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# Yield and Composition of Cottonseed as Influenced by Fertilization and Other Environmental Factors[1]

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[1] Submitted for publication May 14, 1948. The experiments were conducted in cooperation with the State agricultural experiment stations of Arkansas, Florida, Georgia, Louisiana, North Carolina, and South Carolina, and with the Georgia Coastal Plain Experiment Station.

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[3] All analyses of cottonseed composition were performed at the Arkansas Agricultural Experiment Station, Fayetteville.

[4] Grateful acknowledgment is made for the cooperation of all State and Federal experimenters who have furnished cottonseed from fertilizer trials and provided data of other cotton cultural studies. Among these workers are E. E. Hall, W. L. Nelson, A. R. Knudsen, E. R. Collins, P. H. Kime, G. M. Armstrong, C. C. Bennett, and C. C. Miley. Appreciation is expressed for assistance during planning of the study, statistical evaluation of the results, and guidance in preparation of the manuscript to J. O. Ware and H. D. Barker, of the Division of Cotton and Other Fiber Crops and Diseases, and to the late O. A. Pope, Office of Foreign Agricultural Relations. Since the submission of this manuscript, H. B. Brown has retired and R. P. Bledsoe has died.

THE advent of World War II brought about a great demand for each of the four principal cottonseed products: Crude oil; high-protein meal; linters; and hulls. Each was considered critical and was either rationed or its use controlled to an extent that warranted extensive studies in regard to the relative productivity and partial composition of cottonseed that might be influenced by variety on the one hand and by cultural practices on the other. Accordingly, cottonseed from a great many Federal-State cooperative experiments throughout the United States has been examined for differences associated with varietal potentials and for differences induced by variations in cultural practices. The results are summarized as follows.

## SUMMARY

Fertilizer applications that tend to increase seed yields also tend to increase cottonseed grade through higher percentage deposition of oil or protein or both. The degree of change in percentage composition, however, was found dependent upon experimental conditions, particularly those related to availability of the specific elements and to balance within the natural nutrient supply of the soil.

Percentage of composition of seed was less affected by variation in environment than the partial gram composition of the seed or the pounds-per-acre yield of oil, protein, kernel, hull, and fuzz. Conditions tending to increase acre production of cottonseed tended also to increase acre production of each product, almost regardless of variation in percentage composition.

Increase in nitrogen supply to the plants was associated with an increased percentage of protein content and a slightly lowered percentage of oil content, thereby contributing to a slightly higher percentage reserve capacity (percentage of oil plus percentage of protein) of the fuzzy seed. Cottonseed grade, being more dependent upon oil than protein content, tended to be unaltered, so that unit price of seed was little changed by increase in nitrogen supply.

Increase in phosphorus supply did not produce any consistent increase or decrease in oil and protein content of cottonseed. Where it was added to soils markedly deficient in phosphorus or where it was added in considerable excess it occasioned variability, but the exact effect on morphological and chemical composition of seed was dependent upon other experimental conditions.

Increase in potassium supply usually occasioned a marked increase in percentage of oil content of cottonseed and only a slight decrease in percentage of protein content, with an increase in the percentage of both the total reserve capacity and the cottonseed grade. One distinct exception was found where both yield and percentage of chemical composition of seed were reduced.

The main effects of nitrogen, phosphorus, and potassium fertilization on these variables were not found to be entirely independent, but no general conclusion could be drawn as to exact dependence of increase in one element of supply as affected by the level of one or both of the others. The net exact effect on composition (and on yield and acre value of seed as well) appeared to be related to the manner in which the application affected the

balance and availability of the total nutrient supply to the cotton plant. The highest total percentage of reserve capacity of the seed or kernel was usually found at a point where the yield indicated an optimum balance of the nutrients available for growth of plants and maturation of seed.

Sodium appeared to have an effect similar to that of potassium, but it was not tested sufficiently to permit exact deductions.

Calcium and magnesium were not found to occasion any markedly consistent variations in composition of cottonseed. The effects observed were more probably related to induced changes in the pH value of the soil (where lime, gypsum, magnesium sulfate, and dolomite were used), which conditioned comparative availability of the other elements of supply.

Natural manures increased total percentage of reserve capacity of seed, but specific effects on percentage of oil and nitrogen content were dependent on moisture supply and other within-test conditions.

Seed from the top or later crops was usually higher in oil content and often higher in percentage of protein than was the earlier initiated seed from the bottom crop. This trend is also dependent upon experimental conditions. In highly infertile soil and under drought conditions the later seed tended toward a less adequate percentage of reserve composition.

