Bright Tobacco Culture in the Coastal Plain of Georgia

By

J. M. CARR, Agent

UNITED STATES DEPARTMENT OF AGRICULTURE
(This Bulletin Supersedes Bulletin 10)
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INTRODUCTION

Flue-cured tobacco in the last 12 years has become one of the most important money crops in the Coastal Plain area of Georgia. This crop has a comparatively high acre value and costs considerably more to produce than any other crop grown in the same area. Tobacco is unlike most farm crops in that the profit to be derived from producing it depends primarily upon the quality produced rather than the yield per acre. It makes its growth quickly and readily responds to climatic conditions, soil conditions and the form of plant food available. The quality produced is largely dependent upon these factors. It is therefore necessary that experimental data dealing with fertilizers for this crop be presented in considerable detail. The data in this publication, however, are not presented as a technical treatise, but in the light of their general application by growers and fertilizer manufacturers.

IMPORTANCE OF TOBACCO AS A CROP

The first knowledge the white man had of tobacco was its use by the Indians. When the first white settlement was made in North America the settlers found the Indians growing this peculiar plant along the Coastal Plain of what is now Virginia. The whites soon learned the pleasing effects resulting from the use of the plant and began using it, but were not familiar with its culture. It therefore became a medium of exchange for the Indians in trading with the white colonists. John Rolfe and Sir Thomas Dale were the first to promote tobacco production among the colonists. They lectured on tobacco planting and induced them to grow their own supply, rather than depend on the Indians for it. Their efforts were successful and tobacco soon became a medium of exchange among the colonists, and was one of the first export products of the New World.

The production of tobacco increased rapidly and the producing area was enlarged, spreading mostly south and westward as the colonists extended their boundaries. Between the years of 1618 and 1790 the production increased from 20,000
pounds to 130,000,000 pounds. The greatest increase in production has come about in the last quarter century, due largely to the World War which stimulated the demand for cigarettes, and to modern manufacturing devices which have resulted in machine-made cigarettes of excellent quality at a small cost to the consumer. With the increase in demand for cigarettes, the flue-cured tobacco producing areas have spread to the greater portion of southeastern United States and many other parts of the world. An example of this increase in the production of flue-cured tobacco may be noted by referring to Table I which gives the production by years for the past 16 years in Georgia.

**TABLE I.—TOTAL ACREAGE, PRODUCTION, VALUE AND AVERAGE VALUE PER 100 POUNDS OF FLUE-CURED TOBACCO GROWN IN GEORGIA FOR YEARS 1917 TO 1932, INCLUSIVE**

<table>
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<tr>
<th>Year</th>
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<th>Production (Pounds)</th>
<th>Total Value</th>
<th>Average Price Per Hundred</th>
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<tr>
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<td>9,677,000</td>
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<td>12,501,000</td>
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In this period of time Georgia has increased her annual production of tobacco from 350,000 pounds in 1917 to a maximum of over 104,000,000 pounds in 1929. The reduced production in 1931 was due to low prices the previous year and to unfavorable weather conditions during the 1931 growing season. The 1932 production was extremely low, because of a scarcity of plants caused by diseases and freezing of plant beds. The increase in production as shown by this table was not limited to Georgia as other states also have greatly increased their production. In 1931 the total production of tobacco in the United States was 1,604,226,000 pounds of which 664,967,000 pounds were of the flue-cured type.1 Flue-cured

1U. S. D. of A. Yearbook, 1933.
tobacco is grown to some extent in every state in the South Atlantic group and as far north as southern Ontario, Canada.

**THE RELATION OF RAINFALL TO TOBACCO PRODUCTION**

The annual rainfall in the Coastal Plain area of Georgia is usually sufficient for the growth of flue-cured tobacco, but is not always distributed so as to be of maximum benefit to the crop since extremely wet or dry weather in the critical stage of growth materially affects both yield and quality. The absence of sufficient moisture followed by an excess, especially when the plant is near the ripening stage, often causes a renewed growth in the plant that is known as "second growth." Plants that have made this second growth are difficult to cure to the desired lemon color. The ideal growing season is one that enables the plant to make uninterrupted growth until it reaches maturity. Since flue-cured tobacco fertilizers are applied just before transplanting, the rainfall that follows during the growing season is of great importance. Extremely heavy rains soon after planting often leach or wash from the soil considerable plant food, particularly the soluble nitrates, causing the plant to make poor growth. On the other hand, during extremely dry periods there may not be sufficient moisture to make available the plant foods present, which of course results in poor growth, premature ripening and reduced yield and quality.

The rainfall records in ten-day periods for the growing season and also monthly records for the fall and winter months (years 1922-1932 inclusive) at the Georgia Coastal Plain Experiment Station are given in Table II. Arrangement of rainfall in ten-day periods serves to show the approximate distribution of rainfall throughout the growing season. The heaviest rains of this period usually come in July and August, which is during the harvest season. That portion of the crop remaining in the field when these heavy and prolonged rains come, often makes second growth. Every effort, therefore, should be made to plant the crop before April 10 so that the most of the crop may be harvested before these rains occur.

**SOILS ADAPTED TO FLUE-CURED TOBACCO**

The soils of the Coastal Plain area best adapted to the pro-
duction of flue-cured tobacco are the intermediate types of the Norfolk and Tifton series. The Norfolk series consists of the low lying or slightly rolling gray or grayish yellow soils underlain with yellow sandy clay subsoils of a friable nature. These soils contain few or no pebbles. The Tifton series have

**TABLE II.—RAINFALL IN INCHES AT TIFTON*, GEORGIA, 1922-1932, FOR TEN-DAY PERIODS DURING MARCH, APRIL, MAY, JUNE, JULY, AUGUST, SEPTEMBER, AND THE TOTAL MONTHLY RAINFALL FOR JANUARY, FEBRUARY, OCTOBER, NOVEMBER AND DECEMBER**

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<td>55.22</td>
<td>48.05</td>
<td>34.41</td>
<td>48.34</td>
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</table>

*Record of rainfall has been kept at Tifton since April 1, 1922. The record from January 1, 1922 to April 1, 1922 was furnished through the courtesy of the Weather Station at Thomasville, Georgia.

gray to brownish gray surface soils and yellow to slightly reddish yellow subsoils. Both the surface and subsoils contain numerous small reddish iron concretions or pebbles. These
soils are found on the higher ridges and are more rolling than the Norfolk types. The easiest way to identify the two series is by the abundance of red pebbles in the Tifton series and by the presence of few or no pebbles in the Norfolk series. The strictly Norfolk sands are too poor and sandy for any agricultural purpose and are usually found on ridges covered with a growth of scrub oak and long leaf pine. The Norfolk sandy loams, and in many instances the loamy sands, are well adapted to tobacco. The heavy pebbled types of the Tifton series are too fertile for tobacco. These soils are known as ideal cotton soils and should not be planted to tobacco. The light types of this series found well down on the sides of the ridges produce good quality tobacco and may be used to advantage for this crop. In all cases tobacco to be used for cigarettes should be planted only on well drained, friable soils that are not too fertile to produce the light yellow type required.

The Norfolk loamy sand and Tifton sandy loam soils were both used for experiments reported in this publication. The work on the Tifton soil began in 1922 and additional tests were added from time to time. No work was done until 1927 on the Norfolk soils (see tables on results). Since that time much of the work has been duplicated on both types of soils.

