TABLE 93
TUNG OIL—ADAPTATION TEST
Average Yield for Years 1927 to 1938, Inclusive
Yield Expressed in Pounds per Tree*

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<td>Lbs. Dry Wt</td>
<td>92</td>
<td>14</td>
<td>93</td>
<td>20</td>
<td>33</td>
<td>8.5</td>
<td>50</td>
<td>19</td>
<td>62</td>
<td>3.21</td>
<td>1.56</td>
<td>73.22</td>
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<td>Age of Trees</td>
<td>4</td>
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<td>Crop Years</td>
<td>1st</td>
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*Air dried weight in pod.

Cherries: With the exception of Capulin, all varieties of cherries in the trial grounds have died, and it not only is making indifferent growth but its fruit is of poor quality. Therefore, it is concluded that the varieties of cherries now available are not adapted to the Coastal Plain of Georgia.

Persimmons: Japanese persimmons are becoming increasingly susceptible to both fruit and plant diseases, with the result that many trees have died and those remaining mature only a small portion of their fruit.

Walnuts: Walnuts growing in the trial grounds since 1922 lack vigor and, with the exception of Japanese, have matured only a few fruits.

Quince: This fruit is highly susceptible to blight and as a result holds little promise of successful culture in South Georgia, particularly in the lower Coastal Plain area.

Chestnuts: Only blight resistant varieties of chestnuts are surviving in the trial grounds. They, however, appear vigorous and well adapted to this area.

Other fruits: Among the fruits that have shown the least evidence of adaptability in the trial grounds are: Apricots, hazlenuts, prunes and raspberries.

NEMATOLOGY

In cooperation with the Division of Nematology, Bureau of Plant Industry, United States Department of Agriculture, experiments have been conducted on various phases of nematode control, with special reference to our most common nematode parasite of plants—the root-knot nematode.

CHEMICAL CONTROL OF THE ROOT-KNOT NEMATODE

In former years, numbers of chemicals for root-knot nematode control have been tested, but good results have been obtained with only two—chlorpicrin (tear gas) and carbon bisulphide. All other chemicals
tested, including some extensively advertised for use against this pest, have been found to be entirely ineffective.

Carbon bisulphide injected into the soil at the rate of 500 to 1000 pounds per acre reduced root-knot more than 90 per cent. However, this chemical is extremely disagreeable and dangerous to handle, having a bad odor and being highly inflammable and even explosive. Under some conditions, chloropicrin at the rate of 150 to 200 pounds per acre has given excellent control of root-knot, but has failed entirely under other conditions with similar amounts applied. Work of the past year has been directed toward a study of the conditioning factors assuring the highest effectiveness of this chemical and toward the design of machines for applying it.

The method of application of both carbon bisulphide and chloropicrin is essentially the same. Measured quantities of the chemical are placed in holes 8 to 10 inches deep punched in the soil at regular intervals. The holes are then filled in and a cover placed over the soil to prevent escape of the gas formed by the evaporation of the chemical.

Experiments this year have indicated that the soil should be fairly moist—neither dry nor water-soaked—and that the chemical application should be made when the soil temperature is about 70°F. However, the past season’s experiments were not entirely conclusive and are being continued.

Both carbon bisulphide and chloropicrin are too expensive for use on a large scale, but will have considerable value for treatment of seed-beds, greenhouses, and similar small areas of infestation, particularly if the soil is valuable.

In view of the above, unqualified recommendations cannot yet be made for chemical control of nematodes in the soil. Prospective users are requested to write to this Station for detailed instructions for the application of chemicals for this purpose and are cautioned that such applications must be considered experimental, which means that the possibility of complete failure must be taken into account.

A hand applicator has been developed for applying these chemicals, and a description and drawings of it can be furnished to those interested.

It has been definitely established that ammonium thiocyanate, used either dry or in solution in infested soil, has no appreciable control effect on root-knot nematodes.

**ACTIVE MIGRATION OF THE ROOT-KNOT NEMATODE**

Experiments have shown that the root-knot nematode can move through sandy soil at the rate of about one centimeter a day (approximately one foot in 30 days) and that it can travel at least two feet from its starting point during its active larval life. These figures are for active migration of the nematode and do not take into account such transporting agencies as running water, soil carried on farming implements, the feet of men and animals, infested nursery stock, etc. These latter agencies seem to be far more important in the spread of nematode infestation than movement of the nematode itself.

**SPREAD OF NEMATODES FROM AN INFESTED AREA**

By placing root-knot nematodes in a carefully defined area and planting various crops in continuous rows across the area, it was shown that
the infestation spread at the rate of 7.5 mm (3/10 inch) per day along rows of squash and at the rate of about 3.5 mm (1/7 inch) per day on cowpeas and lima beans. No explanation of the varying rates of travel on the three crops was found. Again it is apparent that cultivation along the rows and water running along the rows is far more responsible for enlarging a nematode infested area than the multiplication and movements of the nematodes themselves.

**TUNG TREES AND ROOT-KNOT**

An experiment to determine the effect of root-knot on the growth and yield of the tung tree has been set up. Several years must elapse before any worthwhile data will be available.

**CONTROL OF ROOT-KNOT IN THE FIELD**

As the root-knot nematode attacks and weakens to some extent all of the principal crops grown in the Coastal Plain, and as most of our soils are very favorable to the pest, farmers should give careful consideration to the planning of their crop rotations.

Tobacco, watermelons, squash, cucumbers, tomatoes, and truck crops in general are severely damaged by root-knot and should never be planted on soil known to be infested. Nor should one of these crops follow any of the others if it can be avoided, for, while the first crop may escape noticeable damage, the nematode population may be increased to the danger point and subsequent crops badly damaged. Corn, peanuts, velvet beans, oats, and other grains are generally not badly damaged by nematodes and have a tendency to decrease the nematode population, so these crops can be planted on infested soil. After two or three seasons of the less susceptible crops, the soil again may be used for the more susceptible ones for a season with a degree of safety. Even then, caution must be used, for the nematodes will not be eliminated entirely and one or two susceptible crops will again build up the population to the danger point.

Cotton can be classed as a semi-susceptible crop. While it is attacked by the nematodes and sometimes damaged, the damage is generally not severe. But cotton will increase the nematode population and should never be followed the next season by one of the highly susceptible crops.

