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Effect of Nitrogen, Phosphorus, and Potassium in Fertilizers on the Earliness of Cotton

By

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By H. B. Brown and H. W. Pope

INTRODUCTION

It has been well known for a good many years that needed fertilizers applied to cotton will increase the growth of plants and their production of bolls. It has been found, too, by several investigators that certain fertilizers containing phosphorus will increase the earliness of cotton, especially the rate of fruiting during the first weeks of the fruiting season. On account of the amount of damage that the boll weevil does to cotton in parts of Louisiana, and because anything that increases the rapidity of cotton fruiting lessens boll weevil damage, it has seemed worth while to determine definitely the effect of the main cotton fertilizers on rate of fruiting when used under conditions in south Louisiana, where the climate is humid and especially favorable to boll weevils.

REVIEW OF LITERATURE

Nelson and Ware (1), in some recent research in Arkansas, made a study of the effect of nitrogen, phosphorus, and potassium fertilizers on the fruiting of cotton. This study extended through a period of five years and was made on cotton growing on Arkansas river valley soil in central Arkansas. They found that the first or lowest application of phosphorus increased the percentage of earliness, but further additions appeared to be ineffective. The lint in 100 bolls was increased slightly by the lowest application of nitrogen, but heavier applications produced no further increase. The weights of seeds were slightly higher from the heavier applications of nitrogen, but the lint index and the percentage of lint were lower. Staple length was not affected by the various nitrogen treatments used. Potassium, on the average, appeared to increase slightly the number of squares, blooms, and bolls.

Williams and associates (2) investigated the effect of superphosphate on the yield and earliness of cotton grown on certain soil types in North Carolina. They found that increasing the percentage of phosphoric acid applied resulted in an earlier crop and profitable increases in yield were obtained very generally from the use of phosphorus-bearing fertilizers.

Warner (3), of South Carolina, reported that, both on lands in cotton continuously and in rotations, a higher percentage of phosphorus in a complete fertilizer resulted in earlier fruiting. On land continuously cropped to cotton, an increase in the amount of nitrogen increased the rate of fruiting and prolonged the fruiting period. Where cotton was rotated with cover crops, nitrogen delayed maturity slightly. Potash had no significant influence on early fruiting, but apparently prolonged the fruiting period.

Buie has carried on a number of fertilizer experiments in South Carolina in which studies were made of the effect of the main fertilizer ingredients on the earliness of cotton. In a recent paper, Buie (5) makes a summary of 42 experiments. He says: "Nitrogen, by inducing early vegetative growth, hastens early flowering; phosphoric acid hastens reproductive activity of the plant, and potash prolongs the period of produc-
tive fruiting. Either one is most effective only when an optimum amount of the others is present, however, which means that ordinarily a complete fertilizer should be applied to cotton. The specific analysis found to be best suited to local conditions should be used.”

Foaden of Egypt, Duggar of Alabama, Fox of Mississippi, Ethridge of Missouri, and others have reported that phosphoric acid in fertilizers hastened maturity. Most investigators have found that nitrogen and potash increased yields but that they did not increase earliness. Several have reported that potash appeared to delay maturity.

LOUISIANA FERTILIZER EXPERIMENTS

In 1927 a rather extensive general cotton fertilizer experiment was started on bench land soil on the Experiment Station Farm at Baton Rouge. The soil type was mainly Olivier, but the plots contained some areas of Lintonia. This was old land but in fair tilth and fertilizers gave moderately good gains as a rule. The seasons were about normal. In this region there is usually a sufficiently heavy rainfall to keep the land moist at all times but too much rainfall is unusual. Much of the rainfall during the time the cotton is fruiting comes in the form of frequent, light, afternoon showers. These rains favor the growth of cotton plants, but they make the control of boll weevils difficult. Weevils are usually abundant and do much damage unless controlled with poison.

In the experiment, 92 plots were used, each containing 1/30 acre. These were divided into four series, each containing 24 treatments. Each series contained three divisions. In the first of the divisions, the application of phosphoric acid was varied from 0 to 24 per cent in 4 per cent increments, the other two fertilizer ingredients being held constant at 5 per cent for the nitrogen and 4 per cent for the potash. In the second division of the series, the nitrogen was varied with the percentages running 0, 3, 4, 5, 6, 7, and 8; the phosphoric acid was held at 8 per cent and the potash at 4 per cent. In the third division of the series, the potash application ranged from 0 to 12 per cent in 2 per cent increments, and the nitrogen and phosphoric acid were held at 5 per cent and 8 per cent, respectively. All the applications were made before planting at the rate of 600 pounds per acre.