**VARIETIES**

To discuss varieties by name would mean very little in view of the fact that there are hundreds of so called varieties, a number of which may be identical. These numerous varieties may be divided into two general groups known as the heavy and light types of flue-cured tobacco. In the heavy type group are included those varieties such as Warne, Adcock and Gold Leaf which produce a heavy bodied thick leaf usually of an orange or mahogany color. This group of varieties does not produce, under Georgia conditions, a leaf as desirable for cigarettes as the varieties of the light type group, which includes such varieties as Jamaica, Bonanza, Cash and Yellow Pryor. These varieties are characterized by tall plants with leaves spaced wide apart. They produce a thin, highly colored leaf which is ideal for cigarette manufacture.

Table III. gives results of tests with a few of the outstanding varieties of both the light and heavy groups. The light type varieties gave the greatest returns per acre. Of these, Jamaica, Cash and Yellow Pryor led. Several other popular varieties
such as Bonanza, White Stem Orinoco and Yellow Mammoth have not been tested long enough to furnish conclusive data but seem to produce well under Georgia conditions. The heavy type varieties such as Warne, Adcock and Gold Leaf are not recommended for Georgia conditions. Variety 10 of the same table gives results of not topping as compared with topping as shown by variety 6. In this instance proper topping and suckering increased the average annual net return per acre by $48.42. It is therefore evident that proper topping and suckering increases both the yield and the quality of tobacco.

SEED BEDS

A liberal supply of strong, vigorous plants early in the season is a most important step toward a successful crop. The soils best suited for the growth of tobacco plants are usually found covered with gallberry bushes or blackberry plants near streams. To insure good plants thorough sterilization of the seed beds is necessary. Sterilizing the soil kills the weed seed and helps materially in controlling diseases that may be present. Old beds should always be sterilized before being used again. This may be done by burning with wood, brush, corn stalks or other combustible material, or by steam (Farmers' Bulletin 1629, United States Department of Agriculture). In either case the soil should be heated until a potato the size of a man's fist, buried four inches deep, will be thoroughly cooked. Before sterilizing, the soil should be loosened with
spade or plow so that the heat may penetrate it more readily.

Fertilizers should be applied liberally. Two to three pounds per square yard of a high grade tobacco fertilizer (8-3-5 or 8-3-8) on first year beds will usually supply sufficient plant food to grow the plants rapidly enough for early transplanting; somewhat smaller quantities may be used on old beds. Seeding should be done in late December or early January at the rate of one well rounded tablespoon full of well cleaned seed, running high in germination, to 100 square yards of seed bed. The seed should be firmed in by packing with a small, heavy roller, or by tramping with the feet. This helps to bring the moisture to the surface of the ground, thus facilitating germination. It is very important that ditches be dug around the bed to provide proper drainage, the depth of the ditch depending upon the nature of the soil. In periods of wet weather, water often settles in the depressions of beds located in low places. This should be eliminated by ditching completely around the beds to a depth sufficient to keep the water from accumulating. Almost invariably the best fields of tobacco are those transplanted in late March or early April and every effort should be made to have a good supply of well-

FIG. 1. Plants growing on steam sterilized seed beds. Note the absence of weeds and the uniform stand of plants.
grown plants by this time. One hundred yards of bed will usually plant from two to two and one-half acres if no diseases destroy the plants.

CULTURAL METHODS

PREPARING SOIL FOR TRANSPLANTING: Soils that are to be used for tobacco should be thoroughly broken in the fall or winter in order that all vegetable matter may decay before transplanting time. In the spring just prior to putting out the fertilizer the soil should be rebroken and worked into a fine tilth. Where stable manure is used, the rows should be opened and the manure drilled in the row and listed on from ten days to two weeks before the fertilizer is to be put in. To put in the fertilizer the rows are opened with a five or six-inch "scooter" or shovel plow (where manure has been used the lists are reopened), and the fertilizer drilled with a distributor or by hand. The fertilizer is then listed on with a one-horse turn plow, two furrows to the row. Immediately before transplanting, the lists should be smoothed down to almost the original ground level with a weighted board drag. The plants are transplanted on the list either by hand or with a horse drawn transplanter.

FIG. 2. Farmers looking over tobacco experiments.
PLANTING: Tobacco plants are usually transplanted in much the same manner as tomato plants, in rows three to four feet apart and 18 inches to three feet apart in the row, depending on the fertility of the soil. The general practice is to space the plants two feet apart in rows four feet apart. The plants should be carefully selected as they are drawn from the bed and none but the best plants, of uniform size, used. Plants from six to eight inches in length are usually considered the best size for transplanting. When sufficient rainfall comes at the right time, plants may be transplanted without watering, but in all cases care should be taken to press the soil firmly to the roots. Plants should be set so that the bud will be even with or slightly below the surface of the soil.

CULTIVATING: Tobacco is a rapid-growing plant and therefore should be cultivated frequently, ordinarily after every rain. The first cultivation should be made as soon as the plant has established its root system which is usually about ten days after planting; care should be taken not to loosen the newly established root system. The first cultivation should be shallow, the second should be deep but not close enough to damage the root system of the plants. After the first two cultivations, comparatively shallow plowing should be practiced. With each cultivation the soil should be worked to the plants so that at the last working, which should be about the time the flower buds begin to show, the plants will be on a high ridge. This gives drainage, and is thought to confine the root system to a limited area. It also enables the plant to put out roots higher up on the stalk in the event anything happens to the lower roots.

TOPPING AND SUCKERING: The height at which to top is a matter of judgement with the grower, depending on the individual plant. The object is to top at a height so that with favorable weather conditions the top leaf will grow to full size. If unfavorable weather occurs after topping, several leaves may be taken out of the top so that those left will fully develop. Topping should begin as soon as several flowers of the seed head open, and should not be delayed or plant food needed for the leaf will go into the seed head.

The suckers which appear in the axils of all leaves after the plant has been topped should be pulled out as soon as they reach a length of three to four inches. In no case should they be allowed to grow longer or they will push the leaves from
the stalk and also take up the plant food necessary to make a heavy, well-bodied leaf.

EXPLANATION OF FERTILIZER TERMS AND NAMES USED IN THIS PUBLICATION

In order to make clear to those who are not familiar with the various materials that are used in commercial fertilizers it might be well to explain briefly the meaning of the fertilizer terms and names used in this publication.

All the materials used in manufacturing fertilizers may be divided into two groups, organic and inorganic. We may, for all practical purposes, class as organic those materials such as dried blood, fish meal or scrap, cottonseed meal, tobacco stems, which are derived immediately from living plant or animal matter. These materials are not readily soluble in water and must be decomposed by soil organisms before their plant food can become available to the plant. The decomposing process can only take place under favorable conditions with regard to temperature, moisture and air, and is comparatively slow even then. Therefore, we consider organic materials as slowly available. However, there are small amounts of readily available plant food in most organic fertilizer materials. These amounts vary with the material and the manner in which it is processed.

All other materials not derived from living plant or animal matter are classed as inorganic and may be formed in many ways. Some are made synthetically by combining various chemicals under artificial conditions. Of these we have as examples, synthetic nitrate of soda, sulphate of ammonia and many others. Many of these materials are deposited in nature by the evaporation of water that is saturated with these salts in much the same manner that scales are formed in the ordinary tea kettle. As examples of this process we have nitrate of soda and some of the potash salts. The availability of the inorganic materials varies with their chemical make-up. The nitrate salts are the most readily available of the ammonia carrying materials, while all inorganics are somewhat more readily available than the organic materials.

The terms ammonia and nitrogen mean the same thing as far as fertilizers are concerned, and both terms are often used in discussing fertilizers. Ammonia, however, is only 82.5 per cent nitrogen, and therefore a fertilizer containing three per
cent ammonia contains only 2.47 per cent nitrogen. The term nitrogen is coming more and more into popular use and many states have passed laws requiring that fertilizer formulas be expressed on the bags in terms of nitrogen rather than ammonia, as was the common practice of manufacturers until recently.