Crops which definitely decrease the nematode population are few. The best one is peanuts where the nuts are harvested. Either the Spanish peanut or the runner peanut may be used. Crotalaria, particularly *Crotalaria spectabilis*, will also reduce the nematode population. It has the advantage of adding nitrogen to the soil. Oats and rye may also be used. Some of our native weeds, such as Florida pursley (*Richardia scabra*), coffeeweed (*Cassia tora*) and beggarweed (*Desmodium tortuosum*), are highly resistant to root-knot and where these weeds have predominated for several years, the soil should be fairly safe for nematode susceptible crops. Bare fallow also decreases the nematode population, but is not generally practical. Velvet beans may also be used. (See also section on tobacco diseases in this report.) In any case, the nematode resistant crops must be grown for at least two successive years before noticeable reductions of the nematode are obtained.
Several nematode resistant varieties of cowpeas are available. The best known of these are the Iron and Brabham. The Ootoan soybean is also resistant. None of these possess complete immunity; they will not eliminate the nematode population of the soil and should never be followed by a highly susceptible crop. However, they will produce a good crop where non-resistant varieties would fail because of nematode infestation.

It does not seem to be generally known that the root-knot nematode is easily killed by drying, though this fact has a practical application. At the end of the season the roots of any nematode susceptible crop will contain a large number of eggs, larval and adult nematodes, and the soil immediately around the roots will contain many more. If these roots are removed from the soil and allowed to lie exposed to the wind and sun, all the contained eggs and nematodes will be killed in about one week. The roots should be removed just as soon as the crop is harvested, for this has the advantage of stopping reproduction of the nematodes in the roots at the earliest possible time. (The root-knot nematode is capable of producing a new generation every 30 days and each generation may have several hundred times as many individuals as the preceding one.) The time and trouble expended in removing the roots will be repaid in increase of subsequent crop yields, although it is not to be expected that nematodes can be eliminated entirely in this way.
Tobacco fertilizer experiments.

TOBACCO

FLUE-CURED TOBACCO (AGRONOMY)

Flue-cured tobacco research work at the Georgia Coastal Plain Experiment Station is a cooperative project in which the Division of Tobacco and Plant Nutrition, Bureau of Plant Industry of the United States Department of Agriculture and the University of Georgia College of Agriculture are engaged.

Agronomy investigations include studies of soils, the various plant food elements as they affect stand, growth, yield and quality; rotations as related to yield and quality, and the selection and testing of varieties. The following report is primarily a progress report with general recommendations included for the benefit of growers who wish to use this publication as a reference.

GENERAL RECOMMENDATIONS

Soils: The quality of flue-cured tobacco is closely geared to the type of soil on which it is produced. The finest quality is always grown on light sandy loam soils with bright lemon to light orange colored subsoils. In the Coastal Plain of Georgia the predominating soils of this
type are the Norfolk sandy loams and loamy sands and the light phases of the Tifton sandy loams.

The typical Norfolk sands are too open and low in water-holding capacity to produce tobacco profitably and the typical pebbly Tifton sandy loams are too heavy to produce a fine quality of flue-cured tobacco. Regardless of the type of soil used it should be low lying enough to hold moisture well in periods of temporary drought and yet have sufficient fall to drain well in wet weather. It should be soft and mellow and fairly low in nitrogen reserve.

**Varieties:** The tobacco trade now demands a thin highly colored smoking or luggy type of leaf. Numerous varieties will produce this type of leaf. According to tests, the best varieties for South Georgia are Jamaica, Gold Dollar, Bonanza, Virginia Bright Leaf and Yellow Mammoth. These varieties are much better suited to produce the type of leaf in demand than such varieties as Warne, Gold Leaf, Addcock, White Stem Orinoco and the Gooches which are strictly old belt varieties used to produce an orange colored heavy leaf.

**Seed-Beds:** More tobacco failures can be attributed to improper selection, preparation and care of tobacco seed-beds than to any other causes. A profitable crop can be grown only when uniform, well-grown plants are transplanted to the field at the proper time. When properly fertilized the rate of growth of tobacco plants depends largely on three factors—heat, light and moisture. Seed-bed locations should always be selected with slope to the south or southeast. This enables the sun to strike the beds at a more direct angle, giving more heat to the square foot than other slopes. All shade should be eliminated so that the sun can shine directly on the bed throughout the day.

The best seed-bed soils are the deep loamy, moist soils locally known as “gallberry land.” Soils that have been washed down from an adjoining field are likely to be infested with root-knot.

Sterilization of the seed-bed, if done properly, will control weeds and root-knot. However, definite control of both of these pests requires a rather elaborate set-up on a permanent seed-bed location. Practical control of weeds and root-knot can be obtained by steaming with the pan method when the soil is very dry. Weed control may be obtained by burning brush or any other available material on the soil. Regardless of the method of sterilization used, the heat will penetrate the soil more readily if it is uniformly loosened before the heat is applied. Soil can be effectively loosened by means of a plow stock or soil fork or spade but should never be turned as the turning process puts the top and most fertile portion of the soil out of reach of the shallow feeding roots of the seedling. If sterilization is not to be undertaken, seed-beds should be located on clean new soils every year.

The rate of fertilizing seed-beds will vary with the method of handling. New beds require approximately two pounds per square yard of a plant bed fertilizer analyzing 4–8–3 (NPK), in which all of the potash is derived from sulphate of potash, or some form other than muriate or kainit. Old beds require less because of the residue carried over from previous years.

Seeding should be done in late December or early January at the rate of one well rounded tablespoonful of good clean seed per 100 square
yards. Better stands are obtained when the surface of the beds is left completely smooth so that the moisture will rise evenly to the surface and bring about uniform germination. A rough uneven bed permits the high spots to dry out which prevents seed from germinating, and results in a spotted uneven stand. For this reason it is much better to roll the seed in with a heavy iron or concrete roller than to trample them in by foot. Tobacco seed will not germinate unless the surface of the soil is moist.

