costirostris obliquus* (Klug)
Wireworm:	
Eastern field	*Limonius agonus* (Say)
Tobacco	*Conoderus vespertinus* (F.)
Species of	*Aeolus mellillus* (Say)
	Conoderus auritus (Herbst)

[2] Prepared by F. S. Chamberlin, Entomology Research Division.

[3] Entomology Research Division, "Insecticide Recommendations of the Entomology Research Division for the Control of Insects Attacking Crops and Livestock for 1961," U.S. Dept. Agr., Agr. Handb. 120.

PRECAUTIONS

Insecticides are poisonous. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. Keep insecticides in closed, well-labeled containers, in a dry place where they will not contaminate food or feed, and where children and pets cannot reach them.

Diluted dusts or water sprays of DDT, Dylox, malathion, and TDE can be used safely without special protective clothing or devices. However, concentrates and oil solutions require special precautions. Avoid spilling them on the skin, and keep them out of the eyes, nose, and mouth. If any is spilled, wash it off the skin and change clothing immediately. If it gets in the eyes, flush with plenty of water for 15 minutes and get medical attention.

Aldrin, chlordane, dieldrin, heptachlor, lindane, and Thiodan can be absorbed directly through the skin in harmful quantities. When working with these insecticides in any form, take the same precautions as with concentrates.

Endrin, methyl parathion, and parathion are extremely poisonous and may be fatal if swallowed, inhaled, or absorbed through the skin. These highly toxic insecticides should be applied only by a person thoroughly familiar with their hazards and who will assume full responsibility for safe use and comply with all the precautions on the labels. To reduce the danger of skin exposure, wear recommended protective clothing and equipment. Wear a respirator or mask of a type tested and recommended by the U.S. Department of Agriculture. Full-face masks are needed while loading or flying aircraft used in applying these insecticides. A list of acceptable protective devices may be obtained from the Entomology Research Division, ARS, Beltsville, Md.

If you must handle plants within 5 days after treatment with endrin, methyl parathion, or parathion, protect your skin by wearing clean, dry, cotton gloves or a good grade of rubber gloves, either natural or Neoprene but not Buna. You should also wear tightly woven clothing.