Since the term acid phosphate implies or suggests that the material carries free acid (which it does in small quantities but not enough to cause any ill effects) the American Association of Official Agricultural Chemists has recommended that the name acid phosphate be changed to superphosphate. This change is coming more and more into every-day use. The term superphosphate is used throughout in this publication where reference is made to the material formerly known as acid phosphate.

In fertilizer formulas given in this publication the phosphorus (P₂O₅) is expressed first; ammonia (NH₃), second; and potash (K₂O), third. For example, 8-3-5 signifies eight per cent phosphorus, three per cent ammonia and five per cent potash.

EFFECTS OF PHOSPHORUS ON THE TOBACCO PLANT

Any element essential to plant growth, that is contained in the soil in insufficient amounts in relation to other essential elements, naturally becomes a controlling factor in plant growth. Increases in the supply of such an element will be followed by increases in productivity of the soil until some other element or condition becomes the limiting factor. In tests on virgin Norfolk loamy sand where phosphorus was omitted and 1000 pounds of a mixture analyzing 0-3-5 was applied per acre, the yield and acre value differed very little from plots having no commercial fertilizer (see plots 13 and 14, Table IV). When 4 per cent phosphorus was added to this mixture, the yield was increased from 317 pounds to 1068 pounds per acre, and the acre value increased from $10.72 to $125.34 (plots 12 and 13, Norfolk sandy loam, Table IV.). On soils that had received applications of phosphorus under crops preceding tobacco, these differences were not so great (plots 12, 13 and 14, Tifton sandy loam). This was because of the residual phosphorus in the soil. However, after a few years of cropping without applications of phosphorus, this supply of residual phosphorus is depleted and the plants behave very much alike on both the virgin and old soils. Other tests on
<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Phosphorus from 16% Super phosphate</th>
<th>Ammonia from 16% Dried Blood</th>
<th>Potash from 48% Sulphate Potash</th>
<th>Phosphorus Series</th>
<th>Ammonia Series</th>
<th>Potash Series</th>
<th>Fertilizer Application Per Acre</th>
<th>NORFOLK LOAMY SAND SOIL</th>
<th>Tifton Sandy Loam Soil</th>
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<tr>
<td></td>
<td>P-N-K</td>
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<td>Yield per Acre</td>
<td>Ave. Value per 100 Pounds</td>
<td>Value per Acre</td>
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<td>581</td>
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</table>

Note: The selling prices of tobacco were somewhat higher in 1924, 1925 and 1926 than in succeeding years which made the average values on the Tifton sandy loam soil somewhat above those on the Norfolk loamy sand soil.

Both the Norfolk and Tifton soil series indicate that the chief limiting element in both soils is, in all probability, phosphorus.

To the casual observer, phosphorus deficiency is not as evident in the growing plant as nitrogen and potash deficiencies, except in extreme cases. There are no outward signs such as the yellowing that appears in plants deficient in nitrogen, or the curled, wrinkled, rusty appearance found in plants deficient in potash. Since phosphorus is essential to the normal growth of leaf, stem and root of the plant, and also promotes...
ripening, about the only signs of phosphorus deficiency is a
dwarfed green plant that grows slowly and never ripens as it
should, although it may eventually reach fair size. In extreme
cases the plants make little or no growth and the lower leaves
soon break down and dry to a reddish brown color. Tests with
varying amounts of phosphorus on both the Norfolk loamy
sand and Tifton sandy loam soils (Table IV.) resulted in only
slight increases in yields when applications of more than 40

FIG. 3. Left, 1000 pounds 0-3-5 (P-N-K) per acre. Right, 1000
pounds 4-3-5 (P-N-K) per acre. Showing importance of phosphorus
to proper development of tobacco plant.

pounds of phosphorus (amount of P.O₅ contained in 1000
pounds of a 4-3-5) per acre were applied. There was, how-
ever, considerable increase in quality as the rate of application
was increased from 40 up to 80 and to 100 pounds of P.O₅ per
acre (plots 7 to 12 inclusive). This improvement in quality was
due to better growth and ripening than with the lowest phos-
phorus applications. These increases continued to the maxi-
mum application of phosphorus, which was 120 pounds P.O₅
per acre. Due to the possibility of trouble from premature rip-
ening and firing of the plants in the field, it is believed that the
amount of P.O₅ contained in a tobacco fertilizer should not be
more than 10 per cent, where applications of 1000 pounds or
more per acre are made.
FIG. 4. Left, no fertilizer. Right, 1000 pounds 0-3-5 (P-N-K) per acre. Showing phosphorus deficiency of virgin soils of Coastal Plain.

EFFECTS OF AMMONIA ON THE TOBACCO PLANT

The soils used for flue-cured tobacco are those of a sandy nature which usually are low in ammonia. The crop is planted on this type of soil because of the necessity of having the ammonia supply under control. In order to grow the desired quality of tobacco the ammonia supply must be practically exhausted by the time the plant reaches maturity, and thereby cause the green color to fade out, permitting the plant to ripen properly. It is largely because of the unknown and often excessive quantities of ammonia which legumes store in the soil, that it is an undesirable practice to plant tobacco immediately after legumes. An excess of ammonia will cause the plants to grow large and coarse, and make the crop especially susceptible to second growth during the wet weather that occurs quite frequently in the Coastal Plain of Georgia during July and August. It is most difficult to cure tobacco that has had too much ammonia to the desired color, for the leaf will remain green or turn red or almost black during the curing process. Ammonia in insufficient quantities produces a pale leaf that is light in weight and poor in quality but often of good color.
The amount of ammonia that must be applied to produce a maximum crop of good quality tobacco will vary with the reserve supply in the soil. Tests on Norfolk loamy sand and Tifton sandy loam with rates varying from 20 to 50 pounds of ammonia (NH₃) per acre (Table IV., plots one to four) show that the yield is in proportion to the amount of ammonia applied but that the quality begins to decrease when more than 30 pounds of ammonia (NH₃) per acre is used (plot three). However, the ammonia on these plots was derived entirely from dried blood. Other tests (Table VII.) show that the amount of ammonia that may be applied will depend somewhat on the source from which it is derived. Ammonia from the nitrates and urea may be applied at heavier rates than ammonia from the ammonia salts and some of the organics. The rate of application recommended for most soils is 30 pounds of ammonia (NH₃) per acre, or the amount contained in a 1000-pound application of fertilizer containing three per

TABLE V.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS WITH DIFFERENT SOURCES AND COMBINATIONS OF SOURCES OF AMMONIA ON TIFTON SANDY LOAM SOIL FOR YEARS 1922-1932, INCLUSIVE

<table>
<thead>
<tr>
<th>PLOT (For reference)</th>
<th>FERTILIZER TREATMENT 1000 POUNDS PER ACRE*</th>
<th>Ave. Yield per Acre Pounds</th>
<th>Ave. Selling Price per 100 Pounds</th>
<th>Ave. Gross Value per Acre</th>
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<td>910</td>
<td>13.97</td>
<td>127.14</td>
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</tbody>
</table>

*NOTE: Superphosphate was used as a source of phosphorus (P₂O₅) and sulphate of potash was used as the source of potash (K₂O) in the basic fertilizer treatments given in above table. The phosphorus and potash contained in cottonseed meal was considered in making fertilizer calculations for plots receiving this material. Horse manure where indicated is used at rate of 4 tons per acre. The average selling price of tobacco on which all value calculations were based was somewhat higher previous to 1927 than thereafter which makes the values in Table V, greater than in Table VI. This tends to show the Tifton soil as the better of the two soils for tobacco. However this is not the case, for generally speaking the Norfolk soils are considered better suited to tobacco than the Tifton soils.
TABLE VI.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS WITH DIFFERENT SOURCES AND COMBINATIONS OF SOURCES OF AMMONIA ON NORFOLK LOAMY SAND SOIL FOR YEARS 1927-1932, INCLUSIVE

