which greatly improves the condition of the cotton and facilitates the ginning operation. With the general application of the improvements that are possible in the mechanical adjustment and operation of the ginning machinery, the present enormous losses through poor ginning and consequent damage to quality and utility of the fiber should be largely avoided.

C. B. DOYLE, *Bureau of Plant Industry.*

FERTILIZER Composition and Placement Play Big Part in Cotton Growing

In the production of cotton some 2,000,000 tons of commercial fertilizers are utilized annually in the United States. These fertilizers are especially important in cotton production in the Southeastern States, where about 95 per cent of the cotton acreage receives commercial fertilizers. Approximately one-third of all the fertilizer consumed in the United States is used in cotton production. In the south-central cotton-producing States only about 50 per cent of the acreage receives fertilizers, and in the southwestern belt only a small amount of commercial fertilizer is used in growing cotton, and this is confined to a relatively small acreage.

Composition of Fertilizers

The composition of fertilizers best suited for cotton growing differs with soil and climatic conditions. In the Southeastern States most soils used for cotton require, for normal growth and development, a complete fertilizer containing a well-balanced proportion of nitrogen, phosphoric acid, and potash, the analysis and fertilizer material depending in a large measure on the type of soil.

On the gray sandy loam soils of the coastal plain, occuring in the extreme northeastern section of the Cotton Belt including southeastern Virginia and northeastern North Carolina, which normally produce a rank vegetative growth, making early maturity an essential factor, a mixture containing 4 per cent of nitrogen, 12 per cent of phosphoric acid, and 4 to 6 per cent of potash is suitable. On the lighter soil types in this area, on which vegetative growth is inclined to be less vigorous, a mixture containing 6 per cent of nitrogen, 10 per cent of phosphoric acid, and 4 to 6 per cent of potash usually gives the best results.

For the heavy clay loam and sandy loam soils of the central coastal plain section, including eastern North Carolina and eastern South Carolina, which normally produce rank vegetative growth, making early maturity essential, a mixture containing 4 per cent of nitrogen, 10 per cent of phosphoric acid, and 4 per cent of potash is suitable. On the lighter sandy and sandy loam soils of the area a mixture containing 4 to 5 per cent of nitrogen, 8 per cent of phosphoric acid, and 3 to 4 per cent of potash may be used with better results in order to stimulate vegetative growth. On the lighter sandy soils of this area the application of materials containing 18 to 30 pounds of nitrogen per acre in readily available form has proved profitable when made after the cotton is up, in addition to the complete fertilizers applied at planting.

For the clays and clay loams of the piedmont section of North Carolina, South Carolina, Georgia, and Alabama, a mixture containing 4 to 5 per cent of nitrogen, 10 per cent of phosphoric acid, and 2 to 3 per

cent of potash has given good results. The sandier soils of this section may do better with mixtures containing 4 to 5 per cent of potash. On its less fertile soils it is considered good practice to use from 18 to 30 pounds of nitrogen per acre, from readily available materials, after the cotton is up, in addition to the preplanting application.

On the coastal plain soils of Georgia, particularly the heavy, dark, pebbly soils of the Tifton series, a mixture containing 3 per cent of nitrogen, 9 per cent of phosphoric acid, and 5 per cent of potash is recommended. A mixture containing 3 per cent of nitrogen, 9 per cent of phosphoric acid, and 8 per cent of potash may be better for the sandier and lighter phase of this soil. The gravelly, sandy soils of the Norfolk series respond well to a mixture containing 4 per cent of nitrogen, 8 per cent of phosphoric acid, and 4 per cent of potash; and for the red and brown soils of the Greenville and Orangeburg series a mixture containing 4 per cent of nitrogen, 10 per cent of phosphoric acid, and 4 per cent of potash seems most effective. On the light, porous, sandy soils of this section from 18 to 20 pounds of readily available nitrogen per acre can be used at the first cultivation of cotton after chopping, in addition to the usual application of complete fertilizer before planting.

For the hill and flatwoods soils of Mississippi a fertilizer containing 4 to 6 per cent of nitrogen, 8 per cent of phosphoric acid, and 4 per cent of potash is suitable; for the prairie section the mixture may contain 8 per cent of nitrogen and 8 per cent of phosphoric acid, except on soils subject to cotton rust, where an 8–8–4 mixture is recommended. Where it is desired to use a higher-analysis fertilizer, multiples of the foregoing ratios should be used.

For the Mississippi Delta and other bottom soils near streams in the central Cotton Belt, from 25 to 30 pounds per acre of nitrogen alone has generally been used with success, and on the soils subject to cotton rust 25 pounds per acre of potash in addition to the nitrogen may be profitable.

The fertilizer requirements of the soils used for cotton in western Louisiana and eastern Texas are somewhat similar to those of the more eastern soils of the central Cotton Belt. Little fertilizer is used in the southwestern Cotton Belt, which may be designated as that area having its eastern edge at the dividing line between the great black-prairie region and the timbered section of the East. It includes three-fourths of the States of Texas and Oklahoma and all of New Mexico and Arizona.

In the black-prairie region where there is considerable loss of cotton from root rot, response from applications of quickly available nitrogen fertilizers or mixtures of phosphate and quickly available nitrogen has been noted in recent experiments. This response is shown primarily in the rapid growth produced, and the early fruiting of the plant and maturing of the cotton, that result in a considerable increase in yield at the earlier pickings. The earlier maturing of cotton on these black-prairie soils, brought about by the addition of quickly available nitrogen and phosphoric acid, is a means of preventing losses from killing of plants by root rot later in the season. The rational use of fertilizers and a practice of modified tillage, in conjunction with crop rotation, soil conservation, and other measures of maintaining or restoring fertility, offers promise for directly or indirectly controlling cotton root rot in the black-land region of Texas.

