**Chestnuts:** Blight resistant varieties of chestnuts are showing vigor and adaptability in the trial grounds but produce fruit of seemingly low quality.

**Persimmons:** Persimmons are attractive, of fair quality, and mature when there is a scarcity of fresh fruit in the home orchard. Consequently it is considered of value for home use. Due to disease, persimmon trees are relatively short lived, which will necessitate frequent plantings.

**Other Fruits:** Cherries, walnuts and quince are poorly adapted. Although some varieties are still surviving they are of little or no value. Among the fruits that have shown the least evidence of adaptability are: apricots, hazlenuts, prunes and raspberries.

**NEMATOLOGY**

Studies of the plant parasitic nematodes of this section were conducted in cooperation with the Division of Nematology, Bureau of Plant Industry, United States Department of Agriculture.

**CONTROL OF ROOT-KNOT BY CHEMICALS**

Information derived from experiments indicates that chloropicrin (or tear-gas) is the most efficient chemical yet found for control of the root-knot nematode (*Heterodera marioni*). Many other chemicals have been tested, but were found to be either ineffective or too dangerous for general use. Chloropicrin has the disadvantage of being too expensive for field use, but has a very definite place in control of root-knot in small areas such as greenhouses and seed beds.

Chloropicrin is a colorless liquid with a specific gravity of 1.63. It vaporizes easily and the vapor is extremely irritating to the eyes, causing them to water profusely. Larger concentrations taken into the lungs cause violent coughing. However, these effects are produced by concentrations far below the lethal point and are only temporary. It is not inflammable or explosive. If the user transfers it from one vessel to another only in the open air and takes ordinary precautions, it is not particularly dangerous to handle.

Chloropicrin is used by injecting small amounts into the soil at regular intervals. In the soil, the chloropicrin vaporizes and permeates the soil mass, killing the nematodes.

Certain precautions must be taken and the soil must be in the proper condition if good results are to be obtained.

The soil must be loose—that is, plowed and leveled. It must be free of lumps, clods and undecayed roots. It should be moist—neither very dry nor very wet—and as warm as possible. Good results cannot be obtained if the soil temperature (at a depth of one foot) is less than 65° F.

Since chloropicrin is disagreeable to handle, some sort of special applicator is necessary to inject it into the soil. Applicators measure the doses accurately and the larger models also automatically inject the chemical into the soil. Improvised applicators can be made which will measure the doses which can then be placed in prepared holes. Where any considerable area is to be treated, a commercial applicator will be a good investment.
The area to be fumigated is marked with parallel lines 12 inches apart and these lines are crossed at right angles with a second set of parallel lines 14 inches apart. Lines are made with a small row marker and should be accurately located. The soil surface is then sprinkled lightly with water. The applicator is adjusted to deliver the proper amount and the depth gauge set at 6 or 8 inches. The actual application is made by thrusting the point of the applicator into the soil and delivering the measured amount of chemical, or by pouring the measured amount into prepared holes. The holes are filled with soil after the chemical is placed. Applications are carefully located as follows: Working along the 12-inch lines one dose is placed at the intersection of these lines with the 14-inch lines on the first row. On the second row, the doses are placed midway between the intersection of the lines. The operation is repeated, the doses being placed on the intersection of the lines and halfway between the intersections on alternate rows until the full area is treated.

When 200 or 300 square feet have been covered, the soil is raked smooth and again sprinkled with water. Enough water should be used to wet the top inch or so of the soil. This prevents the too rapid diffusion of the fumes into the air and so greatly increases the efficiency of the chemical.

After the whole area has been fumigated it should remain undisturbed for at least one week before planting. Even then it should not be planted if any odor of chloropicrin remains in the soil, for the chemical is very poisonous to plants and even a trace remaining in the soil will prevent germination of seed or injure seedlings. Chloropicrin should never be applied to the soil within two feet of the roots of any plant.

Amounts of chloropicrin to be used and its spacing will vary somewhat under different conditions. Experiments in sandy loam soil have indicated that root-knot can be effectively controlled for one season by the use of 1.5 to 3.0 cubic centimeters per application point with spacing as above. This corresponds to 150 to 300 pounds per acre. Under other conditions larger doses may be needed or the spacing should be varied. It is recommended that users make preliminary trials with varied dosages and spacings before making extensive applications of chloropicrin. Dosages might be varied between 1.5 and 4 cc., and spacing of 9 by 10.5 inches be tried as well as the above 12- by 14-inch spacing.

In fact, it should be emphasized that soil fumigation may or may not produce worth while results and that the only way the user can be sure is to make a trial under his own conditions. Where nematode infestation is severe and a crop highly susceptible to nematodes is to be planted, good results can be expected if the conditions are right and the application is carefully made, but the user should also be prepared for total failure and should insure against it by making small preliminary applications.

Much the same technique may also be used to fumigate small lots of potting soil. The soil should be placed in a box and a 5 to 10 cc. dose of chloropicrin placed in the center of each cubic foot.

A variation of the application of chloropicrin for control of nematodes is being explored. This is the so-called "spot treatment" which can be used in the field on crops which are planted in widely spaced hills. In this case,
the whole area need not be treated, but only the small portion of the soil occupied by the roots of the plants. The hills are carefully located and the injections made on the same spot as will be later used for planting. Preliminary tests have indicated that spots so treated will remain free of root-knot for more than three months in many cases and that severe root-knot can be prevented in nearly all cases. With a crop such as watermelons, large areas can be protected from root-knot at a very low cost.

This Station will be pleased to furnish further information on the subject on request.

**SPREAD OF ROOT-KNOT**

Experiments have shown that the root-knot nematode spreads very slowly by its own efforts. Even under the best of conditions, the nematodes will spread from an infested area at the rate of little more than one foot per month. This applies both to progress along continuous rows of plants and to migration through bare soil. It is obvious that other agencies are much more important in the distribution of nematodes over large areas than are the efforts of the nematodes themselves.

Over short distances, nematodes are most frequently carried by running water and by cultivating instruments. Plows and cultivators collect infested soil and plants in one portion of a field and drop them in another portion. They may even carry the infestation to other fields. Such spreading of nematodes can be prevented by working infested portions of a field after the clean parts have been worked. Spread from field to field can be prevented by cleaning the tools of all soil after use in an infested field. Tools thoroughly cleaned of adhering soil and exposed to the sun and air to dry for an hour or so can be used in clean soil without fear that they will carry root-knot nematodes to clean soil.

Spread of nematodes by running water can be prevented by diverting surface drainage so that it does not flow over lower fields.

Probably the most common source of infestation of clean soil is nematodes brought in on the roots of plants. Setting out of infected plants not only invites trouble on one crop but also on all subsequent crops.

**EFFECT OF ROOT-KNOT ON CUCUMBERS**

Average green weight of root-knot infected seedling cucumber plants was found to be 37.5 per cent less than the average green weight of uninfected plants grown under the same conditions. While growth decreases may be somewhat less in other plant species which are less susceptible to root-knot, such results indicate that time and trouble spent on nematode control are well worth while. Infested soil which is to be used for such nematode susceptible plants as truck and garden crops, should be subjected to rotations recommended for tobacco in another section of this bulletin.

**ROOT-KNOT RESISTANT CROPS**

A root-knot resistant crop might be defined as one which will produce a normal crop on heavily infested soil. Obviously, such crops can be more
profitably grown in infested fields than those which are heavily attacked and badly damaged by nematodes. Fortunately, many crops are resistant to nematodes and varieties of other crops have considerable resistance. None of the resistant crops can be considered immune and only one or two will have any beneficial effect in reducing the nematode population, but all can be profitably used on infested soil.

The best known of the resistant varieties are the Iron and Brabham cowpeas. Of the two, the Brabham is rather more resistant to nematodes and should be preferred.

A pole snap bean has recently been placed on the market under the name of Alabama No. 1. This bean has been tested under severe nematode conditions at this Station and found to be highly resistant to root-knot. It can be recommended for home garden use.

Other highly resistant legumes are the velvet beans, peanuts, Laredo, Biloxi and Otootan soybeans, beggarweed and all the Crotalaria species. The growing of harvest peanuts, velvet beans, and Crotalaria has a tendency to reduce the nematode population, and a series of two or three crops of these is excellent preparation for the growing of truck crops.

Corn, oats, grains and grasses are seldom injured by root-knot nematodes, though only oats and rye have been proven to be of value in nematode reducing rotations.

The Red Jersey, Southern Queen, Yellow Belmont and Porto Rico sweet potatoes are less susceptible to root-knot than most other varieties.

Resistant species and varieties are also available in ornamentals and flowers. *Gardenia thunbergi* is more resistant to root-knot than other gardenias and may be used as a rootstock. Marigolds are generally quite resistant to root-knot and the African marigolds are more resistant than the French species. Zinnias are generally not heavily attacked. These flowers can be grown in badly infested flower beds where other susceptible species fail entirely.

**EFFECT OF COVER CROPS ON ROOT-KNOT OF PEACHES**

It is a well-known fact that the root-knot nematode is one of the most, if not the most, important parasite of the peach tree in the South. Due to the fact that it attacks the roots of the tree instead of above ground parts, it is impossible to control once it becomes well established. Therefore, it is highly important that only clean or nematode free nursery stock is used in nematode free soil, if possible, and then the greatest precautions taken to keep the nematodes out or at least at a minimum.

It is believed that only nematode resistant cover crops should be used in the orchard because a susceptible crop will help increase the nematode population. If the spaces between the trees are comparatively free of nematodes the new roots may not suffer so much from nematode interference, probably adding several years to the productive life of the tree.

An experiment was set up in 1939 to check the influence of the cover crop on the nematode infested peach orchard. Ninety-six Elberta peach trees
were set out in lightly infested soil and arranged so as to have 16 plots of six trees each. The following treatments were carried out with four replications of each.

1. Susceptible cover crop—Whipplewillow cowpeas, grown until mature and plowed under as green manure. Austrian winter peas used as winter cover crop.