<table>
<thead>
<tr>
<th>PLOT (For reference)</th>
<th>FERTILIZER TREATMENT 1000 POUNDS PER ACRE*</th>
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<th>Ave. Yield per Acre Pounds</th>
<th>Ave. Selling Price per 100 Pounds</th>
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<td>8-3-6</td>
<td>Nitrate Soda</td>
<td>1285</td>
<td>14.05</td>
<td>180.48</td>
</tr>
<tr>
<td>6</td>
<td>8-3-6</td>
<td>Dried Blood</td>
<td>1361</td>
<td>13.55</td>
<td>170.85</td>
</tr>
<tr>
<td>8</td>
<td>8-3-6</td>
<td>Sulphate Ammonia</td>
<td>1270</td>
<td>13.22</td>
<td>167.92</td>
</tr>
<tr>
<td>3</td>
<td>8-3-6</td>
<td>Dried Blood</td>
<td>1234</td>
<td>12.59</td>
<td>155.41</td>
</tr>
<tr>
<td>2</td>
<td>8-3-6</td>
<td>Cottonseed Meal</td>
<td>1118</td>
<td>13.60</td>
<td>152.04</td>
</tr>
<tr>
<td>5</td>
<td>8-3-6</td>
<td>Sulphate of Ammonia</td>
<td>1125</td>
<td>11.79</td>
<td>132.64</td>
</tr>
<tr>
<td>1</td>
<td>8-0-6</td>
<td>No Ammonia</td>
<td>918</td>
<td>12.17</td>
<td>111.72</td>
</tr>
</tbody>
</table>

*NOTE: Superphosphate was used as a source of phosphorus (P₂O₅) and sulphate of potash was used as the source of potash (K₂O) in the basic fertilizer treatments given in above table. The phosphorus and potash contained in cottonseed meal was considered in making fertilizer calculations for plots receiving this material. Horse manure where indicated is used at rate of 4 tons per acre. The average selling price of tobacco on which all value calculations were based was somewhat higher previous to 1927 than afterwards which makes the values in Table VI, greater than in Table V. This tends to show the Tifton soil as the better of the two soils for tobacco. However this is not the case, for generally speaking the Norfolk soils are considered better suited to tobacco than the Tifton soils.

SOURCES OF AMMONIA

Since the ammonia in a tobacco fertilizer must be available to the plant with such timeliness as to start the plant off quickly, continue growth uninterrupted until maturity, and then be present in such small quantities as to allow the plant to ripen to the desired pale green color, the source of ammonia is of extreme importance. It is recognized that factors other than the materials from which the ammonia is derived affect the rate at which it becomes available to the plant. These factors, such as moisture and temperature, however, are usually beyond the growers' control. Tests on both the Tifton and Norfolk soil series (Tables V. and VI.) show that horse manure
is the best single source of ammonia for tobacco. This manure was well rotted, finely pulverized and applied to the row at the rate of four tons per acre about ten days before planting. When 15 pounds of ammonia (NH₃) per acre from nitrate of soda (87 pounds nitrate soda) was added to these treatments (plot ten, Tables V. and VI.) the yields were increased on an average of 180 pounds per acre on the Norfolk soil, and 117 pounds per acre on the Tifton soil. The increases were accompanied by a slight improvement in quality on both soil types. Nitrate of soda when used as the entire source of ammonia gave the heaviest yield and largest net returns per acre of any commercial source (plot four, Tables V. and VI., and plots 2A and 2B, Table VII.). Urea gave average yields and values ap-

**TABLE VII.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS WITH DIFFERENT SOURCES OF AMMONIA ON TIFTON SANDY LOAM SOIL FOR YEARS 1925-1932, INCLUSIVE**

| Section A—20 Pounds Ammonia (NH₃) per Acre | 
|-----------------|-----------------|-----------------|-----------------|
| Plot (For reference) | Source of Ammonia* | Ave. Yield per Acre | Ave. Value per 100 Lbs. | Ave. Gross Value per Acre |
| 2 | Nitrate of Soda | 1316 | $13.47 | $177.31 |
| 8 | Sulphate of Ammonia | 1329 | 13.18 | 175.14 |
| 10 | Fish Scrap | 1266 | 13.31 | 168.56 |
| 4 | Urea | 1201 | 12.90 | 164.02 |
| 9 | Dried Blood | 1237 | 13.15 | 162.65 |
| 5 | Ammonium Nitrate | 1236 | 12.64 | 156.18 |
| 7 | Cyanamid | 1217 | 12.03 | 145.41 |
| 1 | No Ammonia | 1076 | 12.25 | 131.83 |
| 3 | Potassium Nitrate | 1087 | 11.62 | 128.35 |
| 6 | Ammonium Phosphate | | | |
| | No Ammonia | 1021 | 12.00 | 122.54 |

| Section B—40 Pounds Ammonia (NH₃) per Acre | 
|-----------------|-----------------|-----------------|-----------------|
| Plot (For reference) | Source of Ammonia* | Ave. Yield per Acre | Ave. Value per 100 Lbs. | Ave. Gross Value per Acre |
| 4 | Urea | 1308 | 13.50 | 188.76 |
| 2 | Nitrate of Soda | 1381 | 13.38 | 184.76 |
| 10 | Fish Scrap | 1366 | 13.38 | 182.75 |
| 5 | Ammonium Nitrate | 1411 | 12.63 | 178.23 |
| 8 | Sulphate of Ammonia | 1341 | 12.60 | 168.92 |
| 9 | Dried Blood | 1267 | 13.20 | 167.24 |
| 3 | Potassium Nitrate | 1284 | 11.65 | 149.65 |
| | Ammonium Phosphate | | | |
| 7 | Cyanamid | 1205 | 11.99 | 144.47 |
| 1 | No Ammonia | 1024 | 12.04 | 123.27 |
| 6 | No Ammonia | 985 | 11.98 | 117.99 |

* All treatments with exception of plot 3 on both sections of this table received a basic application of 1000 pounds of a 4-0-5.6. The phosphorus was derived from 16% super-phosphate and the potash from 48% sulphate of potash. Plot 3, Section A, received a mixture of potassium nitrate and ammonium phosphate equivalent to 1000 pounds of a 4-2-2.8 without the use of other materials. Plot 3, Section B, received the same materials in double the amounts applied to plot 3, Section A.
proximately equal to nitrate of soda when applied at rates of 20 and 40 pounds of ammonia (NH₃) per acre (plots 4A and 4B, Table VII). Potassium nitrate and ammonium phosphate used as a complete fertilizer (plots 3A and 3B, Table VII) consistently produced poor quality tobacco and in some instances gave gross yields and values closely approximating those on check plots. The check plots in this series received only 80 pounds of phosphorus (P₂O₅) from 16 per cent superphosphate and 56 pounds of potash (K₂O) from 48 per cent sulphate of potash per acre. While the mixture of potassium nitrate and ammonium phosphate carries phosphorus, nitrogen and potash in proportions equivalent to a high grade fertilizer (8-4-5.6), it is quite evident from the growth resulting from applications of this mixture that it is deficient as a plant food. This can be readily explained by the facts presented by other investigators¹ that calcium, sulphur, and several other elements not usually considered in commercial fertilizers, are essential to a normal growth of the tobacco plant. The mixture of superphosphate and sulphate of potash mentioned above carries phosphorus, potassium, calcium and sulphur in comparatively large quantities and possibly small quantities of other essential elements. The potassium nitrate and ammonium phosphate mixture carries only phosphorus, nitrogen and potash. Therefore the poor showing made by this mixture may be attributed to the absence of essential minor elements rather than the form of ammonia.