During years of heavy blue-mold attacks, much damage is done by the excessive use of nitrogen carrying top dressers such as nitrate of soda and cal-nitro. These materials applied dry, under most conditions, will cause severe burning of the leaf. The only safe way to apply them is in solution. Five pounds of top dresser dissolved in 50 gallons of water applied to 100 square yards of beds, will not burn plants if washed off the plants immediately with another 50 gallons of water. Greater concentrations are likely to burn the plant before it is possible to wash off the solution. Usually one application of five pounds of nitrate of soda per 100 square yards is all that is necessary during a season. However, under no conditions should more than three applications of five pounds each be made to 100 square yards, as a heavy concentration of any soluble fertilizer will kill the plants.

**Fertilizers:** The general conception of fertilizers is that they are plant food mixtures containing nitrogen, phosphorus and potash. This conception has prevailed so long that the importance of other elements of plant foods has been overlooked. Experiments have shown conclusively that no plant can be grown with nitrogen, phosphorus and potash alone. Normal growth of the tobacco and all other plants depends on the presence of many elements, the most important of which, from the standpoint of fertilizer practice, are nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Boron, zinc, copper, iron, manganese and possibly others are required but as far as known at present are usually found in the soil or as impurities in fertilizers, in sufficient quantities. Each of these elements has a definite function in plant life and must be present in the soil in certain quantities if normal plant growth is to occur.

**Nitrogen:** This plant food increases the size of leaves and the intensity of the green coloring of the plant. Excessive applications of nitrogen under flue-cured tobacco, either in fertilizers or as plant residue, increases the size and greenness of the leaf to such an extent that quality is lowered. Nitrogen applications below the minimum requirements of the plant results in a small yellow plant low in yield but of comparatively good quality. The ideal application of nitrogen is one that produces growth combining satisfactory yield with high quality. On average soils 24 to 27 pounds of nitrogen per acre are sufficient, or in terms of field application, 800 to 900 pounds of a fertilizer analyzing 3 per cent nitrogen. On light sandy soils 30 to 33 pounds of nitrogen may be required to produce optimum yields consistent with high quality.

One-third of the nitrogen should be derived from high grade organic nitrogen materials such as cottonseed meal, fish meal or tankage, and two-thirds from a combination of inorganic nitrates and urea or inorganic nitrates alone.
Phosphorus: Phosphorus increases the rate and size of growth and brings about normal ripening. The virgin Coastal Plain soils of Georgia contain very little available phosphorus and, therefore, will produce poor growth if this element is not applied. While 40 pounds of phosphorus (P₂O₅) per acre will apparently produce a normal size tobacco plant, it takes 80 to 100 pounds per acre to produce a plant that will mature and ripen normally. In terms of field applications this would require 800 to 1000 pounds of a fertilizer analyzing 10 per cent phosphorus (P₂O₅). Superphosphate or any other form of readily available phosphorus is a satisfactory source so long as the calcium and sulphur content of the mixed goods is given due consideration.

Potash: The absence of sufficient potash probably does more to lower the quality of Georgia flue-cured tobacco than a deficiency of any other nutritional element. Deficiency symptoms have frequently been observed where 50 to 80 pounds of potash (K₂O) per acre were applied. These symptoms take the form of a bronze-colored leaf-tip high up on the stalk. Extreme potash deficiency symptoms are characterized by reduced growth and rough crinkled leaves that “fire” around the leaf margins and between the veins. The quality is usually lowered in proportion to the increase in the potash deficiency symptoms. Experiments show that potash can be applied profitably at rates as high as 120 to 150 pounds (K₂O) per acre, or in terms of field application, from 800 to 1000 pounds of fertilizer analyzing 15 per cent potash (K₂O).

Practically all potash materials used in fertilizers carry other plant food elements than potash and it is these secondary elements that determine the potash carrier best suited to tobacco fertilizers. Two per cent chlorine is desirable in all tobacco fertilizers and since muriate of potash is a source of chlorine as well as potash, this material should be used only to supply the desired amount of chlorine. Two per cent magnesia (MgO) is also desirable and can be derived from sulphate of potash magnesia in the same way that chlorine is derived from muriate of potash. The remaining potash may be derived from any other water soluble material that does not contain chlorine.

Magnesia: In the absence of sufficient magnesia a bleached appearance occurs between the veins of the lower leaves while the leaf area in close proximity to the veins remain green. This condition is known as “sand drown” or magnesia hunger, and may be so severe as to involve the whole plant and completely destroy the quality of the leaf. Magnesia hunger is quite often called “sun burn” in the Georgia flue-cured belt, and is more prevalent than generally believed. To avoid this trouble it is recommended that all tobacco fertilizers carry 2 per cent magnesia (MgO), one-half of which should be water soluble. Sulphate of potash magnesia or other sulphates of magnesia may be used for the water soluble portion and dolomitic limestone for the water insoluble portion of the magnesia supply.

Chlorine: Small quantities of chlorine increase the spread of leaf, vigor and resistance to drought of the tobacco plant. However, excessive quantities deprecate the burning qualities of the leaf, and under drought conditions, will reduce growth and cause the leaf to become thick and fleshy and curl inward around the margins. The amount and source of chlorine has already been discussed under potash.
Animal Manures: These materials are valuable supplements to the regular fertilizer application when used properly. Manures (cow or horse) should be well rotted and finely pulverized, and should be applied in the drill at the rate of two to three tons per acre at least two weeks before applying the commercial fertilizers. After the application has been made, the row should be covered lightly and left. The commercial fertilizer should be distributed in the row with the manure and mixed well with the soil before listing. Where manure is applied at the above rates, no reduction in the amount of commercial fertilizer should be made.

Fertilizer Formulae and Rates of Applications: From the foregoing discussion of the various plant food elements, it becomes evident that flue-cured tobacco fertilizers should contain certain elements in definite proportions. The proportions of these elements should be approximately 3 parts nitrogen, 10 parts phosphorus (P₂O₅), 10 to 15 parts potash (K₂O), 2 parts magnesia (MgO), and 2 parts chlorine (Cl). These proportions are pounds per hundred of mixed goods or percentages. The mixed goods should, therefore, contain 3 per cent nitrogen, 10 per cent phosphoric acid, 10 to 15 per cent potash, and 2 per cent each of magnesia and chlorine. The rate of application of such a fertilizer should be from 800 to 1000 pounds per acre, depending on the fertility of the soil.