Plant diseases that kill maturing plants or seriously limit nutrient uptake and translocation—fusarium wilt of cotton and Texas root rot—caused reduced oil and nitrogen content of seed, particularly in seed from late-initiated bolls.

Oil and protein content of cottonseed tended to vary in an inverse manner in response to changes induced by fertilization and environment, but the association was found more consistently significant when measured as percentages in the kernels. This limitation exists mostly because variations in proportions of kernel to fuzzy hull are often independent of variation in the oil and protein content of kernels, when measured on a percent-in-fuzzy-seed basis. When oil and protein are measured on the basis of grams in each seed or kernel there is usually found a positively correlated variability.

Oil and protein content may be affected by environment in three ways: (1) Either component may be altered singly; (2) both may increase or decrease simultaneously; or (3) one may be increased or decreased in exact proportionate relation to respective decreases or increases on the other component. In the first two cases the total reserve capacity is altered. In the last instance only the oil-to-protein ratio would be changed, since the variation is compensatory.

The number of seed per boll had no effect on composition of seed, provided they were from bolls initiated at the same time within the same environment. Where the number of seed per boll bears some relation to an environmental change, particularly lateness of boll initiation, increased numbers of seed may result in lowered percentage of chemical content.

Variability in composition of seed from single-boll samples, all initiated at one time and produced under identical environment, was found to be rather high. It is suggested that extreme care is needed in selecting bolls when only a few are chosen to represent the average composition of a variety or a treatment effect.

Varieties tend to hold rank with respect to percentage composition of seed throughout a series of environmentally induced variations, although percentage composition is more seriously affected in some varieties than in others in which extreme limitations to growth and maturation are found.

Free fatty acids and refractive indices of the extracted oils were not significantly affected by treatment, except where an induced delay in boll maturation may have occasioned a prepicking environment more conducive to seed deterioration and resultant high free fatty acid content of the oils.

## REVIEW OF LITERATURE [5]

Prior reports (*15, 28, 29, 36, 43, 46*)[6] concerning the influence of fertilization with nitrogen, phosphorus, and potassium on the composition of cottonseed are not found in complete agreement. Some of the disparity has been occasioned by the diverse environments of experimentation, but interpretations as to specific trends and the divergent bases of product measurement have contributed to ultimate differences in both results and conclusions. A summary of certain applicable results obtained by previous investigators is presented in table 1, together with explanatory notes and references to specific experimental conditions.

Studies on the effect of nutritive elements other than nitrogen, phosphorus, and potassium showed (*15*) that applications of lime resulted in no significant alteration in the composition of cottonseed from plants grown on Yazoo-Mississippi Delta soils. Reports concerning the specific effects of other elements of supply on the composition of cottonseed have not come to the writers' attention.

Those studying development of the seed (*13, 21, 30, 32, 36, 43*) have demonstrated that it continues to elaborate both oil and protein after the boll first opens.

Studies involving geographic source (*10, 17, 20, 25, 29, 35*)[7] have demonstrated that seed from cotton plants grown under irrigation in the far West often have higher kernel content and higher percentages of oil and protein than seed produced elsewhere in the Cotton Belt. From some of these same studies (*17, 25*) and from others (*22, 23, 24, 37*) it has been found that cottonseed improves in grade through increased percentage of stored reserves as the harvest season advances, provided atmospheric conditions are not favorable for deterioration and subsequent loss in quality. The comparative chemical composition of early, however, as compared to late initiated seed has been found (*43*) under controlled greenhouse conditions dependent upon nutrient supply and other limiting factors (*17, 25*).

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[5] The review of literature and the results of investigations included in this bulletin are given also in a comprehensive review presented in *Cottonseed and Cottonseed Products, Their Chemistry and Chemical Technology (41).*

[6] Italic numbers in parentheses refer to Literature Cited, p. 84.

[7] MELOY, G. S. RELATION OF ATMOSPHERIC HUMIDITY TO FREE FATTY ACID. Address given at 48th meeting of Natl. Cottonseed Prod. Assoc. 1944. [Unpublished. Copy on file in Cotton Branch, Production and Marketing Admin., U. S. Dept. Agr.]