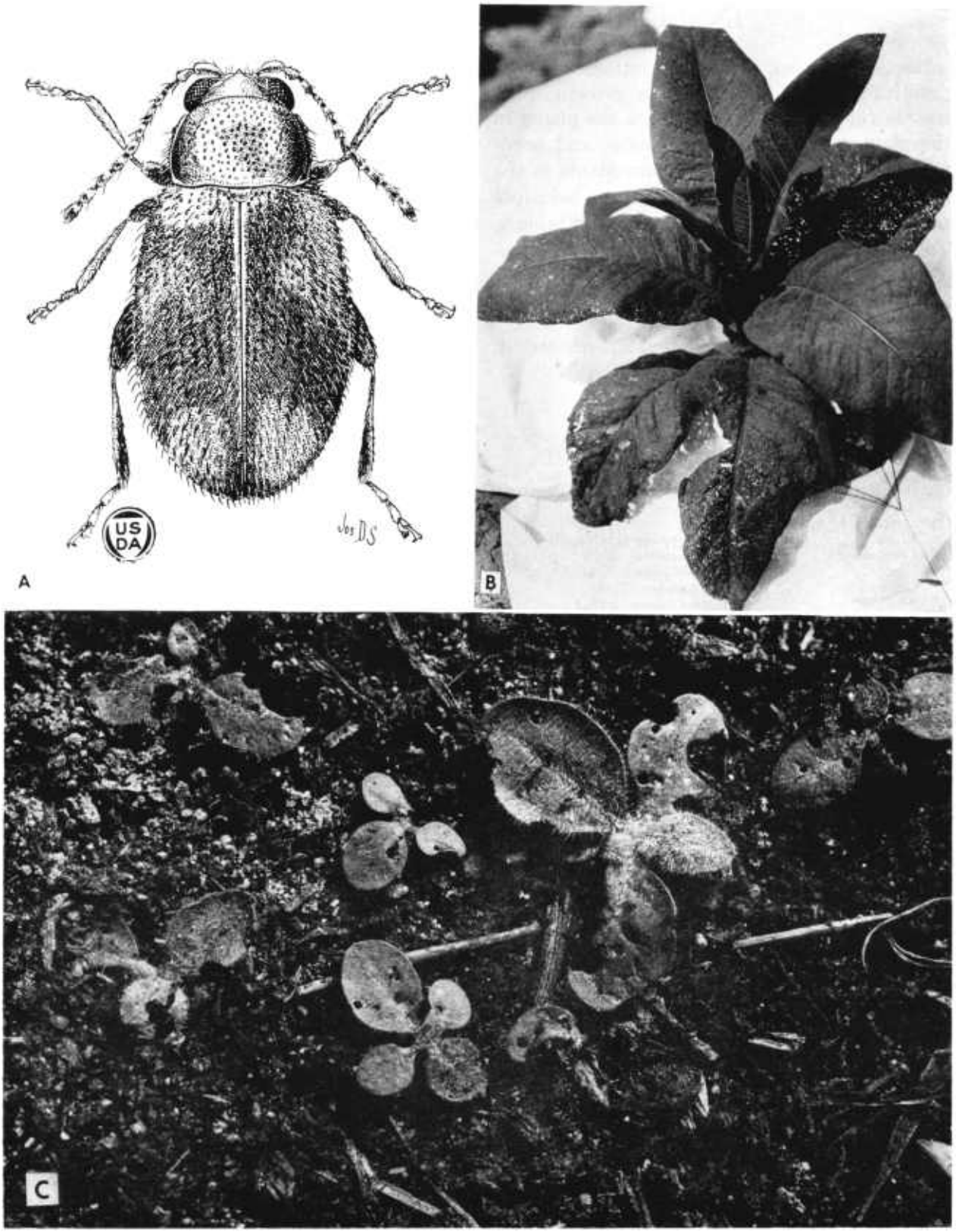

FIGURE 42.—Flea beetles: *A*, Adult (enlarged 35 times); *B*, adult flea beetle injury to plant in field; and *C*, flea beetle injury to plants growing in plantbed.

TABLE 6.—*Insects on tobacco, and how to control them*

IN PLANTBEDS

Insect	Insecticide	Formulations [1]	Rate per 100 square yards [1]	Directions
Flea beetles	DDT	5–10 percent D	¾–1½ lb.	On foliage as needed. An application just before plants are pulled before transplanting can often be used to advantage.
		2 lb. 50 percent WP/100 gal.	3–6 gal.	
Green June beetle larvae or "grubworms".	Dylox	1 percent D	2 lb.	Dust on ground or apply through cover of plantbed.
	Methyl parathion.	Drench: ½ lb. 50 percent WP/50 gal. water	100 gal. water	Apply to soil with sprinkling can. Do not apply methyl parathion or parathion within 5 days before transplanting; these insecticides should be applied only by a trained operator.
	Parathion	½ lb. 20 percent WP/50 gal. water	100 gal. water	
		½ lb. 15 percent WP/50 gal. water	100 gal. water	
Aphids	Parathion	1 percent D	1 lb.	Apply to plants as needed. Do not apply malathion within 3 days or parathion within 5 days before transplanting; only a trained operator should apply parathion.
		1 pt. 25 percent EC/100 gal.	5 gal.	
	Malathion	4 percent D	1 lb.	
		2 pints 50 percent EC/100 gal. water	5 gal.	
	Thiodan	4 percent D	0.3–0.5 lb. D.	
Cutworms	Aldrin	Bait: 4 oz. 25 percent WP/50 lb. bran (water to moisten).	4 lb. (dry wt.)	Scatter around margins of bed, on walks, and other open spaces. Do not put on plants.
	Chlordane	1 lb. 50 percent WP/50 lb. bran (water to moisten).	4 lb. (dry wt.)	
	Heptachlor	8 oz. 25 percent WP/50 lb. bran (water to moisten).	4 lb. (dry wt.)	
	DDT	10 percent D	1 lb. 3–5 gal.	On foliage as needed.
		2 lb. 50 percent WP/100 gal.		
Mole cricket	Parathion	Drench: ½ lb. 15 percent WP/50 gal. water.	50 gal. drench	Apply with sprinkling can.
Slugs or snails		Bait: ready-made product containing metaldehyde. Available under various trade names.	2 lb.	Apply in same manner as for cutworms.
		Hydrated or air-slaked lime (commercially available product).	4 lb.	Apply with hand duster to soil and plants when these are dry. Avoid applications when soil and plants are wet.