2. Immune or highly resistant cover crop—Crotalaria spectabilis grown until mature and plowed under as green manure. Oats used as winter cover crop.

3. Clean cultivation—Plots cultivated whenever weeds began to show up.

4. Trap crop—Whipplewillow cowpeas planted between rows of trees. Cowpeas sampled and roots dissected every day or two to watch stage of nemic growth; when nematodes were about two-thirds grown, cowpea plants were destroyed. The idea was to trap all the nematodes possible in roots, and then destroy the plant before the nematodes could mature, thus reducing the population.

The trunk diameter of each tree was measured at the time of setting, and again at the end of the first season’s growth. The new growth or branches over eight inches long were also measured.

After analyzing the above data statistically, it was found that there was a highly significant difference in growth of trees on plots with nematode susceptible cover crop, and other treatments. Those on susceptible plots were held back considerably. Both methods of measuring growth gave exactly the same results.

**NEMATODE RESISTANT PEACH ROOTSTOCKS**

One of the first and most important questions to ask in planning a planting of nematode susceptible perennials, whether an orchard or a single plant, is “Can this plant be secured on a nematode resistant rootstock”? Probably the best example of this is the peach. Two nematode resistant rootstocks have been brought into this country by the U. S. Department of Agriculture, and are becoming available to the public. These introductions are Yunnan peach from China, and Shalil peach from India. Both varieties were grown from seedlings at this Station last season on soil heavily infested with the nematode. Neither of these varieties could be found infected, while the roots of Elberta peach growing beside them were a mass of knots. These resistant varieties continued to grow and appeared healthy throughout the season, while the Elberta turned yellow and put on very little growth. These two rootstocks can be recommended for this area as far as nematodes are concerned.

**ROOT-KNOT AND SEEDLING TUNG TREES**

Approximately 150 tung nuts were planted on soil heavily infested with nematodes and a like number on a comparatively clean area, the two locations being separated by a terrace.

Ninety-two per cent of the plants on the heavily infested area were found
to be heavily infected. The tap root in most cases was completely blinded at about six inches beneath the surface while the uninfected plants had a tap root two to three feet long.

The average weight of the infected plants was 61.2 grams per plant, while the average weight of the uninfected was 146.7 grams per plant. From these weights, it can be seen that the nematode is capable of causing considerable damage in the seedling stage at least; the grower therefore should be sure he gets clean nursery stock and plant on comparatively nematode-free soil.

**ROOT-KNOT SUSCEPTIBLE AND RESISTANT GRASSES**

Seven species and types of grass were grown on soil heavily infested with nematodes and examined periodically throughout one season for the root-knot nematode.

The following grasses were tested: Vasey (*Paspalum urvillei*), Dallis (*Paspalum dilatatum*), Bahia (*Paspalum notatum*) of both the common and the Paraguay introduction, *Paspalum malacophyllum*, carpet grass (*Axonopus affinis*) and woolly finger grass (*Digitaria eriantha stolonifera*).

Only carpet grass and vasey grass were found to have root-knot, indicating that the rest are highly resistant at least in this locality. All but woolly finger grass were found infected with the meadow nematode (*Pratylenchus pratensis*).

The following grasses have been reported as hosts of the root-knot nematode by other workers:

- Barnyard (*Echinochloa crusgalli*)
- Bermuda (*Capirola dactylon*)
- Orchard (*Dactylis glomerata*)
- Rhodes (*Chloris gayana*)
- Napier (*Pennisetum purpureum*)
- Natal (*Tricholaena rosea*)
- Crab grass (*Digitaria sanguinalis*)

**TOBACCO**

**FLUE-CURED TOBACCO**

Investigations of flue-cured tobacco production at the Georgia Coastal Plain Experiment Station is a cooperative project of the Division of Tobacco and Plant Nutrition, Bureau of Plant Industry, United States Department of Agriculture, and the University of Georgia College of Agriculture.

The research program includes studies of seed bed management and fertilization; studies of the various plant food elements as they affect stand,
growth, rate of ripening, yield and quality; the effect of certain two-, three-
and four-year rotations on yield and quality, and the selection and testing
of varieties for higher yields and quality.

While the following report may be considered only a progress report,
certain recommendations based on accumulated data, are included.

General Recommendations

Soils: The quality of flue-cured tobacco is closely correlated with the
type of soil on which it is produced. The light sandy loam soils with lemon
or light orange colored friable subsoils produce the finest quality. The best
tobacco soils of the Coastal Plain area are the Norfolk sandy loams and
loamy sands with the lighter phases of the Tifton soils ranking second. The
typical pebbly cotton soils are heavy and fertile and produce a correspond-
ingly heavy coarse grade of tobacco, while the Norfolk sands (oak ridge
land) have poor water holding capacities and will not support growth during
temporary dry spells. Soils selected for tobacco should be low and moist
with just enough slope to drain good. Soft, fluffy soils that warm up quickly
in the spring will give much better early growth than tight cold soils that are
easily puddled during wet weather. The nitrogen reserve of all flue-cured
tobacco soils should be comparatively low.

Varieties: Almost all of the varieties now being used will produce the
thin bright leaf now demanded by the manufacturers. The most popular
and apparently best varieties are Gold Dollar, Yellow Pryor, Yellow Mam-
moth, Virginia Bright Leaf, Bonanza, and Jamaica. It is only occasionally
that the heavier type producing varieties such as Gold Leaf, Warne and the
Orinocos are used. More frequently some grower finds an off-type plant
in a field and originates a “special” variety by propagating it. Few, if any,
of these varieties are equal to the standard varieties in quality.

Seed Beds: Poor or late plants cause more crop failures than any other
single factor entering into the production of tobacco. To produce quality
tobacco a uniform stand in the field must be obtained. This can be done
only with strong uniform plants transplanted before the soil temperature
gets too high for a good live. The rate of growth of properly fertilized
plants depends entirely on heat, light and moisture.

For rapid growth, seed beds should be located on low moist soils with a
slope to the south or southeast. These slopes are warmer than northern or
western exposures. Temporary or natural windbreaks on the north and
northwest sides are helpful in protecting the beds from cold winds. All
shade on the south and southeast sides of beds should be removed in order
that the sun may shine on the bed throughout the day.

Deep loamy soils locally known as “gallberry” land are the best plant bed
soils. Old hedgerows or soil that has been washed down from fields above,
are likely to be heavily infested with the root-knot nematode.

Thorough sterilization of seed beds will control both weeds and the root-
knot nematode. However, thorough sterilization cannot be accomplished
except with a rather complicated and expensive buried tile system, installed
in permanent seed bed locations. Practical control of both weeds and root-
knot may be obtained by the pan method of steaming if the soil is dry.
Weeds alone may be controlled by burning brush or similar material on the soil. In sterilizing by any of the above methods, a better distribution of heat will be obtained if the soil is loosened uniformly before the heat is applied. Loosening may be done effectively by using a soil fork, spade or plow stock. Seed bed soils should never be turned as the turning process places the fertile top soil out of reach of the shallow feeding roots of the seedling. Where sterilization is not practical seed beds should be located on clean new locations every year.

The amount of fertilizer required to produce plants will depend largely on whether or not the bed is a first-year or old bed. New beds require approximately two pounds per square yard of a plant bed fertilizer analyzing 4-8-3 \((\text{NPK})\) in which all of the potash has been derived from some form other than muriate or kainit. Old bed sites require less phosphorus and potash because of the residue from the previous applications. However, about the same amount of nitrogen is required every year as this material leaches badly.

The best time for sowing beds apparently is in late December or early January. One well rounded tablespoonful of good clean seed per 100 square yards of area is sufficient. Poor stands are more often due to improper preparation and finishing of the bed than to the absence of sufficient seed. Over seeding results in thin, long spindling plants that are hard to get to live when transplanted, especially in hot weather. Apparently such plants are also much more susceptible to wire worm damage than heavy stocky plants of good stem size. More uniform germination and better stands of plants are obtained when the surface of the beds is left completely smooth so that the moisture will rise uniformly. A rough uneven surface permits the high spots to dry out which stops germination and results in a spotted uneven stand. It is therefore much better to firm the seed in with a concrete or iron roller than to trample them in by foot. Tobacco seed will not germinate unless the surface of the soil is moist.

Excessive use of nitrate top dressers in an attempt to overcome the effects of blue mold damage has resulted in much damage to seed beds during the last several years. These materials are beneficial but when applied dry will often cause severe burning. A dilute solution is a safe and effective method of application. Five pounds of top-dresser dissolved in 50 gallons of water applied to 100 square yards of bed will not burn the plants if washed off of them immediately with another 50 gallons of water. The additional water not only prevents burning but washes the solution from the leaves into the soil where it becomes immediately effective. Concentrations greater than 5 pounds to 50 gallons of water will likely burn the plants before it is possible to wash it off. Unless rainfall is excessive one application of 5 pounds nitrate of soda or the equivalent per 100 square yards of bed is sufficient for the season. Under no conditions should more than three such applications be made as heavy concentrations of soluble fertilizer material will kill the plants.

**Fertilizers:** Normal growth of any plant depends upon the presence of many plant food elements. The general idea that only nitrogen, phosphorus and potash need be applied as fertilizer is misleading. Experiments have shown that the elements—nitrogen, phosphorus, potassium, calcium,
magnesium, and sulphur—should all be contained in commercial fertilizers. Other elements including boron, copper, zinc, iron and manganese are also required for normal plant growth, but deficiencies of these elements have not as yet been identified on tobacco in the Georgia-Florida-Alabama tobacco belt. Under most conditions these elements are either present in the soil or supplied in fertilizers in sufficient quantities for normal plant growth. Some of the so-called minor elements are highly toxic and relatively small applications may cause severe damage. Applications should always be made under the guidance of some one with a knowledge of this danger.