TABLE 1.—*Summary of literature on effects of increases in supplies of nitrogen, phosphorus, and potassium on production and composition of cottonseed*

NITROGEN

| Investigators | Cottonseed product measured | | | | | |
|---|---|---|---|---|---|---|
| | Seed cotton | Seed | Lint | Kernels | Oil in seed | Nitrogen in seed |
| | *Yield* | *Weight* | *Percent* | *Percent* | *Percent* | *Percent* |
| Garner, Allard, and Foubert (*14*)[1] | Increased | Increased | Decreased | Increased | Decreased | |
| Gieger (*15*)[2] | do | | | | do | Increased. |
| O'Kelly, Hull, and Gieger (*28*)[3] | do | Decreased | No significant effect | | do | Do. |
| Seale (*36*)[4] | do | | | | do | |
| Wadleigh (*43*)[5] | do | Increased | Decreased | | do | Increased. |
| White (*45*)[6] | | do | | Increased | Increased | |
| **PHOSPHORUS** | | | | | | |
| Garner, Allard, and Foubert[1] | Decreased | No effect | Increased | Increased | No effect | |
| Gieger[2] | Slight increase | | | Little effect | Slight effect | |
| O'Kelly, Hull, and Gieger[7] | | | | | | |
| Seale[4] | Little effect | | | Little effect | | |
| White[6] | | Increased | | Increased | Increased | |
| **POTASSIUM** | | | | | | |
| Garner, Allard, and Foubert[1] | Increased | Increased | No effect | No effect | Increased | |
| Gieger[2] | Slight increase | | | | Little effect | Little effect. |
| O'Kelly, Hull, and Gieger[8] | Increased | Increased | Little effect | | Increased | Decreased. |
| Seale[4] | Little effect | | | | Slight increase | |
| White[6] | | Increased | | Slight increase | do | |

[1] Used variations in level of each element in complete fertilizers, on a "very poor" soil, Manning, S. C., 1911. Upland cotton.

[2] Used variations in single elements on Yazoo-Mississippi Delta soils, Stoneville, Miss., 1933–37. Upland cotton.

[3] Nitrogen plus phosphate, compared with no fertilizer, at 3 locations in Mississippi, 1926–31. Upland cotton.

[4] Used N, P, and K fertilizers in a 2-level factorial experiment, St. Vincent, British West Indies, 1938–39. Two strains of sea-island cotton.

[5] Used 4 levels of nitrogen supply in greenhouse, sand nutrient culture, Fayetteville, Ark., 1936. Rowden 2088 upland cotton.

[6] Used variations in level of each element (including zero concentrations) in complete fertilizers, Experiment, Ga., 1911–12. Upland cotton.

[7] Phosphates combined with nitrogen and given in nitrogen data. See footnote 3.

[8] Used 5 levels of potash in complete fertilizer, at 3 locations in Mississippi, 1926–31. Upland cotton.

Increased severity of certain plant diseases, Texas root rot and fusarium wilt, have been associated with smaller seed and a lowered percentage of chemical content of kernels (*11, 33, 41*).

Previous investigations of quality factors of cottonseed were directed more toward determining effects of environment during maturation and storage of seed than to ascertaining the effects of factors regulating growth of plant and production of seed. Free fatty acid content is usually considered to be dependent upon environment during and after the opening of the boll rather than upon conditions prior to boll splitting (*41*).

Associated variability in regard to partial chemical composition of cottonseed as influenced by environment has been given considerable attention. It is rather well established that oil and nitrogen content of the seed or kernel tend to vary inversely as influenced by environment (*8, 16, 31, 46*),[8] although some have reported no specific correlation. As with the effects of fertilizer elements, some disparity results because of different bases of measurement used and perhaps a failure to recognize certain factors restricting full development of the storage components. Variation in chemical content of kernels has not been found directly associated with variations in the morphological composition of the seed (*41*), except that conditions most adequate for full growth and maturation usually produce large seed having high percentages of kernels and high oil and protein content in kernels.

## EXPERIMENTAL PROCEDURE

The results considered in this bulletin are from cooperative studies—23 separate experiments—concerned primarily with fertilization and other environmental influences. These studies have included American-upland, American-Egyptian, and sea-island types of cotton and have been carried out in 7 different cotton-producing States. Most of the experiments were designed for a study of variability as affected by applications of the 3 main cotton fertilizer elements: Nitrogen, phosphorus, and potassium.

A few studies have included treatments with sodium, lime, gypsum, magnesium, and barnyard manure. Included also are studies wherein different levels of irrigation were supplied. Effects of disease intensity were studied in 3 experiments, and effects of time of harvesting were measurable in 7 of the 23 tests. A few studies included a range of strains or varieties sufficient to determine the manner in which varietal potentials are affected by alterations in environment.