Calcium cyanamid used as the only source of ammonia gave good yields but produced a leaf of poor quality. In periods of dry weather plants receiving this material showed distinct evidence of rim firing. This condition was aggravated by drought and in periods of extremely dry weather caused considerable reduction in quality. Fish scrap (acidulated fish meal) proved somewhat superior to cottonseed meal and dried blood as a source of organic ammonia. However, there was not enough difference in these three materials to class any one of them as decidedly superior to the others.

When nitrate of soda was combined with other ammoniates, such as dried blood, cottonseed meal and sulphate of ammonia, in every instance the yields, and in some instances the quality, were increased over those when dried blood, cottonseed meal and sulphate of ammonia were used as the only

source of ammonia (Tables V. and VI.). It does not follow, however, that nitrate of soda, urea and similar materials will return the largest profit every year. Due to the solubility of these materials, they are easily leached from the soil. At times this may be an advantage, especially when soil moisture is limited in the early growing season, and abundant in the latter part of the season, which is very often the case in the Coastal Plain of Georgia. Under such conditions the plant is able to make use of the easily soluble nitrogen under the limited moisture conditions in the early season and is not thrown into a second growth as described on page five by an excess of ammonia in the maturing season. This is brought about by the leaching of the readily soluble nitrates from the soil by heavy rains in the latter part of the season. However, if moisture is abundant soon after these easily soluble materials are applied to the soil, they may be removed by leaching before they can be taken up by the plant. This will naturally result in a nitrogen-starved, small, yellow plant. Since the organic ammonia carrying materials such as cottonseed meal, fish scrap and tankage, are not so readily available, these materials furnish the plant little ammonia in periods of limited rainfall and are present and become available slowly in periods of sufficient or abundant rainfall, and thereby especially favor second growth if used in large quantities. It can be seen that since it is impossible to control the season it would probably be unwise to use all nitrate, ammonia salts or organic ammoniates in a tobacco fertilizer. It is therefore recommended that one-half the ammonia in tobacco fertilizers be derived from high grade organic materials such as cottonseed meal, dried blood, fish scrap and/or high grade tankage. The remaining half of the ammonia should all be derived from nitrate of soda or one-fourth from nitrate of soda and one-fourth from nitrate of potash, calcium nitrate and/or urea (which because of its solubility and availability may be classed in this type of materials).

EFFECTS OF POTASH ON THE TOBACCO PLANT

Potash is deficient in the soils of the Coastal Plain area to a somewhat greater degree than in the soils of the Piedmont and Mountainous sections because of the difference in the manner in which the soils were formed. This condition necessitates heavy applications of potash to the soils of the Coastal
Plain to produce a good quality tobacco. An abundance of potash increases the yield, promotes the vigor of the plant and gives the leaf better texture and elasticity. The absence of sufficient potash causes the plant to become stunted and take

FIG. 5. Tobacco plant showing symptoms of potash hunger.

on a hard, droughty appearance. In extreme cases the leaves become puckered and drawn and soon begin firing around the edges and between the veins. Unlike phosphorus and ammonia there is little danger of ill effects from an over supply of potash so long as the right sources are used. Anderson and others\(^1\) found that the potash content of the cured tobacco

leaf may vary from 2.2 to 8.5 per cent. These figures include many types of tobacco and the maximum is much too high for the flue-cured type. However, the amount of potash in the leaf is governed to a large extent by the supply available to the plant. The average for flue-cured tobacco is approximately three to five per cent. If the yield is 1000 pounds cured leaf per acre this will necessitate 30 to 50 pounds of potash (K₂O) for the leaf without taking into consideration the stalk, suckers, and top that are left in the field. In addition to the potash taken up by the plant, considerable amounts are lost from the soil by leaching. The exact amount may vary widely with conditions but in some cases may run as high as 72 pounds per acre on sandy soils. Thus it seems that more than 50 pounds of potash (K₂O) per acre should be applied to the sandy soils of the Coastal Plain area in order that the crop may have sufficient potash for maximum production. Tests with potash in amounts varying from 20 to 80 pounds K₂O per acre on Norfolk and Tifton soil series (Table IV.) show that with an increase in rates of potash applied, there is an increase in yield as well as quality on the Tifton soil. While the data are somewhat inconsistent on the Norfolk soil it is believed that the trend clearly indicates that with tests covering a longer period of time the same would be true on both types of soils. In any case the data seem to be sufficient to justify the conclusion that more than 50 pounds of potash (K₂O) per acre are necessary for maximum production.

SOURCES OF POTASH

The source of potash used in flue-cured tobacco is of great importance when quality is to be considered. Other investigators have shown that there are no consistent differences in the yields obtained where the American potash salts are compared with the German materials. Tests on Norfolk and Tifton soils (Tables VIII. and IX.) show that kainit and muriate of potash produced higher yields and gross values per acre than the sulphate forms of potash. Of the sulphate forms, sulphate of potash magnesia produced on an average higher acre values than the straight sulphate of potash. This increase is

TABLE VIII.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS WITH DIFFERENT SOURCES AND RATES OF APPLICATIONS OF POTASH ON TIFTON SANDY LOAM

<table>
<thead>
<tr>
<th>PLOT (For reference)</th>
<th>Formula P-N-K</th>
<th>Source of Potash*</th>
<th>Years Covered in Tests</th>
<th>Ave. Yield per Acre Pounds</th>
<th>Ave. Price per 100 Pounds</th>
<th>Ave. Gross Value per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8-3-6</td>
<td>(\frac{1}{2}) German Sulphate (\frac{1}{2}) Kainit</td>
<td>1925-32</td>
<td>1555</td>
<td>$14.64</td>
<td>$232.64</td>
</tr>
<tr>
<td>8</td>
<td>8-3-6</td>
<td>German Muriate</td>
<td>1922-32</td>
<td>1397</td>
<td>16.27</td>
<td>227.32</td>
</tr>
<tr>
<td>5</td>
<td>8-3-3</td>
<td>Kainit</td>
<td>1922-32</td>
<td>1380</td>
<td>15.81</td>
<td>218.13</td>
</tr>
<tr>
<td>6</td>
<td>8-3-6</td>
<td>(\frac{1}{2}) Amer. Muriate (\frac{1}{2}) Amer. Sulphate</td>
<td>1926-32</td>
<td>1426</td>
<td>15.28</td>
<td>217.87</td>
</tr>
<tr>
<td>9</td>
<td>8-3-6</td>
<td>Sul. Potash Magnesia</td>
<td>1922-32</td>
<td>1309</td>
<td>16.11</td>
<td>210.83</td>
</tr>
<tr>
<td>3</td>
<td>8-3-3</td>
<td>American Muriate</td>
<td>1922-32</td>
<td>1227</td>
<td>16.67</td>
<td>205.63</td>
</tr>
<tr>
<td>6, 15</td>
<td>8-3-3</td>
<td>American Sulphate</td>
<td>1922-32</td>
<td>1038</td>
<td>19.57</td>
<td>203.17</td>
</tr>
<tr>
<td>7</td>
<td>8-3-6</td>
<td>German Sulphate</td>
<td>1922-32</td>
<td>1279</td>
<td>15.85</td>
<td>202.71</td>
</tr>
<tr>
<td>2</td>
<td>8-3-3</td>
<td>American Sulphate</td>
<td>1922-32</td>
<td>1223</td>
<td>15.58</td>
<td>190.57</td>
</tr>
<tr>
<td>4</td>
<td>8-3-3</td>
<td>Sul. Potash Magnesia</td>
<td>1922-32</td>
<td>1171</td>
<td>15.72</td>
<td>184.04</td>
</tr>
<tr>
<td>1</td>
<td>8-3-0</td>
<td>No Potash</td>
<td>1922-32</td>
<td>833</td>
<td>11.65</td>
<td>97.08</td>
</tr>
</tbody>
</table>

*NOTE: Each plot received a basic application of 1000 pounds of an 8-3-0 per acre. The phosphorus was derived from \(16\%\) superphosphate and the ammonia from dried blood and nitrate of soda in an 8 to 3 ratio.