Nitrogen: The function of nitrogen is to increase the size of the leaves and the intensity of the green color of the plant. It is therefore necessary that the nitrogen supplied flue-cured tobacco be closely controlled. Excessive quantities either from crop residue or commercial fertilizers will produce a plant too large and green for good quality. The absence of sufficient nitrogen produces a small yellow plant of good color but low yield. Somewhere in between these two extremes lies the optimum application which will produce good yields of good quality. However, the optimum application will vary with different soils. On good tobacco soils, 24 to 27 pounds per acre is all that is needed which, in terms of field application, is from 800 to 900 pounds of a fertilizer analyzing 3 per cent nitrogen. On light sandy soils 1000 to 1100 pounds of such a fertilizer will be required to produce maximum yields consistent with good quality.

In formulating tobacco fertilizers one-third of the nitrogen should be derived from some high grade organic material such as cottonseed meal, fish meal or high grade tankage, one-third from materials supplying nitrogen in the nitrate form and one-third from standard inorganic sources of nitrogen.

Phosphorus: Virgin soils of the Coastal Plain area of Georgia contain little available phosphorus and since phosphorus increases the rate and size of growth, these soils will produce very little growth unless this element is applied. Apparently 40 pounds phosphorus (P₂O₅) per acre is sufficient to produce normal size but from 80 to 100 pounds is required to bring about normal maturity and ripening. In terms of field application this would require 300 to 1000 pounds per acre of a fertilizer analyzing 10 per cent phosphorus (P₂O₅). Superphosphate or any other form of readily available phosphorus is satisfactory as a source provided that the calcium and sulphur requirements of the plant are taken into account.

Potash: Of all nutritional deficiency symptoms in the Georgia-Florida-Alabama tobacco belt, potash starvation is the most prevalent and one of the easiest to identify. This trouble takes the form of bronze or rusty leaf tip usually on the uppermost leaves. It is quite often observed where 50 to 80 pounds of potash (K₂O) has been applied under tobacco. Extreme potash deficiency produces a small plant and causes the leaves to become curled, rough and fire between the veins and around the margins. Much of the poor quality of the upper part of the plant can be attributed to potash deficiency as good tips cannot be produced with light potash applications. Experiments have shown that on some soils potash can be applied profitably at rates as high as 120 to 150 pounds (K₂O) per acre or from 800 to 1000 pounds of
fertilizer analyzing 15 per cent potash. However, on most soils 100 to 120 pounds will produce good quality and prevent the appearance of potash deficiency symptoms.

Most potash materials carry other plant food elements in addition to the potash and it is these associated elements that determine the source of potash to use for tobacco. Muriate of potash carries chlorine and since two per cent chlorine is desirable in all tobacco fertilizers this material should be used only in quantities sufficient to supply the chlorine. Two per cent magnesia (MgO) is also required for the prevention of “sand drown”. A part or all of this magnesia may be derived from sulphate of potash magnesia. The remaining potash may be derived from any other potash material that does not contain chlorine.

Magnesia: Magnesia hunger or “sand drown” can be identified by the bleached out appearance between the veins of the lower leaves while the leaf area in close proximity to the veins and midrib remains green. This trouble is caused by the lack of magnesia in quantities sufficient to form the green coloring matter of the leaf. Magnesia hunger is quite prevalent on the light sandy soils of Georgia and is often called “sun burn”. To avoid this trouble tobacco fertilizers should carry two per cent magnesia (MgO), one-half of which should be water soluble. Sulphate of potash magnesia or other soluble magnesia salts except chlorides, may be used for the soluble portion and magnesium limestone for the water insoluble portion of the magnesia supply.

Chlorine: Leaf spread, vigor and drought resistance of the tobacco plant are materially improved by applications of small quantities of chlorine. However, excessive quantities badly depreciate the burning qualities of the leaf and under drought conditions will reduce growth and cause the leaves to become thick and fleshy and curl inward around the margins. The amount of chlorine required and source from which it can be most economically obtained has already been discussed under potash.

Animal Manures: Cow and horse manures are valuable supplements to the regular commercial fertilizer applications. When used properly these manures will greatly improve the quality of the crop with little danger of increasing the plant size to the point of coarseness. All manure used under tobacco should be well rotted and finely pulverized. Applications should be made at the rate of two to three tons per acre applied in the drill at least two weeks before the commercial fertilizer is applied. After the application has been made the row should be covered lightly and left. The commercial fertilizer should be applied in the row with the manure and both well mixed with the soil before listing. Where not more than two to three tons of manure per acre are used no reduction in rate of commercial fertilizer application should be made.

Formulæ and Rates of Fertilizer Applications: Since tobacco soils vary in nitrogen requirement from 24 to 33 pounds of nitrogen per acre, applications ranging from 300 to 1100 pounds per acre of a complete fertilizer analyzing 3 per cent nitrogen must be made. The phosphorus (P₂O₅) requirement varies from 80 to 100 pounds per acre but more than 100 pounds per acre apparently does little harm and will remain in the soil for future crops. A phosphorus content of 10 per cent in mixed fertilizers there-
fore seems to be desirable. Applications ranging from 30 to 150 pounds potash (K₂O) per acre are profitable under most conditions. Such applications require mixed goods analyzing from 10 to 15 per cent potash applied at rates ranging from 800 to 1000 pounds per acre. To guard against "sand drown" all mixed goods should contain 2 per cent magnesia, while 2 per cent chlorine should be added to improve the spread and vigor of the plant. Summing up, tobacco fertilizers should contain 3 per cent nitrogen, 10 per cent phosphorus, 10 to 15 per cent potash, 2 per cent each of magnesia and chlorine. Applications should vary from 800 to 1000 pounds per acre depending on the fertility of the soil.

**Spacing in Drill and Row:** Experiments in spacing indicate that over a period of years there is no advantage in spacing plants closer than 22 inches in rows four feet apart. Due to the greater number of plants per acre, a greater amount of moisture is required for maintaining uninterrupted growth which brings about serious complications under drought or semi-drought conditions. Close spacing also has a tendency to cause the plants to grow tall and spindly with small thin leaves.

**Topping:** Each year a greater number of growers fail to top and sucker their crops. With abundant rain, plants that are not topped will produce fair to good crops. However, leaving the tops in the plant increases the moisture required to sustain it, which is a decided disadvantage in dry weather. It is always advisable to take the top out except where individual plants have become excessively rough.

**Curing:** There is such a wide difference in tobacco as it comes from the field that no fixed schedule for curing will apply except in a general way. A mimeographed article which goes into detail as to the various factors governing curing has been prepared by the Station and may be had upon application.

### Progress Report of 1939 Work

The work in 1939 was continued as outlined and reported in 1938. All of the fertilizer work begun in recent years, has been set up on an eight-element basis including nitrogen, phosphorus, potash, calcium, magnesium, sulphur, chlorine and boron, whereas most of the work in the past was based on nitrogen, phosphorus, potash and chlorine only. With the larger number of plant food elements under control, a much more comprehensive study of fertilizers can be made.

**Complete Fertilizer Tests:** In this series varying rates of application of potash, sulphur, calcium and magnesium continue to show that a balance of all elements making up a tobacco fertilizer is necessary for normal growth of good quality. With the omission of sulphur, typical sulphur deficiency symptoms appear the first time growth is checked by dry weather. With a prolonged dry spell firing of the lower leaves may become general. Omitting potash results in almost a complete loss of the commercial value of the crop, while applications of 50 pounds of potash (K₂O) per acre show symptoms of potash deficiency and a much lower acre value of the crop than treatment receiving 100 pounds potash (K₂O) per acre. Treatments receiving no phosphorus are very slow to grow off and flower. Such inadequate treatments never permit tobacco to ripen properly. No deficiency symptoms have been
observed where magnesium, calcium, chlorine and boron were omitted from the fertilizer. However, the treatment where no chlorine was applied produced a much drier type of leaf than where chlorine was used.

**Potash and Sulphur Relationship Tests:** With only two years' results it seems that with constant applications of potash, increased applications of sulphur have a tendency to increase the rate of growth and earliness of flowering. A reverse trend is noticed when the potash application is increased and the sulphur application maintained at a given level.

**Calcium and Magnesium Tests:** Heavy applications of soluble calcium and magnesium apparently delay growth and ripening but final growth is large, green and of lower quality than on treatments receiving 20 to 40 pounds of magnesium and 60 to 100 pounds of lime per acre. Indications are that increasing sulphur applications may reduce this undesirable effect.

**Acid, Basic and Neutral Fertilizers:** A more desirable type of growth and better ripening are obtained with fertilizers having a neutral or slightly acid reaction than with basic fertilizers. Basic fertilizers produce a late heavy green growth similar to that produced with heavy applications of soluble calcium and magnesia.

**Fertilizer Placement Test:** Fertilizer placed close to the roots of young tobacco plants will cause a large percentage of the seedlings to die. This trouble is more severe in dry weather than in seasons of abundant rainfall. Under all conditions the loss of tobacco plants is heavier than when the fertilizer is placed a distance 2½ inches or more to the side of the roots or mixed well with the soil. Since very few growers have equipment for side placing fertilizer it is recommended that all fertilizer be well mixed with the soil before listing the row and transplanting. Where fertilizer-placing machinery is used the fertilizer should be distributed equally on both sides of the row as placing all of the fertilizer on one side of the row has resulted in potash deficiency and other malnutrition symptoms on the side of the plant receiving no fertilizer.

**Topping and Spacing Tests:** Treatments including two rates of fertilizer applications, 800 to 1200 pounds per acre with plants spaced 12, 18, 24 and 36 inches apart in rows four feet apart, were used to study the influence of spacing on the acre value of the crop. On each of these combinations of spacing and fertilizer applications three heights of topping—8 leaves, 16 leaves, and not topped—were used to determine the effect of topping at various heights on the acre value. It was found that the damage from drought was in proportion to the number of leaves per acre left on the plants. Where plants were spaced 12 and 18 inches apart and not topped the damage from drought was severe. However, such spacing with low topping gave fair yields and quality. The most desirable and profitable type of leaf was produced with plants spaced 24 inches in the drill and topped at 16 leaves. Only heavy coarse tobacco was produced on the 24- and 36-inch spacings topped at 8 leaves.