The values discussed in the data from these studies are in terms that are familiar to the cottonseed industry and those most often used by research workers. The industry deals with the seed as it comes from the gin, containing variable quantities of moisture and trash, and the industrial measurements are usually referred to the exact condition of the original sample of ginned (fuzzy) seed. The research worker, on the other hand, seeking to establish less variable and more fundamental bases of measurement, has often utilized the delinted seed or the dehulled seed (kernel) as a basis for expressing chemical content of cottonseed.

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[8] See also footnote 7.

The more general data considered here are based on composition of the ginned (fuzzy) seed, at a constant moisture content, these measurements being comparable to those used by the American Oil Chemists' Society. For the more comprehensive studies the data are presented in these same industrial terms and, in addition, they are presented on the several different bases that allow for more fundamental interpretations in regard to the biological principles involved. Detailed descriptions of 3 of the more comprehensive studies are presented in the text with brief descriptions of 20 additional experiments discussed in relation to them. Some of the summarized data are included in text tables (1 to 11), but for the most part the discussion of results is facilitated by the use of figures 1 to 37 and detailed analytical data presented as Appendix tables 12 to 59.

## ANALYTICAL METHODS

The more generalized data relative to oil and protein content of cottonseed will be given in terms most familiar to the cottonseed industry—as percentages of the ginned seed, residual lint or fuzz included, but at a constant 10 percent moisture content. Measurements of oil and ammonia[9] content for this type of presentation have all been made following the specific rules of the National Cottonseed Products Association (*26*), but with the exception that determinations were carried out moisture-free, then calculated to 10 percent moisture content of the ginned seed.

From the foregoing measurements of oil and protein content, the quantity index of cottonseed has been calculated and is here presented as cottonseed grade. Actually the grade, as used in industry, represents both quantity of oil and ammonia and quality of seed as influenced by free fatty acids, excesses of moisture and trash, and color. These quality factors are mostly dependent on what happens to the seed after it is mature, and for this reason the quality is here assumed constant so that it may have no influence on the quantitative factors of grade. The quantity index of cottonseed was calculated, using the rules for the period (1944) when these seeds were produced, as follows:

1. For cottonseed that by analysis contains 17 percent or more of oil, the quantity index shall equal 4 times the percentage of oil, plus 6 times the percentage of ammonia, plus 5.

2. For cottonseed that by analysis contains less than 17 percent of oil, the quantity index shall be 5 times the percentage of oil, plus 6 times the percentage of ammonia, minus 12.

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[9] The results of the actual measurement of protein in the Kjeldahl nitrogen determination are recorded in terms of percentage of ammonia. The nitrogen found in cottonseed, however, exists almost entirely as protein (ammonia × 5.13 = protein). For this reason the discussion of the results in the text are given in terms of protein, but many measurements tabulated in the Appendix are given as percentage of ammonia—particularly where cottonseed grade was calculated.

The basis grade of seed is considered as 100 points, a 1-percent increase in price being allowed for each point over basis grade and a 1-percent deduction for each point under basis grade.

Two other values of commercial interest are based on the measurements of oil and ammonia content of ginned seed. These are the pounds of available oil and the pounds of available (8 percent ammonia) cake or meal per ton of cottonseed.

Available oil is calculated as the percentage of oil in seed times the pounds of cake (2,000) less the quantity of oil residual in the pressed cake. This residue of oil depends upon the ammonia content of the seed, and the exact deductions per ton of seed are found tabulated in the Rules (*26*).

Available 8-percent ammonia cake, or meal, per ton of cottonseed is calculated as follows:

$$(\text{Percentage of ammonia in seed} \times 0.94) \times \frac{2{,}000\ (\text{lb.})}{8} = \text{Available 8-percent ammonia cake per ton of cottonseed}$$

Measurements and terms utilized in the more comprehensive studies are explained as follows.

Fuzz, also known as linters and as residual lint, is that part of lint fibers and fuzz hairs not removed by ginning. About 30 grams of fuzzy seed were dried until moisture-free. They were delinted in just enough concentrated sulfuric acid to wet the seed for 1 minute and then washed in running water for half an hour. The sample was again dried until moisture-free, and the loss in weight was calculated as percentage of fuzz and the sample referred to as fuzzy seed at 10-percent moisture content.

Seed index is the weight in grams per 100 cottonseed and here is referred to as fuzzy seed at 10-percent moisture content.

Kernel content of cottonseed refers to the percentage of kernel. The 100-seed samples from the seed index measurements were used to determine kernel content. They were cut when rather moist to eliminate fracturing, and then the two fractions were separated quantitatively and weighed. moisture-free. The weight of kernels was calculated as percentage of the total fuzzy seed at 10-percent moisture content—assuming 10 percent moisture in kernel as well as in hull.