The main object of the fertilizer test was to determine the fertilizers needed for the land mentioned and the most profitable ratios to use. Results dealing with these questions have been published in Louisiana Experiment Station Bulletin 301. A secondary object of the experiment was to determine the effect of each fertilizer ingredient on the earliness of cotton. This was measured by the percentage of cotton obtained from various plots at the first picking and by the comparative blooming rates. Bloom counts were made on check plots in each series, on plots that received a heavy application of the particular fertilizer in question, as phosphorus for instance, and on plots that received the regular application of the other two fertilizers, but none of the first ingredient. (See legends of Figures 1 to 9). Counts were made daily for a period of five to seven weeks, which covered the main blooming period for the years studied. Blooming later in the season is irregular, due to boll weevil punctures.

EFFECT OF PHOSPHORUS ON EARLINESS AND YIELDS

Figure 1 shows graphically the effect of phosphorus on the earliness of cotton as measured by the percentage of the seed cotton that is obtained the first picking. The plots receiving the heavy application of phosphoric acid (24 per cent in a 600 pound fertilizer), shown by the dotted line, have a comparatively high yield that runs through the different years consistently. The plots receiving nitrogen and potash but no phosphorus (shown by the solid line) were lower in percentage gathered at first picking than the plots receiving no fertilizer (shown by the line of dots and dashes) four years
out of five and the difference was slight the one year. The unfertilized plots had more bolls that failed to develop properly, and more that opened prematurely, than the plots receiving nitrogen and potash.

The percentage of seed cotton obtained at the first picking depends in a measure on the time of the season that the picking is done. As will be readily seen, if the picking is delayed, a larger percentage of the total crop will be gathered at the first picking, but since this applies to all treatments alike, results are comparable. The figures used in constructing the graphs were five-year averages.

Figure 2 shows the effect of phosphorus on the earliness of cotton as measured by blooming rate during the first two weeks of the blooming period. Here, as in case of Figure 1, the curve for the plots receiving the heavy application of phosphorus is consistently high and regular. The curve showing the blooming rates of plots receiving only nitrogen and potash is very similar to that for the no fertilizer plots, indicating slight difference in blooming.
At first thought it may seem that two weeks is a short period of time in which to measure or get a line on seasonal blooming. A glance at Figure 10 will show that, on the average for the five-year period during which blooms were counted, the peak of blooming was reached during the second week counted. It has been learned, too, by making shedding studies, that a high percentage of the blooms that open during the first two weeks make bolls, while only a very low percentage of the later blooms produce bolls.

![Figure 2. Effect of Phosphorus on Earliness in Cotton as Measured by Percentage of Blooms the First Two Weeks of Blooming.](image)

Figure 3 indicates graphically the effect of a heavy application of phosphorus fertilizer on yields of seed cotton. The yields from the plots receiving the phosphorus fertilizer are consistently higher than the yields from plots receiving no phosphorus fertilizer, and considerably higher than those from plots receiving no fertilizer. The difference in yields between the heavy phosphorus and the no phosphorus plots is not as great as might have been expected from the appearance of the curves in Figures 1 and 2. This may be at least partially accounted for by the fact that the boll weevils were controlled fairly well so that the later plants had a chance to produce a good crop of cotton.
EFFECT OF NITROGEN ON EARLINESS AND YIELDS

In Figures 4, 5, and 6, the effect of a heavy application of a nitrogenous fertilizer is shown in comparison with the effect of a fertilizer containing only potash and phosphoric acid, and in comparison with the effect of no fertilizer. Figure 4 shows that there is slight difference between the two sets of plots insofar as earliness is concerned, but there is some indication that nitrogen may retard boll opening to some extent. This is doubtless due largely to the fact that a higher percentage of the bolls on plants well fertilized with nitrogen reached maturity before opening. Although the percentage of open bolls on the no-nitrogen plots was somewhat larger than on the nitrogen plots, the latter produced more good bolls during the season as is evidenced by the higher yields.