TABLE 6.—*Insects on tobacco, and how to control them*—Continued

IN PLANTBEDS—Continued

Insect	Insecticide	Formulations [1]	Rate per 100 square yards [1]	Directions
Vegetable weevils.	Aldrin	2.5 percent D	1 lb. D	Apply on foliage as needed.
	DDT	10 percent D	1 lb. D	
	Parathion	1 percent D	1 lb. D	
Grasshoppers	Aldrin	2.5 percent D	½–1 lb. D	Scatter on soil around margin of bed and in open spaces early in morning. Do not put on plants.
Midge and crane fly larvae	DDT	5–10 percent D	1 lb. D	Apply insecticides to soil when needed.
	Parathion	1 percent D	1 lb. D	

ON NEWLY SET PLANTS

Insect	Insecticide	Formulations [1]	Rate per acre (active ingredient unless otherwise indicated)	Directions
Flea beetles	DDT	5 or 10 percent D	6–15 lb	On foliage as needed.
		2 lb. 50 percent WP/100 gal. water	60 gal	
	Endrin	1–2 percent D	6–15 lb	Only a trained operator should apply endrin.
		19.5 percent EC	0.2 lb	
Cutworms	Aldrin, Chlordane, Dieldrin, Heptachlor	Bait: Same as in plantbed	Before setting 20 lb. B/acre; after setting 3 lb./1,000 plants (both dry wt.).	Before setting — broadcast; after setting — apply near each plant.
	DDT	D, EC, or WP	1–1½ lb	To plants and adjacent soil surface.
	Endrin	D or EC	0.4 lb	
Wireworms: Setting-water treatments.	Chlordane	½ lb. 40 percent WP/50 gal. water	250 gal	Around stems as plant is transplanted. See that soil is wet to the surface.
	Heptachlor	4–8 oz. 25 percent WP/50 gal. water		Effective in hand transplanters, but not always in mechanical transplanters. Keep well stirred.
	Lindane	2 oz. 5 percent solution/50 gal. water		
Soil treatments.	Aldrin	G, WP, or EC	2–4 lb	Broadcast on soil at least 1 month before planting. Work into top 6–9 inches. Only a trained operator should apply parathion.
	Chlordane	do	4–6 lb	
	Dieldrin	do	1–2 lb	
	Heptachlor	do	2–4 lb	
	Parathion [2]	do	2 lb	
Seed-corn maggot.	Aldrin	40 percent WP	5 oz./50 gal. water.	Used in setting water. Keep well stirred. Outbreaks cannot be forecast.

TABLE 6.—*Insects on tobacco, and how to control them*—Continued

ON PLANTS IN THE FIELD

Insect	Insecticide	Formulations [1]	Rate per acre	Directions
Hornworms [3]	Endrin	1–2 percent D	8–30 lb	On foliage as needed.
		19.5 percent EC	1–2 pt	
	TDE	10 percent D	8–30 lb	
		25 percent EC	2 qt	
		50 percent WP	4 lb	
		Bait: 1 lb./75 lb. cornmeal	6–10 lb	A pinch into bud of each plant.
Budworms: [3] On sun-grown tobacco.	DDT	10 percent D	4–20 lb	To upper part of plant as soon as budworms appear. Dosage of DDT and TDE dusts may be reduced to 4–6 lb. if applied directly into buds with small plunger duster.
		25 percent EC	½ lb	
	Endrin	1–2 percent D	8–20 lb	
		19.5 percent EC	0.2 lb	
	TDE	10 percent D	4–20 lb	
		25 percent EC	1 lb	
On shade-grown tobacco.	DDT	10 percent D	10–20 lb	Weekly to foliage.
		25 percent EC	1–2 qt	
		Bait: 1 lb./75 lb. cornmeal	6–10 lb	Pinch into bud of each plant.
Grasshoppers	Aldrin	EC or D	2–4 oz	Treat field borders and fields adjacent to tobacco, preferably when grasshoppers are immature. Do not feed treated vegetation to dairy animals or animals being finished for slaughter.
	Heptachlor	EC or D	2–4 oz	
Flea beetles	DDT	5–10 percent D	15–25 lb	On foliage as needed.
		2 lb. 50 percent WP/100 gal	60–80 gal	
	Endrin	1–2 percent D	15–25 lb	
		19.5 percent	0.2 lb	