**Boron Tests:** Applications of 3.0 pounds boron (B) per acre proved to be highly toxic and resulted in a heavy mortality of plants and delayed
growth. Smaller quantities have given no measurable benefits while the omission of boron entirely has produced no deficiency symptoms that could be attributed to the absence of this element.

**Plant Bed Fertilizers:** Sources of nitrogen tests on tobacco seed beds indicate that nitrogen in some form other than nitrates should be used in tobacco seed bed fertilizers. Organic and ammonical nitrogen do not leach as readily as the nitrate and give a much more satisfactory growth. The use of excessive quantities of organics such as cottonseed meal and tankage, is also undesirable because these materials attract insects and furnish an excellent medium for the growth of fungi.

**FLUE-CURED TOBACCO DISEASES**

The 1939 tobacco crop was below normal both in yield and in leaf quality. This was associated with heavy rains the first week in April which came just after the fertilizer was applied and before the plants had been set or had become established in the field. In order to maintain poundage allotments many growers sold all available scrap and this had a tendency to pad recorded yields and lower quality.

Freezes caused only slight damage to tobacco beds during the winter months. A light freeze January 23-24 resulted in some stunting and yellowing of small seedlings, which condition was generally mistaken for blue mold.

**Disease Survey of 1939 Crop:** The blue mold or downy mildew disease (*Peroonospora tabacina*), made its initial appearance early in the plant bed season and the subsequent epidemic was more destructive than the one in 1938, although slightly less severe than in 1937. Abnormally mild weather in January was associated with early development and spread of the mold fungus. Symptoms were observed in an old tobacco bed in Cook County, February 4, although the disease had been identified a week earlier on hold-over plants in a 1938 discarded bed in the same county. Before February 15, the mold was observed only in old tobacco beds, primarily in those that had been sown December 20 or earlier. During the remainder of February symptoms appeared alike in both old and new locations. A peak of disease activity was reached in the early infected beds February 15-20, but the general outbreak did not come until the first and second weeks in March. Mold killed approximately 60 per cent of the tobacco seedlings in unsprayed beds, individual losses varying from 5 per cent to 95 per cent. Average loss for the entire State, however, was considerably less, because many growers carefully sprayed their beds and these secured over 90 per cent protection against disease damage. In several communities where no beds were treated an acute plant shortage occurred, but surplus plants from sprayed beds in nearby localities were sufficient for setting normal acreages. No serious mold infections were observed in tobacco fields, although numerous lesions appeared during April and May in some early fields.

Damping-off (*Rhizoctonia solani* and *Pythium* sp.) was more destructive than normal in 1939, and killed an estimated 12 per cent of the Georgia seedlings. Losses up to 50 per cent were observed in both old and new beds. The disease was most destructive when the plants were in the 4-leaf and 6-leaf stages. Because excellent stands had been secured early in the season,
the severe mold and damping-off losses did not result in any reduction in the
Georgia crop. Most growers planned to grow from two to four times as
many plants as they expected to use.

Root-knot (Heteroder a marioni) was observed in more than 25 per cent
of the plant beds observed after March 25. It was confined to old beds and
to new locations that had previously been subjected to drainage water from
infested fields. This disease rarely causes actual damage in the plant bed,
but seedlings only slightly affected at this early stage sometimes develop
severe root-knot after being transferred to the field.

Root-knot was the most important field disease in 1939, causing an esti-
mated 5.5 per cent loss of the entire Georgia crop. Heavy rains early in the
season caused partial drowning in many fields and the plants never com-
pletely recovered from this set-back. This condition overshadowed root-knot
to a certain extent. Losses from root-knot have been considerably less dur-
ing the last five years than during the period from 1930 to 1934. More
careful selection of crop rotations has been partly responsible for this
reduction.

Southern root rot and sore shin (Sclerotium rolfsii and Rhizoctonia solani)
affected approximately two per cent of the tobacco stalks in Georgia fields
and caused an estimated one per cent loss of the crop. All leaves on affected
stalks were lost that had not been harvested before symptoms appeared. Most
of the affected stalks did not show symptoms until after several leaves had
been harvested.

Fusarium wilt (Fusarium oxysporum var nicotianae) developed on several
tobacco plants in a number of fields, particularly where sweet potatoes had
been grown within recent years. While this wilt is at present a minor disease
in Georgia, it has gradually increased in the observation fields within the
past several years. Some of the more commonly grown varieties of flue-cured
tobacco such as Gold Dollar and Jamaica are highly susceptible to fusarium
wilt. Granville or Bacterial wilt (Bacterium solanacearum) was not observed
in 1939. Black shank (Phytophthora parasitica var nicotianae) was not iden-
tified in any fields except occasional infections in a few locations in south-
west Georgia bordering the “Shade” belt.

Frog-eye leaf spot (Cercospora nicotianae) developed to a limited extent
on the top leaves in all tobacco fields late in the season. Infections were not
severe enough to cause noticeable losses.

The mosaic (virus) disease of tobacco has practically disappeared from
the State within the last several years. Only four affected plants in one field
were observed during the growing season of 1939. Only seldom were symp-
toms seen on suckers of stalks left in the field after harvest. Ring-spot,
another virus disease, was observed in only one field in 1939.

Experimental Projects: Experiments on tobacco disease control are
limited primarily to (1) development of inexpensive sprays and other prac-
tical methods for controlling blue mold, (2) soil sterilization and plant bed
management tests for eradication of root-knot nematodes, damping-off fungi,
and weed seeds in tobacco beds, (3) crop rotation tests and cultural prac-
tices for prevention of root-knot in tobacco fields, and (4) tobacco breeding test and selection of strains resistant to root-knot, fusarium wilt, blue mold and black shank.

Blue Mold Control

Three methods of controlling blue mold have been thoroughly tested; namely, (1) spraying plant beds with vegetable oil sprays, (2) gassing beds with benzol, paradichlorobenzene and other materials, and (3) control by changing plant bed environment and cultural methods. Of these, spraying with vegetable oil emulsion and cuprous oxide has proved cheaper and more practical.

**Blue Mold Control by Spraying:** Spraying tobacco beds twice a week with the recommended formula beginning before mold develops, is the simplest and cheapest control method known and it is sufficiently effective to furnish 90 per cent control in severe epidemic years such as 1937 and 1939. From 8 to 12 applications have been sufficient in most seasons and the six-year average cost of materials, together with depreciation and repair of hand pumps has been less than $2.00 per 100 square yards a season.

Three very similar spray formulas are now available, each containing the essential ingredients, vegetable oil and cuprous oxide. These vary only in source of the cuprous oxide and whether or not the vegetable oil contains a self-emulsifying agent. Formulas for making 25 gallons of spray are given below. Proportionate amounts of materials should be used for mixing more or less than 25 gallons.

**FORMULA No. 1:**

Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount for 25 Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow cuprous oxide (Cuprocide 54-Y)</td>
<td>6 ounces</td>
</tr>
<tr>
<td>Vatsol OTC (emulsifier)</td>
<td>4 ounces</td>
</tr>
<tr>
<td>Cottonseed oil</td>
<td>1 quart</td>
</tr>
<tr>
<td>Water to make</td>
<td>25 gallons</td>
</tr>
</tbody>
</table>

**FORMULA No. 2:**

Materials

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<th>Material</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Yellow cuprous oxide (Cuprocide 54-Y)</td>
<td>6 ounces</td>
</tr>
<tr>
<td>Self-emulsifying-cottonseed (SEC) oil</td>
<td>1 quart</td>
</tr>
<tr>
<td>Water to make</td>
<td>25 gallons</td>
</tr>
</tbody>
</table>

**FORMULA No. 3:**

Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount for 25 Gallons</th>
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</thead>
<tbody>
<tr>
<td>Home-made yellow cuprous oxide solution</td>
<td>3 quarts</td>
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<tr>
<td>(see foot-note for preparation)</td>
<td></td>
</tr>
<tr>
<td>Vatsol OTC (emulsifier)</td>
<td>4 ounces</td>
</tr>
<tr>
<td>Cottonseed oil</td>
<td>1 quart</td>
</tr>
<tr>
<td>Water to make</td>
<td>25 gallons</td>
</tr>
</tbody>
</table>

**Footnote:** A home-made yellow cuprous 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. 3 is slightly more effective against blue mold than the other two, but is somewhat more complicated in that stock solutions of yellow copper oxide must be mixed in advance. Formula No. 2 is the simplest to use because it involves the mixing of only two ingredients but this is more expensive than the other two. Formula No. 1 is less complicated than No. 3 and is no more expensive, costing less than $2.00 for materials to make 100 gallons of spray.

In mixing 25 gallons of formula No. 1, stir the emulsifier (Vatsol OTC) into a half gallon of water and add the quart of oil. Most brands of cooking oil will be satisfactory since they contain mixtures of cottonseed, soybean and peanut oils. Stir well and then pump the mixture through a spray nozzle until a milky white emulsion is produced. This can be done conveniently by attaching a short piece of hose to bucket pump and holding the nozzle in the mixture near the intake as the pump is operated. The same procedure may be followed in a wheelbarrow or barrel sprayer. After thorough emulsification and no oil globules come to the surface upon standing, add water to the mixture to bring the total volume to 24 gallons. Then stir the cuprous oxide powder into a gallon of water and add to the diluted oil emulsion. Stir well and operate the pump several strokes to complete the mixing and clear the hose of the pure oil emulsion. Make only enough spray at one time for one application and use immediately. In mixing formula No. 3, the same procedure is followed except that 3 quarts of home-made copper solution are substituted for 6 ounces of the commercial powder form. Since the self-emulsifying-cottonseed oil contains an emulsifying agent, all that is necessary for mixing formula No. 2 is to add a half gallon of water to a quart of SEC oil, emulsify in the usual manner, dilute with water and add the yellow copper powder as described above.