Figure 5 shows that, measured by rate of blooming, there was practically no difference in earliness between plots that received nitrogen and plots that did not. The plots that received no fertilizer at all were slightly later on the average, but the difference was not great.

In Figure 6, the effect of the fertilizers on yield is shown. Both sets of fertilized plots are considerably above the unfertilized on the average and the plots receiving the heavy application of nitrogen are consistently and considerably higher in yield than the plots that received no nitrogen. As the experiment became older the margin be-

![Figure 3. Effect of Phosphorus on Cotton Yields.](image-url)
between the yields of the fertilized plots became greater, indicating possibly some cumulative effect of the heavy application.

**EFFECT OF POTASH ON EARLINESS AND YIELDS**

Figures 7, 8, and 9 show the effect of potash in a fertilizer. From Figure 7 it appears that potash retarded boll opening regularly but operated through a rather narrow range. The plots receiving no fertilizer had, on the average, about the same percentage of open bolls on given dates as the plots receiving a heavy application of potash.

![Graph showing effect of nitrogen on earliness in cotton]

**Figure 4. Effect of Nitrogen on Earliness in Cotton as Measured by Percentage of Seed Cotton First Picking.**

Figure 8 shows that the blooming rate, based on the annual averages for the five years, is about the same for all the treatments, including no fertilizer, no potash, and a heavy application of potash. The curves for yields, however, in Figure 9, show considerable difference for the different treatments and the spread between them appears to become greater with the passage of time. Continuous cropping exhausts the nutrients in the soil and makes fertilizers all the more necessary. A complete fertilizer, represented by the heavy application curve, not only maintains the current level of production, but tends to raise the level.
COMPARATIVE BLOOMING RATES INDUCED BY HEAVY APPLICATION OF THE DIFFERENT FERTILIZERS

Figure 10 indicates graphically the comparative blooming rates induced by heavy applications of phosphoric acid, nitrogen, and potash during the first five weeks of the blooming period. The graphs are based on data obtained in a study running through five years. All the fertilized plots received complete fertilizers, the difference being that the special ingredient in a set of plots, as phosphorus for instance in the first set, was unusually heavy, the nitrogen application heavy in the second set, and the potash application heavy in the third. The plots receiving the heavy application of phosphoric acid are outstanding in blooming rate during the first four weeks and very little behind in the fifth week. The plots receiving the heavy application of nitrogen or potash were intermediate between the unfertilized and the heavy phosphoric acid plots in blooming rate, but they are not significantly different from each other. The unfertilized plots are consistently considerably below the fertilized ones.

As was noted previously, the blooming rate, considering the average for the five-year period, reached its peak during the second week that counts were made. Counts were not started, however, until the cotton was blooming rather freely. For some reason, there were waves in the rate of blooming (see Figure 10), alternating weeks
being low and high. This appears in the averages for the five years and in the counts for most of the individual years. It has also appeared in the rate of blooming observed in spacing work conducted by Cotton and Brown (4), and in other cotton experiments. The authors are unable to explain the exact cause of this. It appears, however, that the plants in a wave of heavy flower production use their stored food supplies or energy, then they must be less active for a few days until another supply is built up.

Figure 11 shows the relative plot yields, for a five-year period, of the plots receiving the heavy fertilizer applications mentioned. These graphs show that there is not a great amount of difference between the yields effected by the different treatments, and they follow much the same course. Three years out of five, the plots that received a heavy application of potash appeared to be somewhat outstanding in yields. All the fertilized plots showed an upward trend in yield, while the unfertilized ones showed a downward trend.

By comparing Figures 10 and 11, one may be led to conclude that a heavy rate of blooming, as shown by the phosphorus curve, does not necessarily mean high yields. In Figure 11 the phosphorus curve shows lower yields than either of the other fertilized plots. The rate of shedding may be considerably higher on plants that do much blooming.
Table I gives the fertilizer application and plot yields for the various treatments, each for the five-year period, as well as the average yield for each of the different treatments. The heavy application of potash (5-8-12) leads in average production.