Spacing in Drill and Row: All attempts to increase yields by close spacing, both by placing rows closer together and the plants closer together in the drill, have given negative results. There are no advantages in spacing rows closer than four feet apart and the plants closer than 22 inches in the row. When spaced closer than this, the plants are highly susceptible to drought damage due to the keen competition for moisture. The stalks grow small and spindly and the leaves are small and thin.

Topping: The tendency among growers to leave the top in the plant seems to become more prevalent each year. With abundant rain, plants that are not topped may make fair quality tobacco. However, such plants have a high rate of transpiration and require much more moisture than topped plants which is a decided disadvantage during dry weather. It is, therefore, advisable to always top the plants except where individual plants become excessively rough.

Curing: So many factors are involved in curing tobacco that no fixed set of directions will apply to all curings. A mimeographed article on curing, which goes into considerable detail regarding these factors, has been prepared by the Station and may be had upon application.

PROGRESS REPORT OF 1938 WORK

Much of the tobacco work was continued as in 1937. However, since many of the tests with various fertilizer materials, rates of fertilizer applications and fertilizer formulas begun in 1933 had covered a period of five years, they were replaced with new work in 1938. This new line of work was set up on the basis of plant food elements rather than plant food carriers or fertilizer materials. Essentially it is a study of the balance that should exist between the plant food elements in bright tobacco fertilizers. It is not confined to the three primary elements—nitrogen, phosphorus and potash—but lays particular emphasis on the
secondary elements—calcium, magnesium and sulphur. Since in most mixed fertilizers these secondary elements are contained in quantities several times that of the primary elements, sound conclusions as to the cause of certain fertilizer results cannot be drawn without consideration of all the elements involved. The whole fertilizer make-up, as well as its effect on the soil reaction, must be considered.

**Complete Fertilizer Tests:** These tests involve the omission and varying rates of application of potassium, sulphur, calcium and magnesium, and the omission of chlorine and boron. Results continue to show evidence that there are certain ratios that should exist between all of the plant food elements in tobacco fertilizers. The efficiency of any given element is not dependent upon the amount present but upon its balance with all of the other complementary elements.

**Potash and Sulphur Relation Tests:** In these tests there are indications that with a constant sulphur application, increased potash applications tend to delay flowering and maturity. With sulphur (SO₄) applications of from 100 to 125 per cent of the potash (K₂O) application, there is practically no delay in flowering or ripening with increased potash applications.

**Calcium and Magnesium Tests:** Large quantities of soluble calcium and magnesium tend to delay growth when applied with a constant application of all other elements. Increasing the sulphur application apparently will offset this delay.

**Acid, Basic and Neutral Fertilizers:** Slightly acid or neutral fertilizers are apparently superior to basic fertilizers on the particular soil on which these tests are located. In these tests the basic fertilizers tend to make a heavy green growth similar to that produced with heavy applications of soluble calcium and magnesia.

**Fertilizer Placement Tests:** When placed close to the root system of tobacco seedlings fertilizer will cause a large percentage of the plants to die. When wet weather prevails for some time following transplanting, this trouble is less severe. However, under all conditions the loss of plants is greater than when the fertilizer is placed to the side of the roots or mixed well with the soil. In the absence of suitable machinery for the side placement of fertilizers, it is recommended that all tobacco fertilizers be mixed well with the soil before listing and transplanting. Placing all of the fertilizer on one side of the row resulted in many one-sided plants as well as distinct signs of potash deficiency on the side of the row that did not receive any fertilizer.

**Topping and Spacing Tests:** This series of tests includes two rates of fertilizer applications with plants spaced 36, 24, 18 and 12 inches apart, in rows 48 inches apart. On each of these combinations the plants are topped at 8 and 16 leaves with one series not topped at all. The damage from drought increases as the number of leaves per acre is increased, while the coarseness of leaves increases as the number of leaves per acre is reduced. Where the plants were spaced 12 and 18 inches apart in the row and not topped, very little tobacco of marketable quality was produced. The optimum spacing and topping seemed to be approximately
24 inches in the row and 16 leaves per plant. The series topped at 8 leaves produced only heavy coarse leaves except where spaced 12 inches apart.

Boron Tests: Treatments receiving .75 and 3.50 pounds of boron per acre in addition to a basal fertilizer application of complete fertilizer, resulted in a slight toxic effect with the lower rate treatment and a decided toxic effect on the 3.5-pound treatment. The toxic effect was characterized by delayed early growth with consequent low yields and late maturity. No boron deficiency symptoms were observed on plants receiving no boron.

FLUE-CURED TOBACCO DISEASES

The 1938 plant-bed season was more favorable for tobacco plant production than the preceding one. Damping-off caused by Rhizoctonia and Pythium resulted in only slight damage to the very small seedlings. Blue mold (Peronospora tabacina) was the most important plant-bed disease. Due to an unusually warm January and also to a large number of very early beds sown in old locations, blue mold recurred at an alarmingly early date. First symptoms were observed in two old beds in Cook County on February 2, and during the following week the disease was reported in a number of old beds in widely separated points over the flue-cured belt. The peak of mold activity was reached in the majority of beds during the first half of March. However, abnormally warm weather in March brought temperatures too high for maximum disease damage, with the result that the 1938 outbreak was much less prolonged and less severe than that of 1937. Plants affected in February were killed in large numbers while those attacked in March were not so severely damaged. Approximately 25 per cent of the plants in unsprayed beds were killed by mold, while the loss in sprayed beds was negligible.

Early seeding and the mild winter were responsible for seedlings reaching transplanting size two weeks earlier than normal. In some instances plants were large enough to set before the first of March. A large portion of the crop had been set by the first of April. The spring season was marked also by dry weather which would have hampered transplanting considerably had the crop been set late. With early setting, however, good stands were secured despite deficient rainfall; and the tobacco roots became established in the soil before the advent of hot weather. Dry weather persisted in some sections throughout the Georgia belt, but due to early establishment of the crop, good yields of fair quality tobacco were secured.

The most important field disease in 1938 was root-knot (Heterodera marioni) which caused an estimated loss of 4 per cent. This loss was well under the 15-year average. The disease became most pronounced during early June following a series of light showers. However, with subsequent drought and showers alternating, there was little further root-knot development. Therefore, this disease was less severe than was indicated earlier in the season. The second most important field disease was sore shin or Southern root-rot (Sclerotium rolfsii) which caused an estimated loss of between one and two per cent of the crop.