Two or three gallons of spray are ample for treating a 100 square yard bed when the plants are the size of a ten cent piece. Plants in the 4-leaf stage require only two gallons per 100 yards. This amount should be increased as the plants grow larger until five gallons per 100 yards are applied at each application when the plants reach one-half to two-thirds transplanting size. Thus approximately 12½ gallons are sufficient for a 500-yard bed when the plants are small, while twice this amount will be required to secure good coverage when the plants are large.

Time to begin spraying each winter will be governed by the amount of warm weather in January and February rather than by size of the plants. Control can be obtained only when applications are begun before mold appears in the seed bed. Since symptoms appear first each season in old beds sown early, it may be advisable for growers who have such beds and
who live in areas where mold customarily develops first each season, to
begin spraying soon after the plants reach the 4-leaf stage. This is par-
ticularly advised in warm winters. Under these conditions spraying once a week
may be sufficient until mold is first reported, after which time twice weekly
applications (Monday and Thursday) are advised. Over most of the Georgia
area it is early enough to begin spraying as soon as the first infection is
reported in the belt. In outlying areas where the mold usually develops late,
Spraying once a week may be started as soon as symptoms are reported in
the State, and twice weekly applications begun as soon as the infection
appears in the adjoining county.

Tobacco beds can be sprayed effectively directly through the plant bed
cover, provided the cover is stretched several inches above the plants. This
is especially true early in the season when the leaves lie flat on the ground.
Later when the plants reach half transplanting size it is sometimes advisable
to remove the cover before each application and attempt to spray both sides
of leaves that stand erect. However, where a uniform mist is applied, it is
not considered essential to spray both sides of the leaves. Tests with varying
pressures and different types of nozzles have shown that pressures of 250
pounds per inch or more, while effective, are not necessary for good control.
However, pressures of at least 100 pounds are advised for most nozzles.
Bucket pumps, wheelbarrow sprayers, and barrel sprayers have proven very
satisfactory for spraying small beds, medium bed areas, and groups of
large beds, respectively.

The present spray treatment does not prevent mold infection, but instead
it increases plant resistance to the point where severe attacks do not cause
serious damage and at the same time enables the plants to rapidly recover
from the infection. In this way the spray treatment prevents undue disease
delay. After this initial infection the plants develop sufficient resistance to
remain free from a second severe attack for several weeks, even when no
attempt is made to protect them. Consequently spraying can safely be dis-
continued as soon as all plants have become immunized and begun to recover
from this initial infection. It frequently happens that one end of a plant
bed becomes diseased one week while the other end may not be attacked
until a week or ten days later. By carefully watching the course of infection,
growers will be able to determine when all plants have been infected and
when to stop spraying. When infections are delayed or prolonged, it will
be advisable to continue spraying until the plants are ready to set.

Enough plants to set three or more acres of tobacco in season can be
expected from each 100 yards of sprayed bed. Additional tests are being
conducted with other chemicals in combination with vegetable oils, and
certain of these formulas promise to be superior to the present spray mix-
tures in preventing infection and building up plant resistance. But these
new combinations have not been sufficiently tested under field conditions to
justify recommendations at present. For this reason only the formulas given
in this report can be recommended for immediate use, and growers are
warned against using substitutes.

**Blue Mold Control by Gas Treatment:** This method involves the
evaporation of certain volatile chemicals three nights a week in tightly con-
structed plant beds covered each night of treatment with a heavy sheeting or
muslin (50-65 threads per inch) to hold in the vapors. Benzol (liquid) and paradichlorobenzene (crystals) are the two chemicals that have been most frequently used in test work. The material must be applied inside the bed in such a way as to permit ready evaporation from prepared evaporating surfaces that prevent the raw chemicals from coming in contact with and injuring the plants. Treatments must be applied about sundown and the heavy cover rolled over the bed immediately and fastened securely around the edges to make the bed as air-tight as practical. This heavy cover should be kept over the bed each night of treatment, and it must be removed soon after sun-up the following morning.

Beds should be treated every two or three nights, but usually any three convenient nights during the week will be satisfactory. Gas treatment is most effective during still nights when the wind is not blowing. The longest interval between treatments should not exceed four days. Applications may be started as soon as mold is reported in nearby beds and continued until the plants are ready to set, or until all of them have become affected by mold and started to recover. It is possible to stop mold activity, with either benzol or paradichlorobenzene, after the infection has been observed. Due to the extreme rapidity of disease development it is not generally advisable to delay the initial applications until after the disease appears. Under weather conditions unfavorable for gas treatment a delay of one or two days can mean failure to control. This is especially true if paradichlorobenzene is used, for this material is not effective during extremely cold nights when the temperatures remain near the freezing point.

Benzol is more effective than paradichlorobenzene on cold nights and it is also less likely to injure the plants in warm weather. From four to five quarts of benzol per 100 yards each night of treatment are sufficient. This amount may be divided equally in 15 to 20 pie plates (representing 1/100th of the bed area) spaced every 6 or 7 feet throughout the bed. The pans may be set on blocks or supported a few inches above the ground level in such a way that they remain level and do not turn over.

Paradichlorobenzene crystals applied at the rate of two pounds per 100 square yards may be scattered broadcast directly over the regular cheesecloth cover and the heavy sheeting rolled directly over the top. However, this can be done safely only when the regular cheesecloth cover contains 24 or more threads per inch, or is fine enough to prevent small crystals from falling through and burning the plants. If the regular cover does not contain 24 or 28 threads each way, some other method of application should be adopted. Strips of cheesecloth stretched across the bed every 15 to 18 feet can be used for evaporators or the material can be scattered on boards placed several inches above ground inside the bed. The paradichlorobenzene treatment is somewhat less safe than benzol. Repeated treatments with the crystals often cause the plants to develop narrow leaves and other abnormalities. If the crystals are applied, or the heavy cover left on the bed, while the sun is shining, there is danger of severely burning the plants.

Gas tests conducted over a three-year period under actual field conditions have shown that this method will give excellent control. Serious plant injury can be avoided if reasonable care is exercised in manipulating the heavy covers. Cost of all necessary equipment and materials, together with allow-
ance for depreciation of heavy covers, has approximated a minimum of $8.00 per 100 yards a season. The method requires more hours of labor than spraying, as well as much closer attention to details of bed management. Because of the impracticability of covering the large wide beds customarily used in Georgia, the method is not generally advised. It can be readily adapted to small beds of 50 to 75 square yards each. By joining two small beds together, with a cross partition between, it will be possible to use the same cover on alternate nights for treating both beds. For detailed information on this subject interested growers are requested to write for an explanatory leaflet on gas treatment of tobacco beds.

**Blue Mold Control by Cultural Practices:** The practice of sowing two or three times as many beds as required is still preferred by some growers. This method usually is satisfactory except in severe epidemic years when control is most needed. The cost of sowing one or two extra beds exceeds the total cost of spraying and approximates the cost of gas treatment. For this reason the extra bed method is not advised. Since blue mold is a cool weather disease, it can be controlled by growing plants in temperature regulated hot beds, where summer temperatures are maintained. However, this method is many times more expensive than gassing and is not advised.

The practice of sowing new beds each year or of rotating plant beds will be of material benefit in delaying mold attacks and thereby lessening the cost of the control method used. First mold symptoms are found each year in old beds that were sown early or on holdover plants. By destroying beds each spring soon after transplanting, or before the plants produce seed that later give rise to volunteer plants, this important source of infection can be eliminated. If old beds are to be used it will be advisable to sow these somewhat later rather than earlier in the season. These practices will do much to delay early attacks, which almost invariably are the most destructive. As the initial outbreak each winter is delayed, so can the first spray or other control treatment be postponed and the subsequent number of applications be reduced at a substantial saving.

**Root-Knot Control in Seed Beds:** Location of plant beds in new or virgin land and selection of sites that have remained free of drainage water from nematode infested fields, is the most practical method of avoiding root-knot in tobacco seedlings. In addition to this practice, burning the bed soil for at least one entire day with wood or brush will further guarantee against disease and weed contamination. Burning is less effective than steaming but is more practical. Steam sterilization is the most effective soil treatment known for destroying disease organisms and weed seeds in the soil. As a chemical soil sterilizing agent, chloropicrin closely approximates steam, except that it is not a good weed eradicant. In other respects chloropicrin is superior to steam. It is more effective than steam in controlling damping-off. Because of the difficulty of applying chloropicrin and similar effective soil treatments, chemical sterilization of tobacco bed soil is not advised at present. The method costs approximately $10.00 per 100 square yards.

**Root-Knot Control by Crop Rotation:** The majority of South Georgia field crops, including all domestic varieties of tobacco, and all truck crops have been found to be unsafe or too susceptible to the root-knot nema-
tode to be included in tobacco rotations. It is unsafe to grow any crop, that is highly susceptible to root-knot, on tobacco land during the two years preceding tobacco. By planting one crop of tobacco after two successive years of one or more highly resistant crops, this disease can be controlled successfully in the majority of Georgia fields. Culture of tobacco after only one year of a resistant crop has not proven successful in heavily infested areas. Tests have shown three-year rotations to be most practical and effective, or those involving the growth of tobacco on the same land only one year in three. In a limited number of instances, however, four-year rotations were required for best results.

In selecting crops for tobacco rotations the grower must consider (1) whether the crop is actually resistant to nematodes, (2) whether the crop, if resistant, has been proved by actual tests to be effective in eliminating root-knot, and (3) whether the crop residues left in the soil are favorable for the production of high quality tobacco. A number of crops considered root-knot resistant have been found by test to permit increases in nematode populations. Corn and other summer grasses, as well as certain perennial grasses such as Bermuda grass, are classified as root-knot resistant; yet field tests have shown that severe root-knot damage often develops in tobacco planted in rotations with these grasses. Velvet beans, considered highly resistant, are much less effective in reducing root-knot than peanuts. Only a few of the so-called root-knot resistant crops have proven sufficiently resistant to be reliable in tobacco rotations, and some of these must be excluded because they leave undesirable residues in the soil. Heavy growths of such soil building crops as crotalaria, runner peanuts and beggarweed greatly reduce nematodes in the soil; but tobacco grown after these usually develops thick, rough leaves that remain green in color or turn dark when cured. The resulting low quality leaf is never in demand.