Aphids [3]	Malathion	4 percent D	8–30 lb	Inspect tobacco once a week. Apply insecticide to any plants found infested. If aphids are generally distributed, treat all plants thoroughly but lightly with insecticide.
		2 pt. 50 percent EC/100 gal	50–100 gal	
		4 lb. 25 percent WP/100 gal	50–100 gal	
	Parathion	1 percent D	8–30 lb	
		1 pt. 25 percent EC/100 gal	50–100 gal	
		1 lb. 15 percent WP/100 gal	50–100 gal	
Suckflies	Parathion	1 percent D	12–15 lb	Apply as soon as insects are first noticed. Cover all parts of plant but particularly lower surface of leaves. Repeat if insects become abundant.
		1½ lb. 15 percent WP/100 gal	80 gal	
Thrips	Parathion	1 percent D	8–30 lb	Inspect tobacco once a week. Apply insecticide to any plants found infested. If thrips are generally distributed, treat all plants thoroughly but lightly with insecticide.
		1 pt. 25 percent EC/100 gal	50–100 gal	
		1 lb. 15 percent WP/100 gal	50–100 gal	
White-fringed beetles	Aldrin	D, EC, G, or WP	2 lb	Broadcast on soil when preparing for planting and immediately work into upper 3 inches.
	Chlordane	do	5 lb	
	DDT	do	10 lb	
	Dieldrin	do	1½ lb	
	Heptachlor	do	2 lb	

[1] Abbreviations used: Bait, B; dust, D; emulsifiable concentrate, EC; granules, G; spray, S; wettable powder, WP.
[2] For southern potato wireworms where it is resistant to other insecticides; not recommended for other wireworms.
[3] A dust containing 1 percent parathion and 10 percent TDE may be used to control associated infestations of hornworms, budworms, and aphids. If a spray is used, add 1 lb. 15 percent parathion wettable powder to the quantity of TDE spray to be applied per acre.