Granville wilt (Bacterium solanacearum) was not observed in any field despite the fact that it had been slightly increasing during the three preceding seasons. Only a few stalks of Fusarium wilt (Fusarium oxy-
sporium var nicotianae) were observed in commercial fields, although the disease was very destructive in one test field at Tifton. Black shank (Phytophthora parasitica var nicotianae) also was a minor disease of flue-cured tobacco, only a few affected plants being observed, except in the shade district of Southwest Georgia where it is most prevalent. While mosaic (virus) and ring-spot (virus) were seen occasionally, these diseases were of no importance in 1938. Likewise, frog-eye leaf spot (Cercospora nicotianae) was unimportant, although it was present in most fields. This disease is seldom severe except on late tobacco. Early in the season occasional leaf spotting caused by the blue mold fungus developed on a few of the lower leaves, but these spots were hardly numerous enough to be noticeable.

Disease studies have been confined primarily to development of practical control measures for blue mold and root-knot. A tobacco breeding project was begun in 1937 the object of which is to breed a desirable type of tobacco that is resistant to root-knot and other diseases that often appear in the field.

Blue Mold (Downy Mildew) Control: Several methods for controlling blue mold have been developed in recent years, any one of which gives adequate protection when properly used. The two methods that have received most attention are (1) spraying with cuprous oxide and cottonseed oil emulsion and (2) gassing with benzol or paradichlorobenzene. Of the two, spraying has been demonstrated to be the cheaper and more practical under Georgia conditions, and is the method generally recommended at present.

Blue Mold Control by Spraying: This method involves spraying the tobacco plants twice a week, beginning before mold infection occurs in

*At left, perfect stand protection was secured by spraying. At right, blue mold killed 41% of the tobacco plants and delayed transplanting one week.*
the plant-bed and continuing until the plants are ready to set, or if affected, until after they have subsequently recovered. Usually 9 to 12 applications are ample for average seasons. While this treatment does not entirely prevent infection, it reduces disease intensity to the point where few if any plants are killed, and enables plants to recover rapidly and develop resistance to further mold attack. Spraying can be safely discontinued after the initial attack has occurred on all the plants. Thus it is not often necessary to continue treatment until the plants are ready to set, except in instances of delayed outbreaks. Sprayed plants live well in the field, even when set at the time mildew is present in the plant-bed.

Tests made during the last three seasons have shown that yellow cuprous oxide is superior to the standard red copper oxide. Therefore, the yellow oxide is recommended for future use. Yellow cuprous oxide powder is manufactured for spraying purposes and this powder\(^1\) form may be used; or if desired, the regular home-made yellow copper oxide solution may be substituted.\(^2\) See directions in foot-note for preparing this solution.

Either crude or refined cottonseed oil may be used. The ordinary brands of cooking oil are satisfactory providing these are substantially all cottonseed or soybean oils. One brand of cottonseed oil containing an emulsifying agent has been distributed and this Self Emulsifying Cottonseed oil has been found to give satisfactory results. Several emulsifiers have been tested: Lethane Spreader, Dreft, Orvus and Vatsol OTC, being the most promising. With the new form of yellow cuprous oxide powder and the home-made copper solution, there is no necessity of mixing any spreader directly with the copper since both these forms will go readily in suspension with water. The only need for the emulsifier is to emulsify the oil. The cost of these materials is no greater than that for the old forms, except that the Self Emulsifying Cottonseed oil is more expensive. Either one of the two following formulas may be used, or a combination of them, with satisfactory results. Any amount of spray may be made at one time but it is not advisable to make more than will be required for one application, since the mixture will not keep.

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\(^1\) One tested brand of yellow cuprous oxide is distributed under the name CUPROCIDE 54-Y.

\(^2\) A home-made yellow cuprous oxide solution may be made easily on the farm by mixing bluestone, syrup, and lye according to the following directions. These directions are for mixing two gallons of solution. By using the same formula any amount up to 50 gallons may be prepared at one time. Use earthen or wooden containers. Dissolve two pounds bluestone in one gallon of warm water. Add one quart cheap syrup. Dissolve 13 ounces lye in 2½ quarts of water (One 13-ounce can Red Devil or other lye containing about 75% sodium hydroxide) and pour this into the bluestone-molasses solution, stirring thoroughly. Let stand a few days before using or until the green paste turns to a yellow suspension. Enough may be made up at one time to last through the spray season, but it is not advisable to attempt to keep it longer than three months unless proper storage facilities are available. Use three quarts of this solution to each 25 gallons of spray instead of the six ounces of yellow cuprous oxide powder. Since the yellow copper tends to settle to the bottom, stir the contents thoroughly before dipping any out for use. This solution should be used with the oil emulsion prepared in the regular manner.
FORMULA No. 1:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Amount for 25 Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow Cuprous Oxide Powder (Cuprocide 34-Y)</td>
<td>6 ounces</td>
</tr>
<tr>
<td>Vatsol OTC, or other recommended emulsifier</td>
<td>4 ounces</td>
</tr>
<tr>
<td>Cottonseed or Soybean oil (crude or refined)</td>
<td>1 quart</td>
</tr>
</tbody>
</table>

FORMULA No. 2:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Amount for 25 Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-made Yellow Cuprous Oxide Solution (see foot-note No. 2, Page 123 for preparation)</td>
<td>3 quarts</td>
</tr>
<tr>
<td>Vatsol OTC, or other recommended emulsifier</td>
<td>4 ounces</td>
</tr>
<tr>
<td>Cottonseed or Soybean oil (crude or refined)</td>
<td>1 quart</td>
</tr>
</tbody>
</table>

Use four ounces of Vatsol OTC powder to 25 gallons in soft water or six ounces in hard water. If this powder is not available, one pint of Lethane Spreader, or six ounces of Drelf, or six ounces of Orvus may be substituted in each 25 gallons of spray. If Self Emulsifying Cottonseed (SEC) oil is preferred, no emulsifier will be required. Use one quart of SEC oil with six ounces of yellow cuprous oxide powder, or with three quarts of home-made yellow cuprous oxide solution.