TABLE IX.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS WITH DIFFERENT SOURCES AND RATES OF APPLICATIONS OF POTASH ON NORFOLK LOAMY SAND FOR SIX YEARS, 1927-1932, INCLUSIVE

<table>
<thead>
<tr>
<th>PLOT (For reference)</th>
<th>Formula P-N-K</th>
<th>Source of Potash*</th>
<th>Ave. Yield per Acre Pounds</th>
<th>Ave. Price per 100</th>
<th>Ave. Gross Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8-3-6</td>
<td>(\frac{1}{2}) Kainit (\frac{1}{2}) German Sulphate</td>
<td>1454</td>
<td>$13.39</td>
<td>$194.62</td>
</tr>
<tr>
<td>8</td>
<td>8-3-6</td>
<td>German Muriate</td>
<td>1276</td>
<td>13.48</td>
<td>172.03</td>
</tr>
<tr>
<td>6</td>
<td>8-3-6</td>
<td>(\frac{1}{2}) American Sulphate (\frac{1}{2}) American Muriate</td>
<td>1232</td>
<td>13.57</td>
<td>171.26</td>
</tr>
<tr>
<td>3</td>
<td>8-3-3</td>
<td>American Muriate</td>
<td>1194</td>
<td>14.29</td>
<td>170.65</td>
</tr>
<tr>
<td>9</td>
<td>8-3-6</td>
<td>Sul. Potash Magnesia</td>
<td>1242</td>
<td>13.42</td>
<td>166.63</td>
</tr>
<tr>
<td>5</td>
<td>8-3-3</td>
<td>Kainit</td>
<td>1277</td>
<td>13.01</td>
<td>166.13</td>
</tr>
<tr>
<td>7</td>
<td>8-3-6</td>
<td>German Sulphate</td>
<td>1176</td>
<td>13.87</td>
<td>163.08</td>
</tr>
<tr>
<td>4</td>
<td>8-3-3</td>
<td>Sul. Potash Magnesia</td>
<td>1133</td>
<td>13.38</td>
<td>151.58</td>
</tr>
<tr>
<td>2</td>
<td>8-3-3</td>
<td>American Sulphate</td>
<td>1117</td>
<td>13.16</td>
<td>146.93</td>
</tr>
<tr>
<td>1</td>
<td>8-3-0</td>
<td>No Potash</td>
<td>1022</td>
<td>11.14</td>
<td>113.85</td>
</tr>
</tbody>
</table>

*NOTE: Each plot received a basic application of 1000 pounds of an 8-3-0. The phosphorus was derived from \(16\%\) superphosphate and the ammonia from dried blood and nitrate of soda in an 8 to 3 ratio. It will be noted that on plot 1 which received no potash, the yield was much better than on the corresponding plot in Table VIII. This can probably be accounted for by the fact that the above tests were conducted on virgin soil (new land) which was not as deficient in potash as the old Tifton soil used in Table VIII.
very likely due to the magnesia present in the sulphate of potash magnesia.

Under the present system of marketing, prices are fixed without due consideration to the burn or fire holding capacity of the leaf. The ability of the leaf to hold fire has been studied extensively and has been found to be closely related to its chlorine content. The poorest burning leaves are those produced on plots receiving potash from materials high in chlorine. Applications of such materials will, especially under drought conditions, tend to dwarf the plant and cause the leaves to become thick and brittle. This condition is often found on seed beds fertilized with cotton or corn fertilizers which usually carry kainit as a source of potash. Often tobacco that has a high chlorine content will cure to a dull, muddy color rather than the desirable lemon yellow. Such tobacco will absorb moisture more readily than that grown with the sulphate forms, and in warm moist weather becomes difficult to keep in proper order for handling, without becoming too wet. In view of these disadvantages, it is unwise to use muriate of potash, kainit or manure salts as a source of potash for tobacco. However, since a small quantity of chlorine will not materially affect the burning quality of the leaf and does help the health and vigor of the plant and increase the yield, it is

FIG. 6. Chlorine damage. Note the rolled leaf margins and the thick, glossy appearance of the leaves. These plants are old enough to be in top.

believed that such quantities can be used to advantage. Therefore, it is recommended that two per cent out of the total potash percentage or 40 pounds K-O per ton of fertilizer be derived from high grade muriate of potash and the remainder from sulphate of potash or sulphate of potash magnesia. It should be kept in mind that while kainit and manure salts are muriates they are not considered high grade muriates and should not be used in tobacco fertilizers.

RELATION OF CLOSE SPACING AND HEAVY FERTILIZATION TO YIELD AND QUALITY

Often the questions are raised, is it possible to increase the yield of tobacco by heavy fertilization, and should closer spacing be employed in conjunction with heavy fertilization to maintain quality by preventing a rough, coarse growth? To answer these questions, two series of five plots each were used. On each series beginning with 1000 pounds per acre the fertilizer application was increased in steps of 200 pounds to a maximum of 1800 pounds per acre. The soil was a fairly fertile first year Norfolk loamy sand. On one series beginning with 5440 plants and 1000 pounds of fertilizer per acre, the number of plants was increased by 1000 for every 200-pound in-

TABLE X.—AVERAGE ACRE YIELDS, SELLING PRICE PER 100 POUNDS, AND GROSS VALUES PER ACRE OF TOBACCO PRODUCED IN TESTS OF SPACING AND VARYING RATES OF FERTILIZER APPLICATION ON NORFOLK LOAMY SAND, 1927-1932, INCLUSIVE

<table>
<thead>
<tr>
<th>PLOT (For reference)</th>
<th>Fertilizer Used per Acre*</th>
<th>Spacing</th>
<th>Plants per Acre</th>
<th>Yield per Acre Pounds</th>
<th>Ave. Value per 100 Lbs.</th>
<th>Gross Value per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1000 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1322</td>
<td>14.55</td>
<td>192.33</td>
</tr>
<tr>
<td>2 1200 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>6400</td>
<td>1443</td>
<td>14.49</td>
<td>209.57</td>
</tr>
<tr>
<td>3 1400 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>7400</td>
<td>1578</td>
<td>14.23</td>
<td>224.62</td>
</tr>
<tr>
<td>4 1600 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>8400</td>
<td>1616</td>
<td>13.95</td>
<td>225.55</td>
</tr>
<tr>
<td>5 1800 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>9400</td>
<td>1750</td>
<td>14.09</td>
<td>245.63</td>
</tr>
<tr>
<td>6 1000 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1211</td>
<td>14.66</td>
<td>177.53</td>
</tr>
<tr>
<td>7 1200 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1388</td>
<td>14.74</td>
<td>204.64</td>
</tr>
<tr>
<td>8 1400 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1433</td>
<td>14.70</td>
<td>215.10</td>
</tr>
<tr>
<td>9 1600 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1510</td>
<td>14.95</td>
<td>225.72</td>
</tr>
<tr>
<td>10 1800 Lbs. 8-3-5</td>
<td></td>
<td></td>
<td>5440</td>
<td>1538</td>
<td>14.78</td>
<td>231.43</td>
</tr>
</tbody>
</table>

*Materials used: Phosphorus from 16% Superphosphate; 15 Lbs. Ammonia per acre from 18% Nitrate of Soda; 15 Lbs. Ammonia per acre from 16% Dried Blood; Potash from 30% Sulphate of Potash Magnesia.
crease in the fertilizer application per acre. On the other series only the fertilizer applications were increased, the number of plants being 5440 per acre on all five plots. (See Table X.). Results show that close spacing used in conjunction with heavier applications of fertilizer increases the yields over the higher fertilizer applications without the closer spacing. The yields were increased on both series as the fertilizer application became heavier. As the fertilizer application became heavier, however, the rate of increase in yields became less. The quality varied very little and the only significant thing regarding quality was the slight tendency of close spacing to lower the quality. The inferior quality seemed to be caused by the lack of sunlight and the competition for moisture, caused by the crowded condition of the plants. This was evidenced by the premature ripening and firing in the field and the lifeless chaffy type of cured leaf produced on the plots having plants spaced closer than 7400 plants per acre. These results indicate that it probably will not pay to space tobacco closer than about 22 by 38 inches, or 7400 plants per acre. On light sandy soil the fertilizer application may go as high as 1400 or even 1600 pounds per acre without injury to quality, provided of course that a well balanced fertilizer made up from proper materials is used.