The values presented for oil and for protein content of kernels were not measured directly but were calculated from the measurements of oil and protein and the percentages of kernels in the fuzzy seed. A 0.5-percent oil and 0.5-percent ammonia content of hulls was arbitrarily assumed for these conversions. Oil and ammonia content of hulls was found to vary considerably between varieties and as influenced by environment, but the 0.5 percent allowable is well within the range of values found by analysis in these studies and by others (*12*).

Yield data presented here have been supplied by those conducting the contributive field experiments. Acre values of seed, however, have been calculated at measured grade (quantity index) of cottonseed, utilizing the 1944 support price of $56 per ton for basis grade (100 points) seed. The acre value is equal to the points grade times $56, times the pounds of seed divided by 2,000.

The term "reserve capacity" of seed or kernels is here considered as the summation of oil and protein (ammonia × 5.13) and may be found expressed as percentages or as grams per 100 kernels or 100 seed. The reserve ratio is calculated as the oil content divided by protein content and also may be calculated from percentages or from weights per 100 seed or kernels.

Where free fatty acids have been measured, the titrations were carried out, utilizing the oils extracted from the fumed and ground seed. This small sample, usually about 1 gram, necessitated deviation from official methods (*26*) as to quantities of reagents. Refractive index of the oils was measured on a 4-place Abbé refractometer at recorded temperatures, and the values are presented as corrected to 25° C.

Statistical procedures utilized to evaluate significance of certain data, unless otherwise specified, are those outlined by Snedecor (*40*).

## INFLUENCE OF POTASH, VARIETY, AND TIME OF PICKING

By W. H. Tharp and J. H. Turner, Jr.

### Experimental Plan and Procedure

The cottonseed for this study were obtained from the last 2 years of a 3-year (1941–43) agronomic experiment (*42*) conducted on Tifton sandy loam at the Georgia Coastal Plain Experiment Station, Tifton. A factorial design was used for four varieties of upland cotton (Coker 4 in 1–4, Station 21, Station C, and Station S), receiving three rates of potash fertilization (20, 40, and 80 pounds per acre), randomized in four replicate blocks. The experiment was conducted on an area that had been planted to Spanish peanuts and given 400 pounds per acre of a 2–10–4 fertilizer for the 2 previous years.

Potash was applied in the present study at the acre rates of 20, 40, and 80 pounds, administered in 3–8–4, 3–8–8, and 3–8–16 mixtures, respectively, at the rate of 500 pounds per acre. Potassium was supplied as muriate, phosphorus as superphosphate, and nitrogen as a mixture with two-fifths from nitrate of soda, two-fifths from Uramon, and one-fifth from cottonseed meal.

The four varieties of cotton had been chosen for variations in leaf size, foliage type, and comparative earliness. Coker 4 in 1–4 has a large leaf and medium-heavy foliage and matures bolls medium to late. Station 21 has a large leaf, a little heavier foliage than Coker 4 in 1–4, and is also medium to late. Station C has a medium leaf, medium foliage, and matures early. Station S has a small leaf, produces a small quantity of foliage, and matures early.

Boll samples were taken twice each year: At the time of first picking for the early (bottom) crop when about 30 percent of the bolls were open, and again at the time of second picking for the later initiated cotton (top crop) when at least 80 percent had opened. All samples of seed cotton were ginned under uniform conditions. Seed from 1942 were blended as to replicates before sending to the laboratory for analysis, but replicate identity was maintained for seed from the 1943 crop. The field samples of one-quarter to one-half pound each were stored in the laboratory under uniformly dry conditions prior to taking laboratory samples.

Variance analyses have been carried out on the replicated data within 1943 (*40*). The lack of replicate information for observations within 1942 prohibited any reliable analysis within that year and conditioned departure from routine methods of analysis for the combined data from both years. These combined data have been analyzed in a manner similar to that explained by Brandt (*4*), and an error mean square formed as the mean of error variance for certain interactions. In this study the mean of all interactions with years was used as error, in view of the fact that the effect of years could be less easily assigned—being a combined source of weather influences—than any of the other sources of variation in the experiment. As suggested by Brandt (*4*), the components of error variance were examined and any individual interaction significantly higher than the mean of the remainder was excluded from error. In no analysis of the various products were there more than two such deviations, and all of these were first-order interactions. (See Appendix, tables 12 to 24.)