In preparing the above mixture, emulsify the quart of oil (if for 25 gallons) with the full amount of spreader. First mix the spreader (emulsifier) with a small amount of water, add the oil and pump the mixture through the spray nozzle to produce a stable emulsion. Add this emulsion to the spray tank with water until almost the full volume is reached. Then stir the copper into a bucket of water and pour this into the diluted oil emulsion. Stir well and use immediately after mixing.

Approximately five gallons of spray are required for each 100 yards of plant-bed when the plants are half large enough to set. However, two to three gallons per 100 yards at each application will be sufficient early in the season when the plants have only four or five leaves. Where good pressure is available from the spray pump, the plants may be sprayed directly through the cloth, particularly when the seedlings are small. Later in the season when the plants are larger and there is no danger of frost, it usually is best to remove the cover before spraying.

The most important thing to remember about spraying is that success of the method depends on starting applications well in advance of the attack. In areas where outbreaks usually appear early, especially in warm winters, it may be advisable to begin spraying when the plants reach the four-leaf stage. In more normal seasons it may not be necessary to begin until the largest plant leaves are an inch or more in diameter. The exact number of applications will determine the exact cost of the method. Over a five-year test period under farm conditions, the cost of 12 applications each season, including ample allowance for depreciation on good hand sprayers, did not exceed $2.50 per 100 square yards.

Blue Mold Control by Gas Treatment: This method is described briefly for the benefit of those who may prefer some other method than
spraying. It requires some changes in present plant growing practices and is about five times more expensive than spraying. On the other hand it is a more effective treatment in controlling blue mold when properly done. But unless the necessary preparations are made for proper treatment the method may be even less effective than spraying. Therefore, due care must be exercised in building the bed sidewalls reasonably gas-tight and in fitting heavy covers on the bed to hold in the vapors. Essentially the method involves the building of tight sidewalls around small beds, provision of extra heavy cloth covers in addition to the regular bed cover, and the evaporation of certain volatile substances underneath these covers several nights each week during the mold outbreak. The gas materials most commonly used in test work are benzol (liquid) and paradichlorobenzene (crystals).

Board sidewalls 8 to 10 inches high and nailed tightly at the corners, have been more satisfactory than logs. Cross supports tacked across the bed every few feet will serve as a brace to hold up the heavy covers. These supports should be arched several inches higher than the sidewalls, or held up by posts in the center of the bed to prevent sagging of the cloth. The extra cover, containing from 50 to 65 threads per inch, should be sewn in one piece and made somewhat larger than the bed to allow for shrinkage and overlapping at the sides. Beds not over 12 feet wide and less than 40 feet long are more satisfactory than large ones.

Benzol may be evaporated from shallow pans spaced equidistant, about six feet apart inside the bed, and several inches above the ground level. From 18 to 25 pie plates or shallow cake pans will be sufficient for each 100 yards of bed area. Roughly, the pan area should be approximately one-hundredth of the total bed area. Between four and five quarts of benzol, equally distributed among the pans, should be poured into each 100 yards of bed area each night of treatment. The pans should be charged just before sundown and the heavy covers pulled over the bed immediately afterward. These covers should be removed the next morning before nine o'clock. If all the benzol does not evaporate, place a wad of cotton cloth, about the size of a pocket handkerchief, in each pan, and keep this in place during the night to serve as a wick and hasten the rate of volatilization. Good results have been obtained with three treatments each week during the mold outbreak. Any three convenient nights will be satisfactory. Treatments usually have to be continued from three to eight weeks, depending on the duration of favorable blue-mold weather.

Paradichlorobenzene crystals applied at the rate of two pounds per 100 yards of bed area three nights a week may be used instead of benzol. The material should be used in the same type of bed required for benzol treatment, except that the crystals may be applied in a variety of ways. One of the most practical methods of applying paradichlorobenzene is to broadcast the crystals on cheesecloth strips three feet wide tacked across the bed every 15 to 18 feet. The cloth strips should have as many as 28 threads per inch to prevent the crystals from falling through and injuring the plants. They may be tacked a couple of inches underneath the regular cover or laid flat on top of the cover. If the regular plant-bed cover contains 28 threads per inch, the crystals may be broadcast
on top of the cloth, after which the heavy cloth may be carefully pulled over. Since such covers might exclude too much light in some locations, the cloth strip evaporators are to be preferred. The strips may be removed during the three or four days of each week when treatments are not being applied. Beds may be treated any three nights during the week, although it is best to avoid extremely cold and windy nights. In warm weather do not treat the beds until sundown, and remove the heavy covers immediately after sunup. This precaution is necessary to avoid serious plant injury. Paradichlorobenzene is more likely to cause plant injury than benzoil.

Gas treatments applied more often than three nights a week often result in spindly, weak plants. During mild outbreaks it will be possible to secure good control with only two treatments a week during the blue-mold season.

Blue Mold Control by Cultural Practices: Where no positive control measure can be adopted, the sowing of two or three times the usual bed area sometimes is sufficient to guarantee a supply of plants. However, this practice cannot be depended upon in seasons of prolonged severe epidemics.

The universal practice of sowing new beds or of sowing old beds somewhat later than normal, and of destroying all tobacco beds each spring after the close of the transplanting season, will be of considerable value in delaying early outbreaks and in reducing the cost of control by spraying. The first outbreaks each winter invariably occur in old beds or on volunteer plants in discarded beds of the preceding season. The ill-advised practices of sowing old beds early and of permitting plants to grow in discarded beds are responsible for the early establishment of mold during mild winters.

Root-Knot Control by Cultural Practices: Selection of new sites for plant-beds is the most practical method of preventing root-knot development in seedlings. The bed should be located in a new place that has not been subjected to surface drainage water from nematode infested fields. Clean cultivation of beds during the summer and fall or the growth of velvet beans turned under in early fall will enable growers to use the same bed several years in succession.

Rotation of tobacco with nematode resistant crops is the most practical method of preventing excessive losses in the field. In heavily infested areas it is not advisable to plant tobacco on the same land more often than once in three years. Four-year rotations are sometimes advised. Peanuts and oats are the two most nematode resistant of the more common field crops in South Georgia. Where oats precede tobacco it is advisable to permit weeds to grow after the grain has been cut and to turn the weed crop under early in the fall. Where peanuts precede tobacco, the Spanish varieties are advised. These should be harvested rather than "hoggied off." Peanuts the first year, oats followed by weeds the second year and tobacco the third year is a good three-year rotation.