FERTILIZER FORMULAS AND RATES OF APPLICATION PER ACRE

In the preceding discussion the functions of phosphorus, nitrogen and potash, and the necessity for deriving these elements from certain forms has been considered. Yields and quality resulting from applications of different amounts of these elements per acre have also been discussed. However, it is desirable that the data previously given be summarized into a more concrete form in order that it may be applied without confusion.

The source of plant food constituents that go to make up a fertilizer are of the greatest importance. This is true not only from the standpoint of the availability of the plant food carried by the numerous materials but also from the standpoint of certain so called minor elements carried by some of these materials. These elements are not ordinarily considered in fertilizer formulas and may be beneficial, indifferent or even
harmful to the tobacco plant. It is therefore essential that certain sources of plant food constituents be used if maximum yields of quality tobacco are to be expected.

One-half the ammonia should be derived from high grade organic materials of plant or animal origin such as cottonseed meal, dried blood, fish scrap and/or high grade tankage. The remaining half of the ammonia should be derived from nitrate of soda, or one-fourth from nitrate of soda, and one-fourth from nitrate of potash, urea or calcium nitrate, or a combination of these materials.

The phosphorus should be derived from superphosphate, double superphosphate or dicalcium phosphate.

Forty pounds potash (K₂O) or two per cent out of the total potash percentage may be derived from high grade muriate of potash provided it does not raise the chlorine content of the mixed goods above two per cent. The remaining potash should be derived from sulphate of potash or sulphate of potash magnesia. Where no other source of available magnesia is used it is desirable to use sulphate of potash magnesia in order to supply this element. Magnesia is necessary to prevent “sand drown” or magnesia hunger where the soil is deficient in this material. Fertilizers containing two per cent magnesia (MgO) of which at least one-half is water soluble are believed to be high enough in magnesia to prevent trouble from magnesia hunger.

The fertilizer formulas used for tobacco do not necessarily have to be the standard 8-3-5 or 8-3-8 mixtures (ammonia basis) in order to be excellent fertilizers for this crop. The only requirements are that the proportion of the elements be approximately the same as contained in these standard formulas and that certain fertilizer materials be used in making up the mixed goods. The proportions of phosphorus, ammonia and potash recommended for tobacco are: eight parts phosphorus, three parts ammonia (two and one-half parts nitrogen) and five to eight parts potash or an 8-3-5 to an 8-3-8 formula or the equivalent. As shown elsewhere in this publication the high potash formulas have proved the most profitable. Therefore the eight per cent potash formula is to be recommended over the five per cent goods.

The rate of fertilizer application per acre will depend upon the soil type, the general state of fertility of the soil, and the last crop grown on the area under consideration. On most soils
of the Norfolk series which are so widely used for tobacco, 1000 to 1200 pounds of fertilizer per acre will prove satisfactory. On the average Tifton soils 1000 pounds of fertilizer is sufficient under most conditions. However, on fertile soils and soils that have been cropped heavily to legumes or that have had a legume crop directly preceding tobacco, it may pay to reduce further the fertilizer application to 800 pounds per acre.

**HARVESTING AND CURING TOBACCO**

Harvesting tobacco at the proper stage of ripeness is half of the curing. In order to make good cures it is important that all of the tobacco in a barn be uniform in ripeness and come from the same part of the plant. It is impossible to cure sand lugs in the same curing with leaves from higher up on the stalk. Properly ripened leaves are those that have lost their glossy green color, that have taken on a dull yellowish cast and that are more or less grained. Leaves that have begun drying at the tip, or are of a pumpkin yellow color are too ripe to be of any value except when prices are very high. Such leaves should be discarded in the field. In filling a barn care should be taken not to crowd the tobacco by putting the sticks too close together on the tiers or too many “hands” or bundles of leaves on the stick, as crowding prevents the proper circulation of heat. The spacing of the sticks on the tiers and of bundles on the sticks will depend upon the size of the leaves. With average size tobacco the sticks should not be closer than eight inches apart on the tiers and each stick should not have more than 30 bundles of three leaves each.

The exact procedure to be followed in curing flue-cured tobacco depends upon a number of factors, the most important of which are the following: (1) ripeness of the tobacco, (2) seasonal conditions under which the crop was grown, whether favorable, too wet or too dry, (3) atmospheric conditions both within and without the curing house, (4) variety of tobacco, and (5) the part of the plant from which the tobacco was pulled. It is therefore quite evident that no set of instructions on curing will apply in all cases. It is believed that a general outline of the curing procedure will be of value here.

The curing process is divided into three stages as follows: (1) the yellowing or fermenting stage which is nothing more than encouraging the self-starvation of the leaf tissue by fav-
orable temperature and moisture conditions, (2) drying the leaf which is the process of killing the leaf cells and fixing the color after the fermenting process has reached the proper stage, and (3) drying the stem or midrib of the leaf. In order to get a uniform cure a barn should be completely filled in one day. As soon as the barn has been filled it should be tightly closed, a fire made and the temperature run up to 95 to 100 degrees Fahrenheit. The barn can then be left until the fol-

lowing morning. The fires should then be remade and the temperature kept at 90 to 95 degrees if the tobacco is of the dry weather type, or 95 to 100 degrees if there is an abundance of sap in the leaf. When tobacco is harvested in extremely dry weather it has been found that wetting the floor of the barn during the yellowing process creates a moist condition in the barn which aids materially in yellowing. The above temperatures should be maintained until the tobacco has taken on the desired color which may be described as a greenish lemon color. The length of time necessary to develop this color will vary considerably, but usually runs from 30 to 36 hours after the barn has been filled. In practically no case is it advisable

FIG. 7. Inside view of curing barn during curing process.
to try to yellow tobacco more than 48 hours. Low temperatures for more than 48 hours cause the cells of the leaf to break down, thereby giving a black or splotched cured leaf. After the desired color has been obtained the temperature should be raised five degrees every two hours until 115 degrees have been reached. At this stage ventilation should be given at both bottom and top of the barn. The temperature should then be raised five degrees after two hours to 120 degrees and maintained for three or four hours if there is any green left in the butts of the leaves. If no objectionable green is present, the same rate of increase in temperature should be continued until 140 to 145 degrees are reached. This temperature should be maintained until the leaf is entirely dry on the lower tiers. The ventilators should then be closed and the temperature raised five degrees every two hours until 175 degrees are reached. This temperature should be held until the stems in all parts of the barn are dried completely. In no case should the temperature go over 175 degrees and for exceedingly good tobacco 170 degrees are high enough. Temperatures above these will scorch the tobacco and lower the quality.