## EXPERIMENTAL RESULTS

### SEED INDEX

The average weight of cottonseed has been shown to be a distinct varietal characteristic and subject also to significant alterations associated with location-year influences (*8*, *14*, *29*). In this study it was found that the 4 varieties of cotton represent 2 distinct groups with respect to the average weight in the grams of 100 seed, the measure of seed index (table 12, Appendix).

Coker 4 in 1–4 and Station C each produced seed nearly 2 grams per hundred heavier than those produced by the other two. The early-picked seed, formed toward the bottom of the plants, were found to be heavier than the seed from the bolls formed later toward the top of the plants. In 1943 the conditions for growth and harvest were more adequate for the production of heavy seed than they were in 1942. The differences associated with each of these three main sources of experimental variation in seed weight were of the order of high significance.

The increase in rate of potash fertilization resulted in an increased weight of seed, but it was of statistical significance only within the 1943 crop year (table 12, Appendix). This indicates that the effect of increased potash supply on seed weight depends on the weather during the growing and maturation period of cotton at this location. Otherwise, these sources of experimental variation in seed weight are comparatively mutually independent, all interactions being nonsignificant.

The average weight of 100 cottonseed for this study was found to be 11.78 grams. Of this weight 10 percent was calculated in as moisture and the rest was distributed among the fractional parts: The embryo, the delinted hull, and the linters, or fuzz. Any significant variation from the mean seed weight was accompanied by change in average weight of one or more of these three component parts of the seed. This interrelation of variation in seed weight with variation in seed composition is noted here so that, in the ensuing sections, the variation in the whole can be viewed in terms of the associated variation in morphological parts of the seed, that is, the percentage of fuzz, of hulls, and of kernels.

### FUZZ

The short fibers remaining on the seed of upland cotton following ginning are known commercially as residual lint, or linters, but the term "fuzz" is more commonly used in experimental work and will be used here. The quantity of fuzz on cottonseed has been found to differ widely among leading varieties or strains (*29*, *44*), with less marked tendency for variation within varietal capacities in response to influences of location, or soil type, and weather. In this study (table 13, Appendix) the mean difference of 3.21 percent of fuzz found between the lowest variety, Station S, with

10.37 percent, and the highest, Station C, with 13.58 percent, is not unusual.

The difference in average fuzz content between any two varieties, other than the comparison between Station 21 and Station C, was of the order of high significance. In some cases the seed weight seems to vary in association with some one or more of the morphological parts of the seed. Seed weight and fuzz content, for example, are both lowest for Station S among the varieties. The seed-weight averages for the other varieties would indicate that percentage of fuzz is only one of the several factors influencing total seed weight among varieties.

Seed from 1942 contained less fuzz than that produced in 1943, with the difference between means barely significant, while the average fuzz content of early picked seed was greater than that for the late crop to a highly significant degree. As with seed indices, the interactions among all four experimental factors were without significance on the 2-year basis, indicating relative independence among these sources of variance with respect to change in percentage of fuzz.

### KERNELS

The mature embryo, or kernel, of cottonseed contains nearly all the oil and nitrogen stored in the entire seed. It follows that any significant variation in the proportionate quantity of kernel in seed allows for considerable variation in the chemical content expressed as a proportion of the seed. Two varieties of cotton having equal percentages of oil in kernels will differ as to seed content of oil if the proportion of kernels in seed is different. In this study the variability is measured on a basis of percentage of kernels in the fuzzy cottonseed so that variations in percentage of fuzz will be included in, and will have an influence on, the extent of variation in percentage of kernels in seed.

The four sources of variance in this experiment — varieties, treatments, pickings, and years — were each associated with highly significant variations in kernel content of seed. The comparative inherent capacities of the four varieties measured on a 2-year average (table 14, Appendix) were consistent as to rank throughout the alterations induced by treatment, time of picking, and year. Within the later year, however, the rank of varieties were significantly dependent on time of picking. Station S had the highest average kernel content, Station C and Coker 4 in 1–4 were found intermediate, with Station 21 the lowest.

Under the average conditions of this study, the increases in rate of potash supply from 20 to 40, and then from 40 to 80 pounds per acre each caused significant increases in kernel content of seed. This effect of treatment was not limited by any of the other pooled sources of change, but in 1943 the benefit was significantly less in seed from the first picking than in seed from the second. The kernel content of seed was significantly higher in 1942 than in 1943 and higher for the late-picked crop, and there was a significant difference in response to time of picking within the different years.