Corn, cotton, Iron peas and Brabham peas are not always resistant enough to nematodes to be safe in tobacco rotations, although they may be included at times in the cropping system with safety. In the absence of root-knot, good quality tobacco can be grown after cotton and corn and also where tobacco is grown on the same land every year. The lat-
ter practice is not advised, however, except in occasional fields where additional cultural and sanitary measures are carried out. These measures include the plowing out of tobacco stalks immediately after harvest and exposing the roots to the sun, and of turning the land several times from August to November. Where these practices are followed it is often possible to escape severe root-knot damage in rotations that might otherwise be unsafe. Additional benefits can be obtained where the roots of the rotation crops are plowed out and exposed to the sun in the same manner as tobacco roots.

SHADE TOBACCO STATION

The shade tobacco (cigar wrapper) work is being carried on at the Shade Tobacco Experiment Station near Attapulgus, Georgia, in Decatur County. The experiments in progress include (1) nutrition tests or plant food tests, (2) seed production for growers, (3) breeding and selecting for disease resistance.

AGRONOMY WORK

Nutrition Tests: The object of this work is to determine the optimum ratio between various elements of a shade tobacco fertilizer, the most profitable ratio between organic and inorganic nitrogen, the effect of varying rates of animal manures, the best sources of organic nitrogen and phosphorus, and a comparison of certain fertilizer formulas.

Four acres of Tifton fine sandy loam soil were provided with shade in the spring of 1938, and 120 one-fortieth acre plots consisting of 60
duplicate treatments were established. Cultural practices, method of harvesting, curing, sweating and grading closely approximated those in common use in this area. Notes were frequently taken during the growing period to record visible differences in the type of growth caused by the treatments. All necessary records of grades were taken during the grading period to make quality comparisons from the standpoint of grading. Further tests were made on the finished product, to determine differences in the burn and ash characteristics arising from the fertilizer treatments. The final value of the leaf is thus reflected in the grade index, burn, ash-color and characteristics, taste and aroma.

A shade tobacco fertilizer formula in common use in this area forms the basis for treatment comparisons. This formula carries 250 pounds of nitrogen, 250 pounds of phosphorus ($P_2O_5$), 300 pounds of potash ($K_2O$), 100 pounds of calcium (CaO), 20 pounds of magnesium (MgO), and 125 pounds of sulphur ($SO_2$) per acre. In determining the optimum amounts and ratios of these elements, each is varied in turn from a point below the standard amount to a point well above it.

These tests are of only one season’s duration and insufficient data are at hand to justify fertilizer recommendations. However, the following trends within the plant food series were noted.

**Nitrogen:** This element (N) was varied from 150 to 300 pounds per acre with the most profitable application appearing to be the 200-pound per acre treatment. It should be borne in mind, however, that 1938 was a relatively dry year and that conditions were such that it was not practical to allow sufficient time between fertilizer application and plant setting. Due to this latter complication, fertilizer injury was evident on many treatments, particularly on the higher rates of the nitrogen series. There was a marked increase in plant mortality as the nitrogen rates were increased from 200 to 300 pounds per acre with a corresponding decrease in yield and quality. It was also noted that the fire holding capacity of the leaf decreased materially with each nitrogen increase.

**Phosphorus:** Phosphorus ($P_2O_5$) was varied in four rates from 100 to 350 pounds per acre. The 350-pound treatment was superior to the lower rates in producing a much better stand of plants and correspondingly better yields. Only very slight differences were noted in the quality of the leaf within this series. However, the ash character and fire holding capacity was decidedly better on the lower rate treatments.

**Potash:** The range for potash ($K_2O$) was from 150 to 350 pounds per acre, the optimum amount of which appeared to be the 200-pound treatment. The yield per acre was consistently reduced as the rate of application was increased above the optimum. There was also a reduction in stand of plants, grade index and fire holding capacity with the higher rates of application for this nutrient.

**Calcium:** Calcium (CaO) was varied in four increments from 50 to 300 pounds per acre. The 50-pound per acre treatment was somewhat superior to other rates from the standpoint of yield and fire holding capacity. Higher rates affected stand, grade index and ash quality very little but reduced the fire holding capacity somewhat.

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$^3$Grade index is a measure of value from the standpoint of quality based on the visible characteristics of the leaf. A grade index of 1000 would indicate a perfect crop with every leaf of the highest quality.
Magnesium: This nutrient (MgO) was varied from 20 to 100 pounds per acre. The 60- and 80-pound treatments showed a decided advantage over other rates from the standpoint of yield, grade index and ash color. The 100-pound rate reduced the stand, yield and grade index, but showed an excellent fire holding capacity. This treatment also failed to produce a very desirable ash color.

Sulphur: The sulphur series included four applications ranging from none to 250 pounds SO₃ per acre. Except for fire holding capacity, the highest rate of application proved to be the best for this nutrient. The next highest rate (170-pound treatment) showed a fire holding capacity which is considered fair, while the highest rate reduced this property markedly. All treatments in this series showed a darker ash than was generally observed throughout the various tests. The sulphur treatments also showed little consistency with reference to ash quality. The higher rates of application showed better stands of plants than the lower rates.

Boron: Boron was applied at rates of 0.5 and 4.0 pounds per acre. Results indicated that there is no boron deficiency present in this soil, in that the higher rate reduced the stand, yield and grade index to some extent. However, the higher rate treatments showed a superior fire holding capacity and less flakiness of ash than the lower rate.

Chlorine: Chlorine was applied at only one rate, namely, 20 pounds per acre. The stand was moderately good here; however, the yield and grade index were somewhat below average and the ash heavily flaked (poor) and dark in color. The leaf burned or held fire moderately good.

Varying Ratios of Nutrients: Combining phosphorus (P₂O₅), magnesium (MgO) and sulphur (SO₃) and potash (K₂O), calcium (CaO) and sulphur in different ratios, failed to show any advantages over the single nutrient variations in that a dark ash was invariably obtained. However, when 60 to 100 pounds of magnesium (MgO) was included in a ratio of 200 pounds phosphorus (P₂O₅) and 300 pounds calcium (CaO), a very desirable ash color of good quality (little flakiness) was obtained. A two to one ratio of potash (K₂O) and calcium also gave excellent ash color and quality.