Spanish peanuts (harvested) and oats are the only two common field crops that have consistently proved successful in preventing root-knot from developing in succeeding crops of tobacco. If desired, rye may be safely substituted for oats. Where tobacco is to be planted after oats or rye, it usually is advisable to permit weeds to grow after the grain has been cut, because the native weed growth is more resistant to root-knot than the common hay crops. Moreover, except where heavy growths of beggarweeds predominate, the weed residues left on the land are conducive to good quality tobacco. In this respect oats followed by weeds are definitely superior to harvested peanuts, but the latter is more effective in reducing nematode populations. Crotalaria, runner peanuts, and velvet beans can well be included in the rotation provided these are grown two or more years in advance and a non-legume planted immediately in advance of the leaf crop. Where it is not possible to consistently practice rotations with Spanish peanuts and oats, occasional crops of cotton, corn and Brabham or Iron peas, and Laredo soybeans may be included. Since these are only partially resistant to nematodes, they can be grown to best advantage two years in advance of the tobacco crop. Systematic rotations of tobacco with these moderately resistant crops have not proven successful except where oats or Spanish peanuts were cultivated immediately in advance of the tobacco. Clay or mixed cowpeas should not be used for hay in the rotation.
The following groups of three-year and four-year rotations include those that have been most effective in preventing root-knot during the past ten years.

Three-year Rotations:
1. 1st. year—Peanuts, or oats and crotalaria, or oats and hay.
   2nd. year—Oats and weeds.
   3rd. year—Tobacco.
2. 1st. year—Spanish peanuts, or oats and weeds, or cotton.
   2nd. year—Spanish peanuts (harvested).
   3rd. year—Tobacco.

Four-year Rotations:
1. 1st. year—Corn, interplanted with peanuts and velvet beans.
   2nd. year—Cotton.
   3rd. year—Spanish peanuts (harvested).
   4th. year—Tobacco.
2. 1st. year—Cotton or corn.
   2nd. year—Spanish peanuts (harvested).
   3rd. year—Oats and weeds.
   4th. year—Tobacco.

In the three-year rotations tobacco follows the crop listed for the second year, while crops listed for the first year are two years in advance. In the four-year rotations tobacco is grown immediately following the crops listed for the third year, while the first year crops are farthest removed from tobacco.

**Breeding Tobacco for Disease Resistance:** Breeding tests conducted during recent years have demonstrated the feasibility of developing a variety of flue-cured tobacco resistant to root-knot, fusarium wilt and black shank. Progress has been made in selecting resistant hybrids from crosses between domestic flue-cured types and resistant strains introduced from Central and South America. Since several back-crosses will have to be made before suitable varieties can be established, many years may be required before seed will be ready for distribution. Each new resistant and promising variety developed must first be proved to embody all the desirable qualities demanded by the tobacco trade. Growers are warned against using any new or untired variety of tobacco developed from off-type plants selected in local fields. Such selections usually produce an undesirable quality, despite the fact that the cured leaf may appear to be identical to that from accepted varieties. Unfortunately all varieties of flue-cured tobacco are highly susceptible to both root-knot and blue mold. But until a suitable resistant type is established, growers are advised to cultivate only the standard varieties such as Yellow Mammoth, Bonanza, Virginia Bright Leaf, Gold Dollar, Jamaica, White Stem Orinoco, etc. By adopting the spray or other methods for controlling blue mold, and crop rotation for the prevention of severe root-knot damage, these varieties can be grown successfully.

**SHADE TOBACCO STATION**

Shade tobacco (cigar wrapper) experiments at the Shade Tobacco Experiment Station in Decatur County near Attapulgus, Georgia, were continued
along the same lines as previously reported. These tests include experiments in the nutrition of the tobacco plant, fertilizer placement tests, blue mold control in plant beds, rotations, cultural practices and chemical treatment of soil for control of root diseases, dates of planting, and breeding for disease resistance. In addition a small area is devoted each year to the production of seed for growers.

**Agronomy Work**

**Nutrition Tests:** The object of this work is to determine the optimum ratio between various component elements of a shade tobacco fertilizer, the most profitable ratio between organic and inorganic nitrogen, the effect of varying rates of application of barnyard manure, 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 (combination type) in the spring of 1938, and 120 one-thirtieth 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 taken during the growing period to record visible differences in the types of growth. The necessary records of grades were taken in the grading room in order to make comparisons of quality from the standpoint of grades. Further tests were made on the finished product to determine differences in the burn and ash characteristics arising from the various treatments. The final value of the leaf is thus reflected in the grade index, burn, ash color and character, taste and aroma.

A shade tobacco formula in common use in this area is taken as a standard or normal treatment and 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 $(SO_3)$ per acre. In determining the optimum amounts and ratios of these nutrients, each is varied in turn from a point below the standard amount to a point well above it.

These tests are of only two years duration and insufficient data are at hand to justify fertilizer recommendations. However, average data over a two-year period show the following trends:

**Nitrogen:** This nutrient was applied at rates of from 150 to 300 pounds per acre. The most profitable rate appears to be the 200-pound application. Higher and lower rates reduced the yield of tobacco, while quality from the standpoint of grading and ash color are little affected. The data at hand show that the fire holding capacity of the leaf was materially reduced when excessive amounts of nitrogen were used. Excessive nitrogen has also retarded early growth, increased the number of underling plants and brought about an increase in soil acidity.

- Grade index is a measure of quality based on visible characteristics of the leaf. A grade index of 1000 would indicate a crop of highest quality from the standpoint of grading.
Phosphorus: Rates of applying phosphorus vary from 100 to 350 pounds per acre. The 350-pound treatment has been superior to the lower rate treatments in producing a much better stand of plants and slightly better yields. It is noteworthy that with each increment of phosphorus the stand of plants was improved while the fire holding capacity of the leaf was reduced. Varying amounts of this nutrient affected ash color and soil acidity very little. There is some evidence of phosphorus accumulation on the lower rate treatments.

Potash: The range for potash (K₂O) is from 150 to 350 pounds per acre. The optimum rate appears to be the 200-pound treatment since the higher rates have consistently reduced the yield, stand of plants and fire holding capacity. The quality of the leaf, however, has increased consistently with each increment of potash from the lowest rate application to the highest rate. As with phosphorus, varying the amount of potash showed little effect on ash color and soil acidity.

Calcium: Calcium was applied at rates of from 50 to 300 pounds per acre. The 50-pound per acre treatment has been superior to all other treatments in this series in yield, stand of plants, quality of leaf and fire holding capacity. The higher rate applications of this nutrient have produced somewhat better ash colors than the lower rates.

Magnesium: This nutrient was varied from 20 to 100 pounds per acre. The 80-pound treatment has shown decided advantage over other rates in yield, stand and quality (grade index), whereas the 100-pound treatment has been superior to the lower rate applications from the standpoint of fire holding capacity and ash color. This latter treatment rate, however, reduced yield, stand, and grade index considerably.

Sulphur: The sulphur series includes four rates ranging from none to 250 pounds per acre. The highest rate reduced the yield and fire holding capacity slightly but has been best from the standpoint of stand of plants and quality. While it is apparent that the higher rates of sulphur aid the survival of plants, promote quality from the standpoint of grading and produce slightly better ash colors, the data show that with each increment of sulphur the fire holding capacity has been consistently reduced. Varying rates of sulphur affected ash color and soil acidity very little in these tests.

Boron: Boron was applied at rates of 0.5 and 4.0 pounds (B) per acre. The data indicates that there is no boron deficiency present in this soil in that the higher rate reduced the yield and stand considerably. While the grade index, ash color and soil reaction were not significantly changed by the higher rate treatment, the fire holding capacity was definitely increased by this latter treatment.

Chlorine: Chlorine applied at the rate of 20 pounds per acre gave a relatively poor yield and ash color while the grade index, stand and fire holding capacity obtained were average to good.

Varying Rates of Nutrients: Combining phosphorus (P₂O₅) and magnesium (MgO) with sulphur (S₂O₃) or potash (K₂O) and calcium with sulphur failed to show any advantages over the single nutrient variations in that dark ash colors were invariably obtained. However, when 60 to 100
pounds of magnesium was included in a ratio of 200 pounds phosphorus and 300 pounds calcium a very desirable ash color of good quality was obtained. A two to one ratio of potash and calcium also produced a notably good ash. These data show also that magnesium has aided the fire holding capacity of the leaf in that with each increment of this nutrient in combination with a fixed amount of phosphorus and calcium, the fire holding capacity of the leaf was consistently increased.

Broadcast and 8-inch Side Placement Treatments: In 1939 two placement treatments were included in the set-up. These were: (1) broadcasting the entire amount of fertilizer over the plot area and (2) placing the fertilizer 8 inches to the side of the row center. In both cases the fertilizer was applied at a time to allow the customary interval before setting and the "normal" formula and rate were used. Results obtained are of only one year's duration and show nothing to indicate that either of these methods is superior in yield quality and stand to the usual method of applying the fertilizer directly in the row. However, there was evidence of minimum fertilizer injury to the young plant shown by rapid early growth and vigor on both treatments.

Varying Ratios of Cottonseed Meal Nitrogen, Nitrate and Urea Nitrogen: These tests consist of combining the above sources of nitrogen in various proportions to determine the effects on yield, quality, ash color and burn. Best results were obtained when 75 per cent of the total nitrogen was taken from cottonseed meal and 25 per cent from nitrate nitrogen. The combination of 50 per cent cottonseed meal nitrogen, 25 per cent nitrate nitrogen, and 25 per cent urea nitrogen was equal to the above formula except in the grading qualities of the leaf. Poorest results in this series were obtained when 50 per cent nitrogen was taken from cottonseed meal and 50 per cent from urea. This treatment gave a very poor yield and stand of plants. The quality was good, however, and the fire holding capacity excelled that of all other treatments in this series.