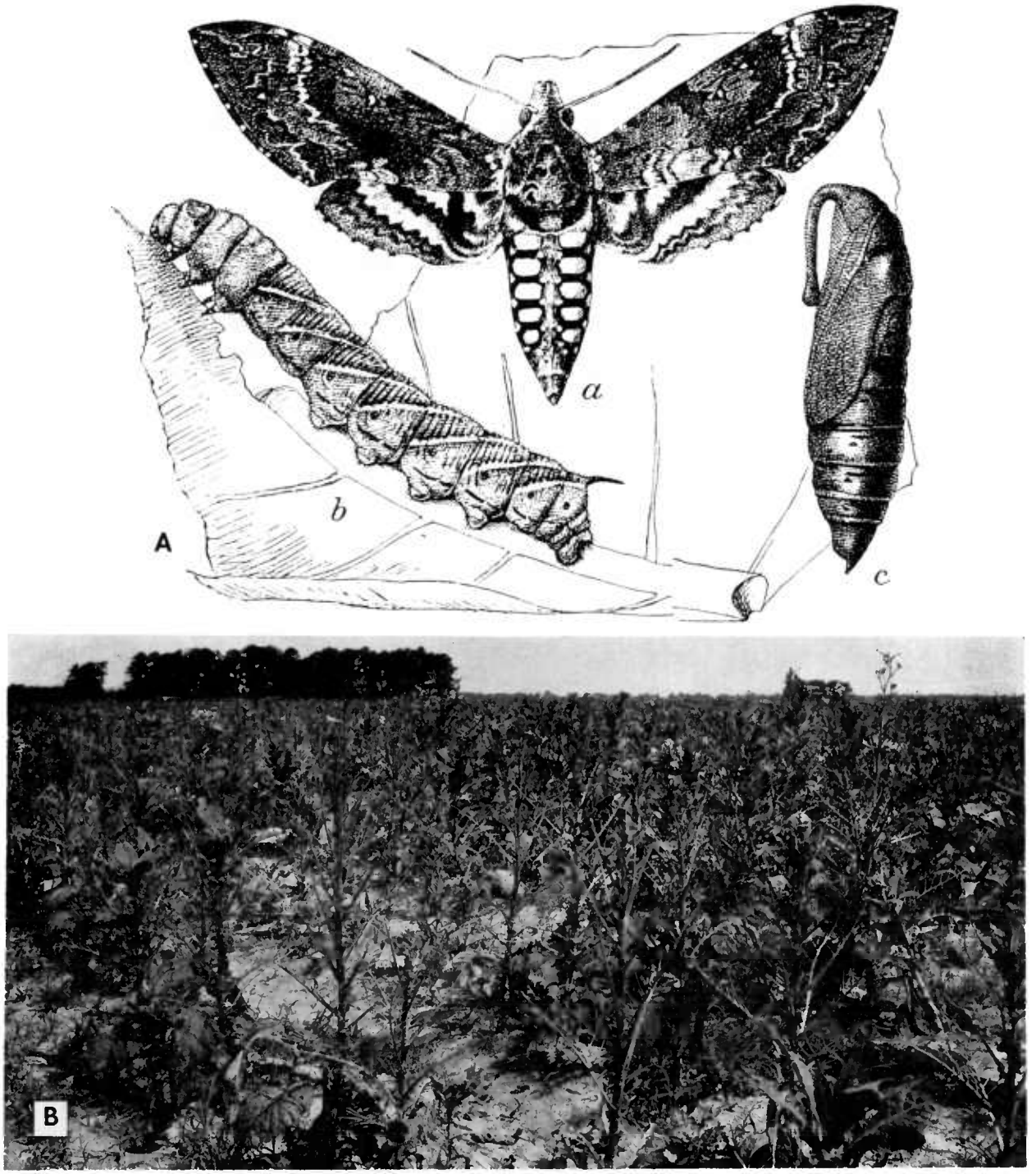

FIGURE 43.—Tobacco hornworms: *A*, *a*, Adult moth; *b*, larva approaching maturity—at this stage they are most destructive to tobacco; *c*, pupa (about natural size); *B*, tobacco field almost defoliated by hornworms.

USE OF SUPPLEMENTARY WATER

Adequate soil and air moisture are among the cardinal requirements for the growth of leaf tobacco that will meet exacting commercial demands. As the cured leaf is the final product, it must possess a definite combination of shape, size, structure, elasticity, veination, color, and a characteristic chemical composition that determines aroma, taste, and unidentified characters indicative of quality for use in a particular product. The fire-holding capacity of the cured leaf is modified by the leaf structure and its composition. These properties are influenced and modified by soil moisture, which determines, in part, the ability of the plant to absorb plant nutrients, and thus, the growth of the plant.

Leaf grown during a dry season is very different from that grown during a wet one. As a result, the adaptability of dry-season tobacco will differ widely from that for a wet-season tobacco for manufacturing purposes. Cured leaf produced during a dry season may show rim burn (fig. 44) and is usually small, dark, and dull in color; high in nicotine; and lacking in elasticity. It possesses more aroma, which is associated with the gums and resins; has a dense structure associated with high weight per unit area; possesses low fire-holding capacity; and manifests a slow and inactive fermentation when bulked or packed.

Cured leaf produced during a season of adequate and well-distributed moisture—with other conditions being equal—is comparatively large, light and bright in color, elastic, low in nicotine, and weak in aroma. It has an open structure or texture associated with lightweight unit area; is low in gums and resins; and shows an active and rapid fermentation when bulked.

Although soil moisture appears to be the dominant factor, atmospheric humidity, shading associated with cloudiness, and air movements that increase evaporating power of the air are all a part of the complex that controls plant growth and development. The organic matter and mineral constituents that affect the physical condition of the soil and control the retention and release of moisture also are highly important in the process of soil-moisture utilization by growing plants.