## CHEMICAL CONTENT OF KERNELS

### OIL

The accumulation of oil in the embryo of cottonseed has been shown to be quite slow for about 20 days after flowering, the largest quantity of oil being deposited within the succeeding 3 weeks of boll maturation (*13, 30, 32, 36*). Certain changes, however, may occur in later maturation that influence final percentage accumulation of oil. Any appreciable effect that a fertilizer application might have on the quantitative deposition of oil in the embryo would be either in conditioning the flow of metabolites to the kernel or in regulating the quantitative as well as the qualitative synthesis of the storage reserves.

The four varieties of cotton tested showed highly significant differences in capacities for accumulation of oil expressed as a percentage of the kernel. The varieties fell into two groups with respect to oil content of kernel (table 15, Appendix), with Station 21 and Coker 4 in 1–4 composing the higher group; this grouping was significantly unaltered by the other experimental variations. Under these experimental conditions the increase in rate of potash fertilization has induced a highly significant increase in oil content of kernels, the comparative increase being unlimited by strains, pickings, or years. The average oil content of kernels was higher in 1943 than in 1942, and the early-picked seed was higher in oil content of kernels than the later top crop, although this difference between picking dates was negligible in 1943.

### PROTEIN

The four varieties of cotton used in this study had average capacities for the accumulation of protein in the kernel that varied inversely in relation to the capacity for accumulation of oil. Station 21 and Coker 4 in 1–4 formed a significantly low group, Station S being significantly higher than these two and lower than Station C in this respect (table 16, Appendix). This rank was not significantly altered by effects of treatments, number of years of growth, or of time of picking. An average decrease in protein content of kernels with increase in potash was also highly significant. Although the proportionate effects of the two increments of potash differed slightly as to varieties, this difference was not significant.

Experimental averages for differences between years and differences between pickings were both highly significant, but the higher average protein content for the second picking was largely attributable to the difference obtained within 1942, the year with the lowest average for protein accumulation in the kernel.

It should be noted here that while the influence on protein content was inversely related to influence on oil as affected by varieties, by treatments, and by pickings, it is positively associated with change in oil content as influenced by years, and both oil and protein content were significantly higher in kernels of the seed grown in 1943 than in that grown the previous year.

### TOTAL RESERVE CAPACITY

It is indicated here and has been pointed out before (*29*) that there is a tendency for an induced increase in oil or protein content of seed to result in an associated decrease in protein or oil content, respectively. Since this inverse or compensatory relationship is one conditioned by the stresses on synthesis and translocation during growth and maturation of the seed and since the kernel is the locus of this activity and storage (rather than the seed coat and its epidermal hairs), then the measurement of this functional relationship is most valid on a percentage-within-the-kernel basis. If the percentage of oil is added to the percentage of protein in kernels, the sum can be considered the total reserve capacity of the kernel for content of these storage products.

The average quantities of oil and protein are rather similar, and the range in variation of one component is quite likely to be similar to the range in variation of the other reserve component. Examination of variability in this sum or capacity enables an experimenter to determine whether the variations in both fractions are compensatory, additive, or subtractive, and to get a better understanding of variation in reserve accumulations in the kernel.

It has been shown that oil and nitrogen accumulate in the embryo of cottonseed in an inverse association in response to differences among varieties and to those differences induced by treatments. Examination of the results in terms of kernel capacity showed (table 17, Appendix) that the associated variation of oil and nitrogen in response to treatment was not only inverse but also additive to a highly significant degree. The inverse variation among the varieties, however, was strictly compensatory, since there were no significant differences as to kernel capacity among the four cottons. The variations in oil and in nitrogen content of kernels associated with picking dates were also inverse, and here again the significance of the difference in reserve capacity indicated an additive rather than exact compensatory variation. The oil and nitrogen in kernels were both found higher in seed from 1943, so that the highly significant difference in capacity between years was expected.

Variation in kernel reserves is only partly represented unless the association of the two contributors, percentage of oil and percentage of protein, is shown as the ratio of oil to protein. With respect to the effects of increase in potash supply it was observed (fig. 1) that the oil was elaborated to a greater extent than protein in all varieties. Reserve capacity of the kernels was also raised by the first increment of potash increase (20 to 40 pounds) in all varieties, but Coker 4 in 1–4 was the only variety observed to have benefited in both ratio and capacity from the extra 40 pounds of potash applied (40 to 80 pounds). This indicates that there is a distinct biochemical specificity among cotton genotypes in relation to environmental stress. Similar evidence of specificity is observed in the lowering of the reserve capacity of Station C, while the capacity of the other varieties was increased from first to second picking (table 17, Appendix) and the ratio of oil to protein in all four varieties was proportionately lowered from the first to the second picking. The reverse is true with respect to average influence of years. Capacity of kernels (table 17, Appendix) was higher proportionately for all varieties in the second year, whereas ratio was lower in 1943 than in 1942 in the kernels of all varieties other than Station C (fig. 1).