Manure Tests: These tests include applications of stable manure at rates of 6, 12, and 18 tons per acre in addition to other nutrients in sufficient quantities to bring the total plant food content up to the "normal" or standard treatment. Each of these treatments has given excellent stands and yields and very good quality tobacco. The burning qualities and ash colors produced, however, have been only fair. It appears that little advantage has been gained by applying manure at rates exceeding six tons per acre.

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. The two-year average results show that tung oil pomace has been the most desirable single source of nitrogen. Cottonseed meal and castor pomace have been the second and third most desirable sources respectively. Soybean meal has given relatively poor results due chiefly to poor stands and mediocre fire holding capacity obtained with this material.

Phosphate Sources: In these tests 180 pounds of the total 250 pounds phosphorus (P₂O₅) were taken from each of the following sources: basic slag, steamed bone meal, dicalcium phosphate and superphosphate. None
of the treatments have given significant differences in yields or stands. Basic slag has given the best quality leaf (grade index) while dicalcium phosphate has been poorest in this respect. Superphosphate has been second to basic slag in producing a good grade index. The ash color from superphosphate, however, has been inferior to those of other materials in this series.

**Formula Tests:** A typical Connecticut shade tobacco formula was compared with the typical Georgia formula in these tests. The Connecticut formula carries considerably less plant food, especially phosphorus than the Georgia formula. Results to date show that the Georgia type formula has been considerably superior to the Connecticut type in yield, quality (grade index) and fire holding capacity. The Connecticut formula has given the best ash color.

**Preliminary Fertilizer Placement Tests With Shade Tobacco:** The fertilizer placement test series with shade tobacco was a cooperative project carried on jointly by this institution (Georgia Coastal Plain Experiment Station) and the Bureau of Agricultural Engineering, United States Department of Agriculture. The machinery used for distributing fertilizers and transplanting was furnished by the Bureau of Agricultural Engineering and operated under the supervision of W. H. Redit of that Bureau. Results obtained from this work are for one year and may be considered preliminary data only, as it was carried on in an open field and not under the conventional cheesecloth shade always used in the production of cigar wrapper tobacco.

The fertilizer used in these tests was the "normal" formula used in the nutrition tests under shade and applied at the rate of 2750 pounds per acre on the day of transplanting.

The treatments were as follows:

1. **2750** Pounds in bands 4½ inches to each side, one inch above root crown.
2. **2750** Pounds in bands 4½ inches to each side, one inch below root crown.
3. **2200** Pounds in bands 4½ inches to each side, one inch below root crown, 450 pounds in row.
4. **2750** Pounds broadcast over 24-inch width mixed, plants set.
5. **1375** Pounds as in (4), 1375 pounds in bands to side.
6. **1375** Pounds in bands 4½ inches to side, 1375 pounds side dress two weeks later.

Notes on the growth of each treatment showed that the surviving plants on treatments, 3, 4, and 5 began growth early and exhibited a green vigorous condition five weeks after transplanting. At this time treatments 1, 2, and 6 were still yellow and hard indicating that the root system had not yet come in contact with the fertilizer. Later all treatments except No. 6 grew off rapidly and reached good size. Treatment 6 continued small and made poor growth, due probably to the fact that no side dressing was used as called for in the outline.
These treatments were reset at weekly intervals and the number of plants replaced on each treatment was recorded. This data showed that treatment No. 4 required approximately twice as many plants as the next most injurious treatment, namely No. 5. Treatment 6 was best from the standpoint of reduced fertilizer injury in that this treatment required the least number of plants for resetting. No. 1 was next best from the injury standpoint followed by No. 2, 3, 5 and 4.

From the standpoint of early vigorous growth and fertilizer injury the data at hand showed that treatment number 3 was superior and treatment number 4 inferior to others in this series. The remaining treatments were intermediate between these extremes.

**Seed Production:** Approximately one-half acre was planted in Rg shade tobacco for seed production in 1939. This work was carried on in an open field about three-fourths of a mile from other tobacco varieties and bagging was considered unnecessary to prevent crossing. All undesirable plants and those of poor growth and vigor were destroyed before the seed flower appeared. These seed were harvested, cleaned and treated by the silver nitrate method and distributed at a nominal charge to growers desiring them.

**Shade Tobacco Diseases**

During the plant bed season of 1939 many plant beds were affected by a slight epidemic of tobacco blue mold (downy mildew); but little damage was done because of the late appearance of the causal fungus (*Peronospora tabacina*).

Under normal conditions by the time blue mold appears in the shade tobacco district the plants are about ready to set in the field. Very often the disease spreads to the shade fields and causes some damage to the lower leaves of the plants. Blue mold was noticed in several fields during the 1939 season, but the disease was not severe enough to cause any appreciable reduction in the crop. Observations in test fields indicate that much of the field damage could be eliminated by having plants ready to set the first week in April rather than the latter part of March. Since the disease generally appears in the shade district during the latter part of March and is practically gone soon after by the first of April, this practice will result in more plants having blue mold in the seed bed rather than in the field. It is more important to eliminate blue mold from shade fields than from plant beds.

The most important field disease in 1939 was frog eye leaf spot (*Cercospora nicotinae*). This disease appeared in fields throughout the shade district. Most of the damage caused by this disease was due to humid weather in April, May and June. In most cases, however, the leaf spot appeared in fields planted unusually late. The rainfall for April and May was 2.5 inches above normal. Wet weather set in the latter part of May and continued on through June with five inches of rain above normal recorded for June. This leaf spot was so severe in some late primings that a 25 to 40 per cent reduction in prices resulted because the tobacco could not be used as cigar wrappers. Crops planted early or at normal transplanting time were not damaged nearly so much as the late tobacco.
Root-knot (*Heterodera marioni*) was prevalent in the shade fields but did not do any appreciable damage to the tobacco crop. The test fields at Attapulgus showed root-knot nematodes to be abundant in the soil and in some cases the crop was reduced.

Black shank (*Phytophthora parasitica var nicotianae*) slightly damaged the commercial fields but did not cause enough damage to greatly affect the crop. Most tobacco planted was of the resistant Rg variety. In fields where a resistant variety was not planted considerable damage was noticed. The entire test field used at the Station for breeding purposes was severely infested with black shank.

**Blue Mold Control:** The grower who wishes to be sure of having plenty of plants to set his crop may spray his tobacco beds with an inexpensive spray which is applied twice a week. This spray is being used by the flue-cured growers and is discussed previously in this report under Flue-Cured Diseases.

There are other methods of controlling blue mold, among them being gassing with benzol (liquid) and paradichlorobenzene (crystals). Both of these methods are considerably more expensive than spraying and involve some changes in present plant bed practices. They appear to give almost complete control by preventing all, or nearly all, mold infection, but actually they do not guarantee an appreciably increased supply of plants over spraying. Due to this and the practice of Georgia shade tobacco growers using shades over their beds instead of cloth covers attached to board sidewalls, it is recommended that they spray instead of gas their tobacco beds.

**Avoid Root-Knot in Plant Beds:** Root-knot free plants are essential for the production of normal leaf crops. If plants infested with the root-knot nematode are set in clean fields, not only is the present crop endangered but the soil may be made unfit for tobacco production for several years, regardless of whether an effective rotation is used or not. Plant beds should be located in virgin land free of nematodes or if this is not possible then the plant bed should be sterilized by steaming. If no means of steaming is available, then burning the bed site with all available brush and wood is the best practice to use to get root-knot free plants. Special care should be taken in selecting land for plant beds to be sure that no water from infested fields has washed over the bed site, otherwise it would be possible for root-knot to develop in beds where plants have never grown before.

**Root-Knot Control by Use of Rotations and Cultural Practices:** In the past shade tobacco growers have had to move their shades because of diseases. Several two-year rotations are being tried to determine whether they will pay for themselves and at the same time help to control root-knot. Where tobacco is grown on the same land every year, late summer and fall rotations, followed by winter cover crops, are being tested. Plowing out tobacco roots and the roots of other crops immediately after harvest each year has proven worth while in controlling root-knot nematodes. This operation brings the nematodes to the surface where they are dried and killed by the sun, and is especially beneficial when followed up by turning the land.
every two weeks during the dry fall months. Where both of these practices are followed every year in conjunction with crop rotation, root-knot damage can be reduced to a minimum.

**Chemical Treatment of Soil in Tobacco Fields:** Treatment of the soil with certain chemicals has a possibility of helping the grower to control root diseases but as yet sufficient information is not at hand to determine the most effective chemical to use. If such treatments prove successful the soil may have to be treated before each tobacco crop. Present costs are considered excessive.

**Irrigation of Shade Tobacco:** An irrigation system is being installed to irrigate several plots of shade tobacco. Row irrigation will be practiced since the water will have to be confined to a small area at any one time.

Shade tobacco is a plant which has a fast growth and must continue its growth steadily until mature to make the best quality of tobacco. Plots are being irrigated regularly during dry seasons to see what effect the extra amount of water will have on the growth of the plant and the quality of tobacco grown. The irrigation system will also be used to irrigate crops which follow tobacco during the dry fall months, and vegetable crops in two-year rotations with tobacco grown on soil sterilized by chemicals.

**Dates of Planting:** The date of planting series is being continued to determine the effects on yield and quality of shade tobacco, and also on the amount of disease present.

Three different planting dates were selected in 1939. The early planting was made on March 30, the medium planting on April 7 and the late planting on April 20. The medium planting is made to correspond to the time when most of the commercial fields are planted. This experiment has not been continued long enough to make specific recommendations except in regard to blue mold.

The early tobacco had considerable blue mold on the lower leaves because it was set in the field before the seed beds had been attacked. Consequently, the mold appeared on the plants in the field rather than in the plant bed. There was very little difference between early and medium plantings with the exception that the medium planted tobacco did not show as much blue mold in the field. Late tobacco was almost always damaged more by frog-eye leaf spot and similar diseases than earlier plantings. The late plantings as a general rule suffer more during long dry periods than early plantings.