Fertilizer Materials

Nitrogen is probably the most important fertilizer constituent in growing cotton on most soils. It is required for vigorous growth in the early part of the season. The principal inorganic-nitrogen sources used in cotton fertilizers are sodium nitrate and ammonium sulphate, and the principal organic sources are cottonseed meal, tankage, fish scrap, and dried blood. The synthetic-nitrogen materials, such as urea and a combination of this with other salts, are suitable for cotton fertilizers. A mixture of inorganic or synthetic nitrogen salts with organic nitrogen of vegetable and animal-waste origin is considered best for most cotton soils, when used with phosphoric acid and potash in preplanting applications.

Phosphoric acid is essential for the cotton plant at all stages of growth, but its principal and most important rôle is in maturing the cotton. Superphosphate is the principal source of phosphoric acid in commercial fertilizers. Grades containing from 16 to 48 per cent of phosphoric acid are available. Ammonium phosphate, produced by combining air-derived nitrogen and phosphoric acid, is available for cotton fertilizers.

Potash is essential for the normal development of the cotton plant and for the proper maturing and opening of the bolls. The principal sources of potash in fertilizers for cotton are potassium chloride, potassium sulphate, manure salts, and kainit. The first two contain approximately 50 per cent of potash, manure salts contains from 20 to 30 per cent of potash, and kainit from 12 to 16 per cent of potash.

Quantities of Fertilizers

The most profitable quantity of fertilizer per acre for cotton varies with soil conditions, farm management, and economic conditions. The largest acreage applications are in the Southeastern States. Experiments on soils east of the Mississippi River show that from 600 to 800 pounds of well-balanced commercial fertilizers per acre have generally proved the most profitable. On many of the heavier overflow soils of this belt, best results may be obtained by adding quickly available nitrogen salts alone at the rate of 18 to 20 pounds of nitrogen per acre, applied after the cotton is up. In that section of the Cotton Belt west of the Mississippi River where commercial fertilizers have proved profitable, from 300 to 500 pounds of commercial fertilizers have generally given as good results as larger quantities.

Placement of Fertilizers

Cottonseed should not be planted in contact with fertilizers. It is common practice in much of the Cotton Belt to apply the fertilizers in an open furrow, mix them with the soil, cover them, and allow the seed bed to settle for 8 to 10 days before planting the seed. By this procedure the seed is planted above the fertilizer, on settled ground, which practice has generally proved satisfactory. Combination planters and fertilizer distributors, which apply fertilizers and plant the seed simultaneously, have recently been introduced. Data made available by experiments with machine application of fertilizers to cotton indicate that to obtain the most rapid coming up of cotton plants, the best stands and the largest yields, the fertilizer placement is in bands about 2 inches

to each side of the seeds and about 2 inches below the level of the seeds. Placement of fertilizers in relation to the seed is an important factor in cotton growing, especially with fertilizer containing quickly soluble salts.

In growing cotton, serious consideration should be given to the selection and fertilization of the land. High acreage yields tend to lower the cost of cotton production, and the use of proper fertilizers should be helpful.

J. J. SKINNER, *Bureau of Chemistry and Soils.*

COTTON Diseases Take Two Million Bales of U. S. Crop Annually

Cotton is attacked by many fungous, bacterial, and physiological diseases which cause annual losses of more than 2,000,000 bales to the cotton crop of the United States. Twenty-eight specific diseases in various sections of the Cotton Belt have been reported by pathologists and mycologists during the last 20 years. The major diseases affecting cotton in the order of their importance, are root rot, Fusarium wilt, bacterial blight (in its various phases), root knot, rust, anthracnose, and Verticillium wilt.

Root Rot

Root rot, caused by the fungus *Phymatotrichum omnivorum*, is the most important cotton disease in the southwestern States. The greatest damage occurs in Texas, especially in the heavy black-waxy soils. In this State the disease attacks cotton in 196 counties and, it is estimated, causes an annual loss of 12 to 15 per cent of the crop; total losses to the State are estimated at $100,000,000 annually. Root rot is also responsible for serious losses in parts of Arkansas, Oklahoma, New Mexico, Arizona, southern California, and in northern Mexico. Observations over a period of years show that the root-rot fungus is native to this region, as it is often found on wild plants remote from cultivation and frequently attacks cotton, alfalfa, and other susceptible plants when virgin land is cleared and planted to these crops. More than 600 cultivated and wild plant species are known to be susceptible to it.

By attacking and destroying the root system, the fungus causes sudden wilting and death of the plants, its growth in the soil being entirely subterranean except when it is producing fruiting bodies. During warm periods following rainy weather in midsummer and later, the disease is very active, often completely killing out large areas of cotton.

In contrast with the ordinary means of dissemination of other fungous and bacterial diseases of cotton, there is no evidence that root rot is spread by such agencies as farm implements, animals, wind, or water from infested fields, but may be carried to new localities through the transfer of infected plants or of sclerotia. The root-rot spots in cotton or alfalfa fields usually persist in the same areas for several years, and enlarge each year by a new belt of growth, where the disease often is more destructive than in the area previously occupied. In cotton fields the spots may dissappear for a season or longer and then reappear as small centers of infection which begin to expand with renewed vigor.

Studies of the fungus have shown that three stages of development occur in its life history. These are: (1) The vegetative or Ozonium