FIGURE 44.—Tobacco leaf showing dry-weather damage known as drought spot; rim burn and large red-brown spots appear between the lateral veins, especially on the lower leaves of the plant.

Supplemental irrigation as an aid in obtaining a more dependable and adequate distribution of moisture for tobacco production is now receiving some attention.[3] For many years, supplementary water has been used in producing shade-grown tobacco. It has been customary in all tobacco areas to add water to growing seedlings and to plants at transplanting time, if transplanting is done during a dry period.

[3] For more detailed information, see "Principles of Tobacco Irrigation," U.S. Dept. Agr., Agr. Inform. Bul. 228, 16 pp., illus. 1960.

In recent years, some fields have been irrigated immediately before or after transplanting. After a stand is established, supplemental irrigation is delayed for 4 to 6 weeks to encourage root development. Supplemental water may be supplied by the gravity-flow method—which can be used only under certain conditions of soil texture and slope—or by overhead sprinklers—which is the more general method.

Excessive applications of water may damage the crop, brought about by a waterlogged soil (fig. 45). It is, therefore, preferable to apply supplementary water as frequent light applications. More favorable responses have been obtained from the application of one-half inch twice a week rather than 1 inch once a week during dry periods. These light applications also lessen the hazard from a heavy rainfall that might follow immediately after irrigation. Excess water may cause leaching of plant food from light soils and drowning, which destroys a part or all the roots and thus causes stunting or even death of those plants growing on heavier soils.

FIGURE 45.—Drowning is associated with the accumulation of water in a low area; this causes the plants to "flop." Most plants so affected will die in a few days.

Composition of water used for supplemental irrigation is important. Content of chlorine, calcium, or other salts and content of total salts must be low. Also, water contaminated with such disease organisms as black shank should be avoided.