**Breeding for Disease Resistance:** Breeding for resistance to black shank and root-knot is being continued. All seeds saved from varieties in 1938 were planted in 1939. Every variety that showed resistance to black shank or root-knot was examined during the growing season and the seeds produced by these plants were gathered for future plantings. The roots of each of these varieties were checked for root-knot and plants were inspected at intervals for black shank. Only a small number of the varieties thus far tested showed any resistance to black shank. None showed complete immunity to root-knot but there were a few which were resistant enough to justify saving for future work. All of the breeding work is being conducted on soil that had previously contained black shank and root-knot. This work
will be continued in the future with the idea of obtaining varieties which will be acceptable to the trade and at the same time have the desirable character of being resistant to some of the most destructive diseases.

REPORT OF FIELD STATIONS IN McIntosh County

For several years the work in McIntosh County has been carried on in cooperation with farmers who own and operate their land. These cooperators were selected in such manner that the principal agricultural soil types would be included in the work. The types of soil on which the experiments are conducted are Altamaha Clay (the delta soil), Eulonia fine sandy loam, Bladen sandy loam and Blanton fine sand.

The tests that are being conducted include several phases of iceberg lettuce production, and variety trials and planting dates of a large number of other vegetables.

ICEBERG LETTUCE ON DELTA SOILS

Tests under way with iceberg lettuce on the delta soils are: Variety trials, planting dates, fertilizer formula test, rates of applying fertilizer, sources of ammonia, and sources of potash.

Variety Trials: Included in this test are Imperial strains 847, 44, 615, 515, and 152. These strains are listed in the order of their commercial importance. Imperial 847 and 44 are both well adapted to delta soils but the former produces a larger percentage of heads of the preferred marketable size. The heads of Imperial 44 have been slightly smaller.

Planting Dates: It has been found that seedlings in the open field between November 15 and December 1 are most desirable.

Fertilizer Formula Test: A seven-year study of fertilizer formulas for lettuce shows that 2 per cent nitrogen, 10 per cent phosphoric acid, and 6 per cent potash will satisfy the fertilizer needs of this crop. A 2-10-6 is considered a practical formula for delta soils.
### TABLE 94

**LETTUCE—FERTILIZER FORMULA TEST—ALTAMAHA CLAY SOIL**

*Average Yield for Years 1933 to 1940 Inclusive*

**Fertilizer: 1600 Pounds per Acre**

**Average Date Planted: November 18**

<table>
<thead>
<tr>
<th>FERTILIZER FORMULA*</th>
<th>Total Yield in Heads per Acre</th>
<th>Days Required to Mature</th>
<th>Days Bearing Period</th>
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<tr>
<td><strong>Phosphoric Acid Series:</strong></td>
<td><strong>Phosphoric Acid Series:</strong></td>
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<tr>
<td>6-4-6</td>
<td>3.29-6-6</td>
<td><strong>8925</strong> ****</td>
<td>134</td>
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<td>8-4-6</td>
<td>3.29-8-6</td>
<td>11150</td>
<td>134</td>
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<td>10-4-6</td>
<td>3.29-10-6</td>
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<th><strong>Ammonia Series:</strong></th>
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<td>8-4-6</td>
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<td>8-6-6</td>
<td>4.94-8-6</td>
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<table>
<thead>
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<td>8-4-8</td>
<td>3.29-8-8</td>
<td>13130</td>
<td>134</td>
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*The first column of figures represents fertilizer formulas of phosphoric acid, ammonia and potash in the order named.

In the second column, the ammonia is expressed in terms of nitrogen and the order rearranged to read nitrogen, phosphoric acid and potash.

**Six-year average.**

Rates of Applying Fertilizer: Tests over a seven-year period show that 1200 pounds of fertilizer to the acre will meet fertilizer requirements of lettuce. Split applications are recommended. About 800 pounds should be applied before planting and the remainder at the first and second cultivations.
TABLE 95

LETTUCE—RATES OF APPLYING FERTILIZER—ALTAMAHA CLAY SOIL

Average Yield for Years 1933 to 1940 Inclusive
Fertilizer: 3.29% Nitrogen, 8% Phosphoric Acid and 6% Potash
Average Date Planted: November 18

<table>
<thead>
<tr>
<th>RATE OF APPLICATION</th>
<th>Total Yield in Heads per Acre</th>
<th>Days to Mature</th>
<th>Days Bearing Period</th>
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<tr>
<td>400 Pounds</td>
<td>8027</td>
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<tr>
<td>800 Pounds</td>
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<tr>
<td>1200 Pounds</td>
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<td>1600 Pounds</td>
<td>14091</td>
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<tr>
<td>2000 Pounds</td>
<td>12167</td>
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<td>18</td>
</tr>
</tbody>
</table>

Sources of Nitrogen: Nitrate of soda as a source of nitrogen has yielded higher than either sulphate of ammonia or urea.

Sources of Potash: Muriate of potash appears to be superior to either sulphate of potash or kainit as a source of this plant food element.

LETTUCE IRRIGATION STUDY

(Soil Type: Blanton Fine Sand)

Irrigation: The normal rainfall of coastal Georgia will usually satisfy the moisture requirements of this crop after the plants begin growth and become well established in the field. The irrigation system has been found valuable for insuring prompt germination of seeds and for use when plants are being transplanted.

Fertilizer Study: A three-year study of the fertilizer needs of iceberg lettuce on the upland irrigated area, indicates that 1,000 pounds per acre of a fertilizer containing, 4 to 6 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 6 to 8 per cent potash will supply the plant food needs of this crop on the upland soils of coastal Georgia. A 4-8-6 fertilizer combination is giving good results in commercial plantings.

VARIETY TESTS OF WINTER VEGETABLES ON UPLAND AND DELTA SOILS IN THE TIDEWATER SECTION OF GEORGIA

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

Broccoli: Green Sprouting broccoli has consistently produced better than the heading varieties.

Cabbage: Included in the varieties under trial are Charleston Wakefield, Drumhead Savoy, Wisconsin All Season, Stein’s Early Flat Dutch, Chinese Chihili, Golden Acre, Marion Market, Wisconsin No. 8, Succession and
Copenhagen. No varieties have produced as consistently as Charleston Wakefield and Copenhagen. The extreme cold of the past winter caused all varieties to produce seed.

Carrots: Chantenay, Danver’s Half Long, Imperator, Red Cored Chantenay, and Oxheart are the varieties being grown. Chantenay and Imperator are best suited for market purposes.

Cauliflower: Early Snowball produces more marketable heads than Autumn Giant and Dwarf Erfurt.

English Peas: Improved Telephone and Thomas Laxton yield higher than Extra Early Alaska and Dwarf Telephone, or Daisy varieties. English peas are recommended for home use.

Kale: Early Green Curled kale produces well in coastal Georgia.

Mustard: The varieties being grown are Tendergreen, Giant Green Curled, and Florida Broad Leaf. For market purposes Tendergreen and Giant Green Curled are superior.

Onions: This study includes Yellow Bermuda, Yellow Globe Danvers, Bloomsdale Extra Early Pearl, Southport Yellow Globe, Sweet Spanish, Ebenezer, Prizetaker, and Australian Brown. Yellow Bermuda, Prizetaker and Australian Brown are well adapted.

Radish: Early Scarlet Globe, Early White Tipped Scarlet, and French Breakfast all produce well.

Rape: Dwarf Essex is recommended for home use.

Rutabaga: Improved American is well adapted to soils of coastal Georgia.

Spinach: This vegetable does not grow well on the acid soils of coastal Georgia without a generous application of lime. Virginia Blight Resistant and Norfolk Savoy are superior to King of Denmark and Long Standing Bloomsdale.

Turnips: Purple Top, Shogoin and White Egg all produce well. Shogoin is best for summer use.

**VARIETY TESTS OF SUMMER VEGETABLES ON UPLAND AND DELTA SOILS IN THE TIDEWATER SECTION OF GEORGIA**

Beans (Lima): Henderson Bush appears to be superior to Jackson Wonder and Fordhook.

Beans (Snap): Giant Stringless, Bountiful and Tendergreen produce well. Giant Stringless seems best suited for market purposes.

Corn (Roasting Ear): With this crop it has been found that Trucker’s Favorite, Golden Bantam and Hastings’ Early Market are superior for home use. The crop appears to hold little commercial value.

Cucumbers: A. & C. Special is superior for market purposes to White Spine, Straight-Eight, Improved Long Green, and Davis Perfect.

Okra: White Velvet is recommended for home use. Clemson Spineless has shown to good advantage this year.
Tomatoes: Marglobe and Livingston Globe yield higher than the other varieties which include Pritchard, Break O’ Day, Greater Baltimore, Rutger’s and Chalk’s Early Jewel.

VEGETABLE PLANTING DATES ON DELTA AND UPLAND SOILS IN THE TIDEWATER SECTION OF GEORGIA

Iceberg lettuce should be seeded in the open field on the delta from November 15 to December 1. On the upland soils it should be seeded in beds two to three weeks earlier under normal conditions. Occasionally a late fall will cause this early seeding to make too much growth before time to transplant and for that reason a second sowing of seed beds the middle of November is recommended as a good farm practice. This crop usually matures in late March and early April when there is normally very little quality lettuce on the market.

Fall cabbage when transplanted to the open field September 15 will mature in early January when the market is usually favorable. A spring crop transplanted in early February will normally mature after the bulk of the Florida crop has been moved, thus giving a better market.

Carrots planted November 1 to 15 will mature in late March and April when market conditions are usually favorable. Considerable trouble has been experienced on the delta soils in properly cleaning the roots for bunching. To date no economical method of cleaning has been found.

Onions should be seeded October 1 to 15. If plants are used they should be transplanted in November.

Tomatoes should be transplanted in early March in order to find a ready market. Later plantings for market are not recommended.

Snap beans planted in early March will normally find a satisfactory market.