Varying Ratios of Cottonseed Meal Nitrogen, Nitrate and Urea Nitrogen: These treatments consisted of combining cottonseed meal nitrogen, nitrate and urea nitrogen in various proportions to determine the effects on yield, leaf quality and ash. Best results in this group were obtained when 75 per cent of the total nitrogen was taken from cottonseed meal and 25 per cent from nitrate nitrogen. Very poor results were obtained when 50 per cent of the nitrogen was taken from cottonseed meal and 50 per cent from urea nitrogen. This treatment gave a very poor stand of plants, accompanied by a low yield; however, the fire-holding capacity of the leaf was exceptionally good as was also the case when all nitrogen was taken from cottonseed meal. Other tests in this series gave intermediate results between these extremes.

Manure Tests: Stable manure was applied at rates of 6, 12 and 18 tons per acre, in addition to other nutrients, in sufficient quantities to bring the total plant food up to the normal or standard treatment. No significant differences were noted in the results of these tests except that the higher rate of application slightly improved the yield and stand of plants.
Organic Nitrogen Tests: In these tests the total nitrogen was taken from each of the following sources: Whale guano, soybean meal, castor pomace, tung oil pomace, peanut meal and cottonseed meal. Tung oil pomace and cottonseed meal proved to be the best single sources of nitrogen. Of these two sources, tung oil pomace was superior to cottonseed meal in producing a better stand of plants, better fire holding capacity and ash color, while cottonseed meal was slightly superior to tung oil pomace in yield and grade index. Whale guano was the next best source of nitrogen followed closely by peanut meal and castor pomace. Soybean meal reduced the stand of plants and gave a poor burn and ash test.

Phosphate Sources: In these tests, 180 pounds of the total 250 pounds (P₂O₅) were taken from the following individual sources: Basic slag, steamed bone meal, dicalcium phosphate and superphosphate. Each of these treatments reduced the yield and stand of plants somewhat; hence the main differences showing up were in the grade index, fire holding capacity and ash color and character. Basic slag was somewhat superior to superphosphate in these latter effects, the only objection to superphosphate being that it produced a dark ash. Dicalcium phosphate and steamed bone meal were inferior to basic slag and superphosphate with little to choose on the whole between these two sources. Steamed bone meal showed somewhat better fire holding capacity than dicalcium phosphate, but the latter gave a better stand of plants and ash color than the former.

Formula Tests: In these tests a typical Connecticut shade tobacco fertilizer formula was compared with the typical Georgia formula. The Connecticut formula carries considerably less plant food, especially phosphorus, than the Georgia formula. No significant differences were noted in comparative results of these tests except for the higher grade index obtained from the Georgia formula.

Seed Production: One acre was planted in Rg shade tobacco for seed production. This work was carried on in the sun. The flowers of plants showing vigor and desirable type of growth were bagged to prevent crossing with other varieties near the location. These seed were used to supply growers in this area. This work is also being continued.

SHADE TOBACCO DISEASES

Black shank (Phytophthora parasitica var nicotianae) and root-knot (Heterodera marionii) are the two most destructive diseases of shade tobacco. Several acres of isolated soil have been selected to carry on pathological experiments for breeding and selection of disease resistant varieties to these two diseases.

Instead of laying off plots, the entire field was planted with hybrids and varieties in 1938. There were sixty-five hybrids and varieties planted and these were inoculated with black shank to make sure the disease would be present in the soil for future crops. It was found after examination of the plant roots, that root-knot nematodes were abundant in the soil.

Plot work will be started next season. Several different rotations will be carried on to determine the effect rotations have on the control of diseases. Other experiments will be conducted, namely, dates of plant-
ing and other cultural practices to determine the effect on disease control and quality of tobacco, chemical treatment of the soil against diseases that might be present, and continuation of breeding and selection of disease resistant varieties.

REPORT OF FIELD STATIONS IN McINTOSH COUNTY

The work at the field stations in McIntosh County is carried on in cooperation with farmers who own and operate their farms. These stations are so located as to represent the more productive soil types of the county.

The soils where the experiments are conducted can be divided into two groups, namely, (1) the delta soils which are made up of an alluvial deposit known as Altamaha clay, and (2) the upland soils composed of Bladen sandy loam, Eulonia fine sandy loam, and Blanton fine sand.

Tests on both delta and upland soils include vegetable variety tests, vegetable planting dates and several phases of Iceberg lettuce production.

Variety Tests of Winter Vegetables on Upland and Delta Soils

Beets: Crosby’s Improved Egyptian appears to be superior to Detroit Dark Red and Edmond’s Early Blood Turnip.

Broccoli: The Green Sprouting variety is superior to the heading type.

Cabbage: Included in this test are the following varieties: Copenhagen Market, Wisconsin Hollander No. 8, Chihilli, Drumhead Savoy, Golden Acre, Stein’s Early Dwarf Flat Dutch, Succession, Charleston Wakefield, Wisconsin All Season, and Marion Market. Copenhagen Market and Charleston Wakefield are showing to better advantage than other varieties.

Carrots: Chantenay, Oxheart, Red Cored Chantenay, Danver’s Half Long, and Imperator constitute the list of varieties under study. Chantenay and Imperator, because of their long slender roots, are superior for market purposes.

Cauliflower: Snowball, Autumn Giant, and Dwarf Erfurt varieties are being tried. This vegetable does not appear to hold much promise as a commercial crop.

English Peas: Improved Telephone, Thomas Laxton, Extra Early Alaska, and Dwarf Telephone, or Daisy, are the varieties being tried. Improved Telephone and Thomas Laxton are producing higher yields of superior quality peas.

Lettuce: Early green curled kale appears to be well adapted to coastal Georgia.

Lettuce: The varieties and strains of Iceberg lettuce used in this test are: Imperial 847, Imperial 615, Imperial 515, Imperial D, Imperial 152, Ferry-Morse 44, Casberg 609, Casberg 214, Kilgore’s Improved Florida Iceberg, and J. E. Knott’s Imperial 44.

Several of these strains of lettuce have been tried only one season. Casberg strains 609 and 214 did not appear to be adapted to this soil and climate. Imperial 847, Ferry-Morse 44, and J. E. Knott’s Imperial 44 were definitely more productive than the other strains.