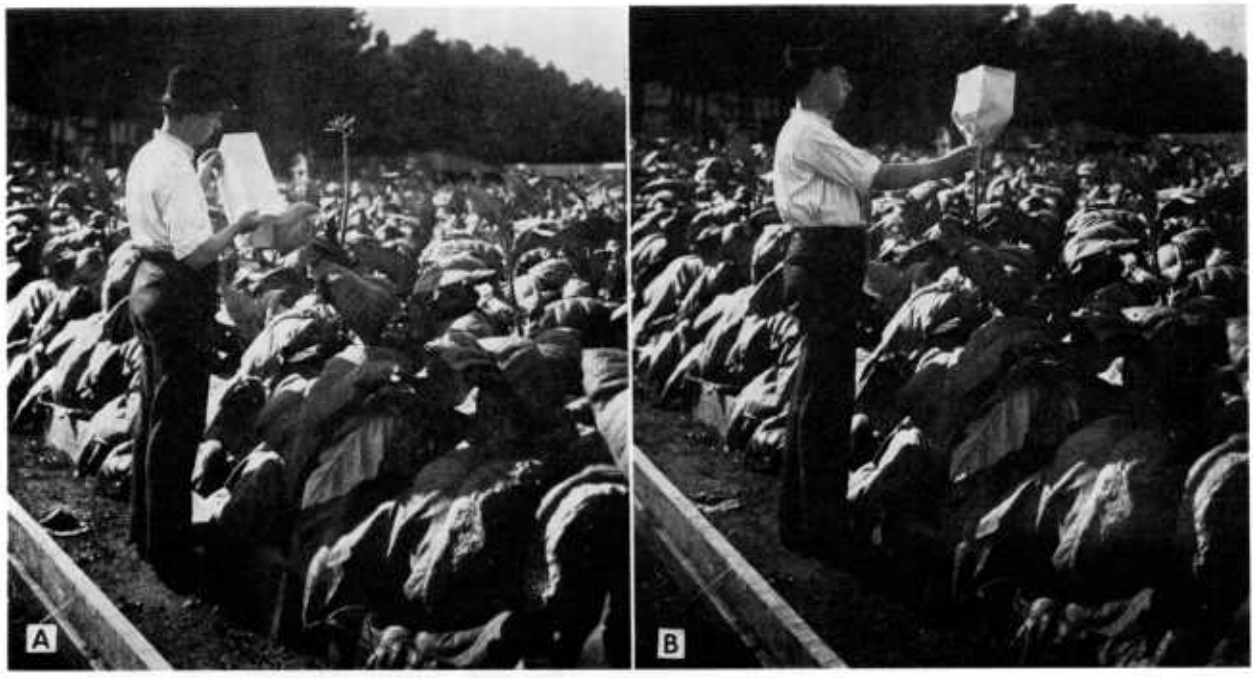

FIGURE 46.—Saving tobacco seed: (*A*) Tobacco flower head is pruned in preparation for (*B*) covering it with a paper bag to prevent cross pollination.

SELECTING SEED PLANTS AND SAVING THE SEED

To have a satisfactory crop, tobacco seed that is true to type should be planted. In recent years certified seed has become available of most familiar varieties, and many growers prefer to obtain their seed from these sources.

Growers can often save their own seed if they so desire. Before topping is done, they should go over the tobacco field carefully in search of desirable seed plants. The advantage of selecting good seed plants will be lost if they are allowed to cross with other types. To prevent this, flower heads are covered with 12- to 16-pound manila paper bags manufactured with waterproof glue. The tobacco flower tends to be self-fertilized, as the pollen is normally discharged by the anthers soon after the flower opens and may fall on the stigma.

Growers should remove the small leaves and branches just below each flower head that is covered (fig. 46) and attach the mouth of the bag securely to the stalk by tying it with a string. Any blossoms that have already opened and previously fertilized flowers and seed pods must be removed before the bag is placed over the flower head (fig. 47). If a flower has already opened, pollen introduced from another flower may bring about a cross with an undesirable kind. The bag must be adjusted from time to time to accommodate the growth of the flowers and maturing seed pods. To control budworms, it is recommended that the seedhead be treated at the time of covering the flower head (see p. 52).

If a grower has planted a pure strain of seed of only one variety, it is not necessary to bag the tobacco flower heads in a field that is adequately isolated from fields of other varieties. The extent of isolation necessary will depend upon the number of pollinators in the area—humming birds, hawk moths, bees, and other visitors—but one-half mile is usually considered an adequate distance.

After the seeds are mature, which is indicated by the seed pods turning brown and the flower head becoming partially dried, the seed head is cut off and hung in a cool, dry place and allowed to air-dry. After thorough air drying, the seed head is shelled out and the seed thoroughly cleaned by screening and using a suitable blower. The seed must be protected at all times from destruction by birds, rats, or mice. Before sowing, the seed should be tested to determine percentage of germination.

GROWING TOBACCO FOR HOME CONSUMPTION

The question often arises as to the possibility of growing tobacco for immediate consumption by amateur tobacco growers. Although it is common for regular tobacco growers to consume some of their product with little or no processing, consumption of "homespun" leaf has never been large. All leaf tobacco, until properly aged, has harsh, irritating properties that render it unacceptable for smoking or for chewing.

As pointed out on page 40, most growers do not have the facilities for carrying out the aging, or fermentation process, which may require one to several years to prepare the leaf for manufacture or consumption. For best results for this step, the leaf is stored in large containers that usually hold 300 to 1,000 pounds of tobacco. Storage facilities are usually inadequate on growers' farms to age small quantities of leaf. The leaf must be packed with the proper moisture content and suitable storage conditions must be maintained. If the leaf is too dry, no aging takes place; if it is too wet, the leaf will decay.

Actually, amateur growers may be able to grow tobacco plants that are acceptable for processing, but they will find it a complicated undertaking to produce cured leaf that is acceptable for consumption.