INSECT CONTROL IN SOUTHERN BELT

Damage from insect injury is somewhat greater in the southern flue-cured belts than in the northern tobacco growing areas making it necessary to adhere to control measures that are not generally practiced in some of the older tobacco growing areas. Insect control measures should begin as soon as the insects appear, which, in the case of budworms can be detected by the appearance of the eggs on the plant. These eggs are small and can be seen only by close observation. The question of time and number of applications of insecticides resolves itself into one of good judgment on the part of the grower.

BUDWORMS: At the present time the best known method for controlling the tobacco budworms is by applying to the buds a mixture of one pound of arsenate of lead and 75 pounds of corn meal (approximately six heaping teaspoonfuls of arsenate to one peck of corn meal). In the preparation of this mixture care should be taken to obtain an even distribution of the poison throughout the meal. For this purpose, mechanical mixers may be employed, where large quantities are required. Approximately one peck of meal is necessary for one application to an acre of tobacco. Cottonseed meal, lime and
sand are sometimes used in place of the corn meal but they have been found to be much less satisfactory. Calcium arsenate or Paris green should not be used as a substitute for arsenate of lead, as severe burning of foliage may result under certain weather conditions.

A small portion of the poison mixture should be dropped into the center of the bud with the hand. The necessity of care-

![Image](image_url)

**FIG. 8.** Illustrating the stick and cup method of applying budworm poison to young tobacco plants.

fully applying the mixture directly to the bud cannot be too greatly emphasized as the effects of careless manipulation may be almost as bad as if no control measures were attempted. When the plants are small, applications may be made by means of a quart cup, with nail holes in the bottom, fastened to a stick. As the plants increase in size the bud leaves become more tightly folded and it is necessary to change to the hand method. The number of applications necessary will vary from one season to another. It appears, however, that from three to five applications of the poison mixture, approximately
one week apart, during the early part of the season will give all the protection needed for this type of tobacco.

**Cutworms:** Cutworms are usually most abundant on land that has been previously covered with green vegetation, especially winter cover crops. This vegetation apparently attracts the moths during egg laying season and afterwards serves as food for the worms. Where cover crops have been on land until a short time before planting the danger from cutworm damage can be lessened by the use of poison bait made as follows: Wheat bran or shorts, 50 pounds; paris green, one pound, and water to moisten.

The addition of syrup to cutworm bait has often been recommended but numerous experiments have shown it to be of little or no value. (United States Bureau of Entomology, Circular E 260.) The bran and poison should be thoroughly mixed in the dry state and water then added until the mixture is moist but not sloppy.

After the land has been put in condition for transplanting the crop, the bait should be broadcast over the field at the rate of 20 pounds (dry weight) per acre. The application should be made late in the afternoon, about sundown, and several days before the crop is planted. If a heavy rain follows immediately, the poison will be ineffective and the application should be repeated. When it is desired to poison after the plants have been transplanted the bait may be scattered down the row but should not come in contact with the plants or severe burning may take place.

**Mole Crickets:** Sometimes these insects get into plant beds and burrow into the soil, doing considerable damage to the young plants, before their presence is noticed. They should be carefully watched for, and when the first run is found, bait should be put out. A mixture made up of one pound of arsenate of lead and 25 pounds of corn meal, with enough water to moisten to a crumbly state, usually proves successful as a control measure. The arsenate of lead and meal should be well mixed in the dry state before the water is added. This mixture should be scattered over the bed at the rate of two to three quarts to the hundred square yards.

**Wire Worms:** No means of controlling the wire worm has been found. Frequent replanting with strong, vigorous plants is the best known practice. This can be done with less difficul-
ty in the early morning when the normal plants are standing up and those attacked by wire worms are wilted.

SUMMARY

The production of flue-cured tobacco in Georgia increased from 350,000 pounds in 1917 to a maximum of over 104,000,000 pounds in 1930. The annual production has varied widely since 1930 due to unfavorable market and weather conditions.

FIG. 9. Farmers inspecting experiments at annual tobacco field meeting.

The amount and distribution of rainfall during the growing season has an important bearing upon the yield and quality of tobacco. Heavy rains soon after transplanting leach much of the plant food from the soil while dry weather at this time stunts the plants, thereby reducing yield and quality. During the harvest season heavy rains or prolonged wet seasons materially injure the quality of tobacco by causing second growth.

The soils of the Coastal Plain area best suited to tobacco are the Norfolk sandy loams and loamy sands, and the light phases of the Tifton sandy loams. Soils planted to tobacco should be light in texture, friable, well drained and comparatively low in ammonia reserve.
The varieties of flue-cured tobacco best suited to the Coastal Plain area of Georgia are those of the light type group which includes Jamaica, Cash, Bonanza.

Seed beds should be sterilized either by steam or by burning whenever it is possible to do so. If it is not possible to sterilize, new beds on virgin soil should be provided. Fertilizers should be applied liberally and only tobacco fertilizers used. Seeding should be done at the rate of one well rounded tablespoon of good seed per 100 square yards. Seed beds should be sown in late December or early January.

Soil to be transplanted to tobacco should be finely pulverized into a mellow, loose condition. Transplanting should be done in late March or early April. The plants should be set approximately two feet apart in rows four feet wide. Cultivations should be frequent and designed to keep the soil mellow and loose. Topping and suckering should not be delayed, or losses in yield and quality will occur.

Phosphorus is essential in all tobacco fertilizers as practically all soils used for tobacco in the Coastal Plain area are deficient in this element. The virgin soils are especially low in phosphorus. Phosphorus deficiency is evidenced by a small, abnormally green plant which never ripens properly. Too much phosphorus causes premature ripening or “firing” in the field. Tobacco fertilizer should contain approximately eight per cent phosphorus where applications of 1000 pounds or more of the mixture are used per acre. Superphosphate is a satisfactory and convenient source of this element.

The ammonia supplied to tobacco should be carefully controlled. Excessive quantities cause the plant to grow large and coarse which makes curing difficult. Insufficient quantities prevent the plant from making its maximum growth and thereby reduce the yield, although the quality may be fair. Tobacco fertilizers should carry three to four per cent ammonia which should be derived from certain types of materials. Horse manure as the sole source or as a partial source has given excellent results. In commercial fertilizers it is recommended that one-half the ammonia be derived from high grade organic materials, and one-half from nitrate of soda or, one-fourth from nitrate of soda and the remainder from other nitrates and/or urea.

Potash has the most important bearing on quality of any element in tobacco fertilizer. Where no potash is applied the
plants make only limited growth and soon break down; such plants produce the lowest quality of tobacco. Potash should be contained in tobacco fertilizers to the extent of from five to eight per cent of the mixed goods. The sources of potash giving the heaviest yields (muriate of potash and kainit) contain chlorine, which in large quantities may impair growth and injure the burning quality of the leaf. However, small quantities of chlorine have proved beneficial. The potash recommendation therefore includes 40 pounds potash (K₂O) per ton from high grade muriate and the remainder from sulphate of potash or sulphate of potash magnesia. It is desirable that the last named material and/or some other material carrying available magnesia be used to supply magnesia to the mixed goods as a preventive of sand drown.

There is no particular advantage in close spacing in conjunction with heavy fertilizer applications. On most soils 1000 to 1200 pounds of fertilizer per acre is sufficient. Occasionally, on very light sandy soils, 1600 pounds may be applied profitably.

The factors involved in curing flue-cured tobacco are so numerous that no definite program can be given that will apply in any except a general way. Good cures can be expected only when uniform, well ripened tobacco is put into the barn, and undivided attention is given it until the cure is finished.

Attention to insect control should begin as soon as the plants begin to grow. By following recommended practices complete control is only a matter of diligence.