**TABLE I. PLOT YIELDS OF SEED COTTON IN FERTILIZER TEST**

<table>
<thead>
<tr>
<th>Fertilizer 600 Pounds per Acre Basis</th>
<th>1927 Pounds</th>
<th>1928 Pounds</th>
<th>1929 Pounds</th>
<th>1930 Pounds</th>
<th>1931 Pounds</th>
<th>Average Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-0-4</td>
<td>77.6</td>
<td>53.6</td>
<td>58.3</td>
<td>69.2</td>
<td>84.8</td>
<td>68.7</td>
</tr>
<tr>
<td>5-24-4</td>
<td>84.6</td>
<td>61.1</td>
<td>61.8</td>
<td>79.6</td>
<td>89.9</td>
<td>75.4</td>
</tr>
<tr>
<td>0-8-4</td>
<td>60.2</td>
<td>48.5</td>
<td>44.3</td>
<td>67.4</td>
<td>56.5</td>
<td>55.4</td>
</tr>
<tr>
<td>8-8-4</td>
<td>77.4</td>
<td>55.3</td>
<td>64.6</td>
<td>81.1</td>
<td>103.9</td>
<td>76.4</td>
</tr>
<tr>
<td>5-8-0</td>
<td>78.2</td>
<td>56.7</td>
<td>59.4</td>
<td>75.1</td>
<td>63.6</td>
<td>66.6</td>
</tr>
<tr>
<td>5-8-12</td>
<td>78.2</td>
<td>63.4</td>
<td>72.3</td>
<td>98.1</td>
<td>97.0</td>
<td>81.8</td>
</tr>
<tr>
<td>0-0-0</td>
<td>60.0</td>
<td>55.3</td>
<td>37.9</td>
<td>54.8</td>
<td>46.6</td>
<td>50.9</td>
</tr>
</tbody>
</table>
GENERAL DISCUSSION

In regions where boll weevils are numerous and hard to control, as in the warm, humid regions like south Louisiana, earliness in cotton is an important matter. The rate at which fruiting goes on after it starts is of more importance than the date of starting. Some varieties, like Okra-leaf Delfos, for instance, start blooming early and bloom freely, but shed forms so heavily that the net results are poor. A desirable early cotton is one that puts on a large crop of good bolls in a short space of time during the fore part of the season.

Proper fertilizers increase the rapidity of growth of cotton plants so that they may begin fruiting sooner, and they also increase the vigor of plants so that there is less

<table>
<thead>
<tr>
<th>Year</th>
<th>No Fertilizer</th>
<th>Heavy Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1927</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>1928</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td>1929</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>1930</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>1931</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

**Figure 8.** Effect of Potash on Earliness in Cotton as Measured by the Percentage of Blooms the First Two Weeks of Blooming.

...shedding. As was shown previously, several experimenters have found that nitrogen has a tendency to cause plants to make a better growth and thus increases their fruiting. They have found, too, that phosphorus increases the earliness and the rapidity of fruiting early in the season, and that potash has a tendency to delay maturity. In these experiments at Baton Rouge, phosphorus increased the rate of flowering decidedly during the first four weeks of fruiting, but later in the season, the rate of fruiting was lower than on some plots that had received no phosphorus. The early setting of fruit had a tendency to retard vegetative growth and the smaller plants had less space for bolls. Shedding was probably heavier also on the plots that had a heavy application of phosphorus.

In these experiments, the cotton was fairly well protected from boll weevil damage by systematic poisoning of the weevils. If the cotton had not been protected from
weevil attack, the results would probably have been considerably different. In cotton not treated to control weevils, it is only the earliest blooms that make bolls. This would favor the early blooming phosphorus plots. As it was, the phosphorus plots were lower in yields, on the average, than either of the other sets of plots that received complete fertilizers. The plots that received the heavy application of potash were somewhat outstanding in yields during most years that the experiment ran. Apparently, the soil was becoming more deficient in potash as the experiment progressed, and the application gave greater returns. (See Figures 9 and 11). On other land if there had been an abundance of potash in the soil, the results would probably have been different.

![Graph showing effect of potash on cotton yields for a five-year period.](image)

<table>
<thead>
<tr>
<th>Lbs. Seed Cotton</th>
<th>1927</th>
<th>1928</th>
<th>1929</th>
<th>1930</th>
<th>1931</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>No Fertilizer</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No Potash</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Application</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>of Potash</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

**Figure 9.** Effect of Potash on Cotton Yields for a Five-Year Period.

**REFERENCES**

Figure 10. Mean Blooming Rates by Weekly Intervals—Five-Year Average.
Figure 11. Annual Yields of Seed Cotton for a Five-Year Period.