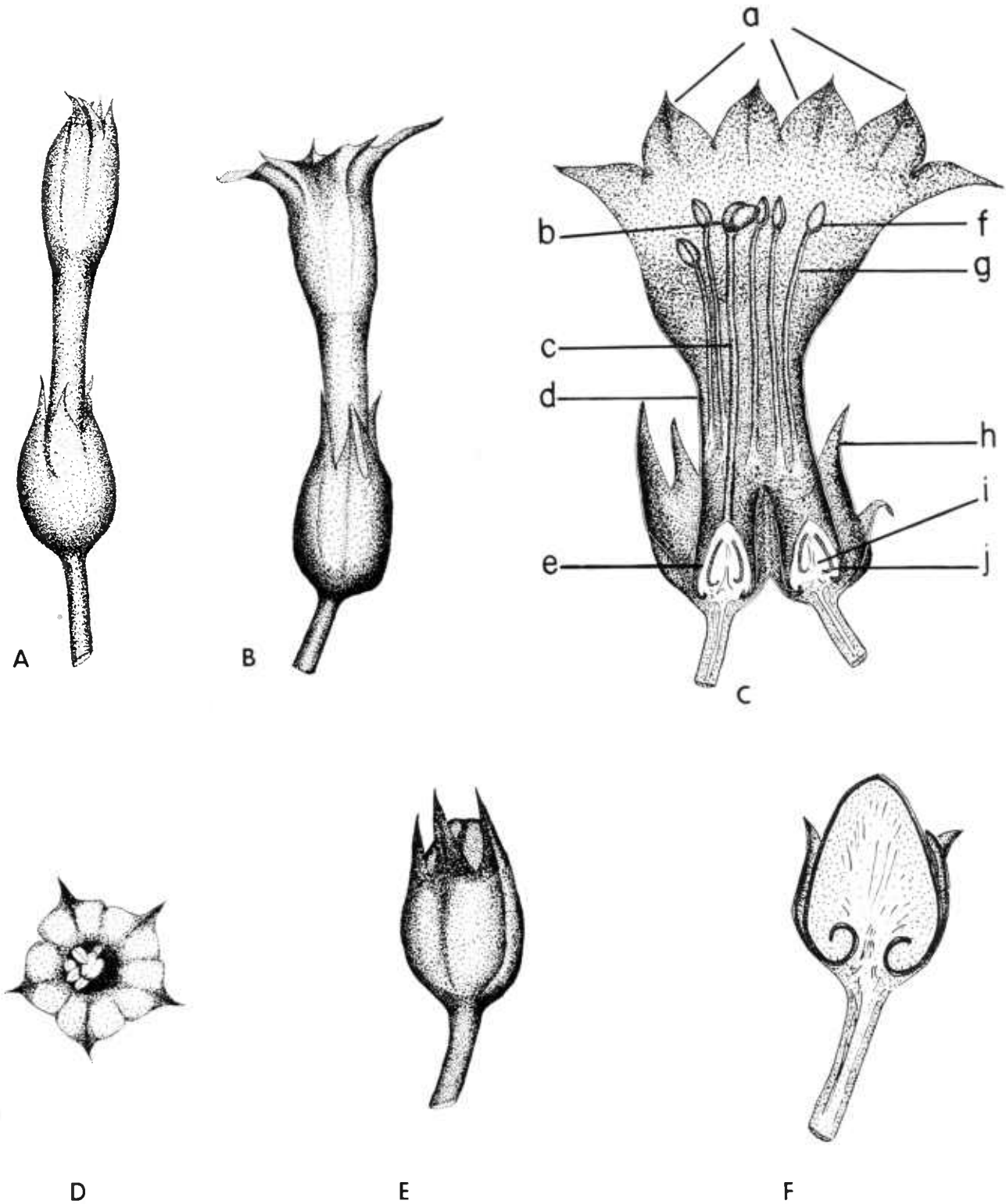

FIGURE 47.—Parts of tobacco flower and seed pod (magnified about 1½ times): *A*, Unopened flower; *B*, open flower, longitudinal view; *C*, flower cut open longitudinally to show essential parts—(*a*) corolla lobes, (*b*) stigma, (*c*) style, (*d*) corolla tube, (*e*) ovary, (*f*) anther, (*g*) filament, (*h*) calyx lobe, (*i*) placenta, and (*j*) ovules; *D*, open flower, vertical view; *E*, seed pod, longitudinal view; and *F*, seed pod cut open longitudinally to show essential parts. (Drawings by M. O. Neas.)

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