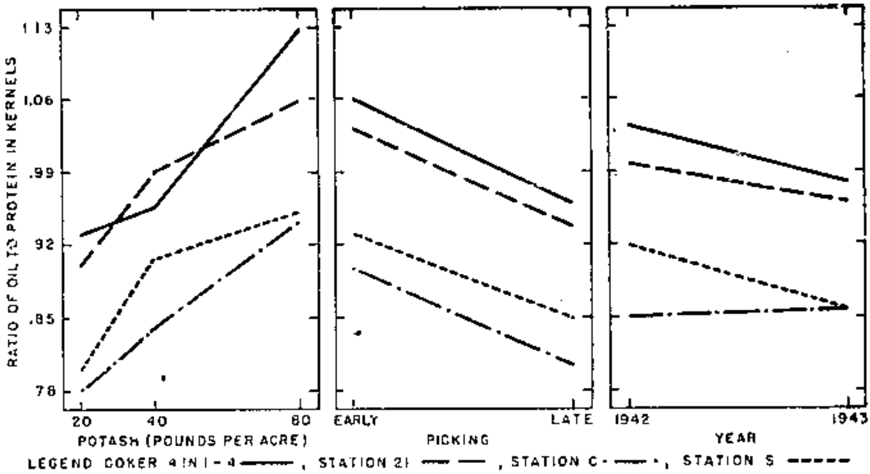


FIGURE 1.—Ratio of oil to protein (percentage of oil divided by percentage of protein) in kernels of four varieties of cotton, as influenced by rate of potash supply, time of picking, and year.

## CHEMICAL CONTENT OF FUZZY SEED

### OIL

The oil content of fuzzy cottonseed is functionally a composite value, being a summation of the oil in the hulls added to that in the kernel, the total oil being reapportioned as of the total weight of the seed. The oil content of hulls can be considered as comparatively negligible, so that variations in oil content of kernels are readjusted primarily by the proportion of kernel when calculated to the basis of oil content of seed. Where experimentation induces comparatively high kernel content of seed as well as high oil content of kernels, the oil content of seed will be raised to an even greater degree.

In these studies the most marked increase in oil content was associated with potash fertilization. Both the second and third increments of potash have resulted in highly significant increases in oil content of seed, and these two average increments of increase were essentially identical, being 1.26 and 1.25 percent of oil in seed (table 18, Appendix). The second increment then produced only half the per-pound (of potash) increase shown for the first. Treatments accounted for the greater part of the total experimental variance in respect to oil content of seed, but, despite this influence of treatments, the consistency of differences among varieties was of sufficient magnitude to be highly significant. Station C was significantly lower than any other variety. Coker 4 in 1-4 attained top rank, with Station 21, then Station S, following, but there was no significance or differences among these last three with respect to oil content of fuzzy cottonseed.

The average oil content of cottonseed produced in 1943 was not significantly different from that produced in 1942. Similarly, the difference between seed picked on the two dates was not of significance when measured as a 2-year average. Although the main effect of time of seed maturity was insignificant, the effect of treatments was significantly limited by time of harvest and within the 1943 seed the rank of varieties was significantly affected by the time at which seed were picked. It should be noted that in this study no attempt was made to determine whether position of bolls on the cotton plant (bottom v. top crop) or time of picking (early v. late harvest) was the main cause of variation attributed here to pickings. Both causes may be influential, but the late-picked bottom, and early-picked top bolls were not segregated, and there is, therefore, no basis for measuring the degree to which picking time per se was responsible for variability in seed-product measurements.

### PROTEIN

The protein content of fuzzy cottonseed is also a composite value dependent on a summation of the two products—protein in kernels and kernels in seed. Tables 14 to 16, Appendix, show that treatments effected an inverse association with respect to the variation in these two partial composition factors, since an increase in potash occasioned increased kernel content of seed and decreased protein content of kernels. The protein content of seed, being a composite value, might then show only negligible variations resulting from treatment. The study showed that this was the case.

The combined effects of the two partial composition factors—protein in kernels and kernels in seed—among varieties have resulted in differences in protein content of seed of high significance. Coker 4 in 1–4 and Station 21 were found to form a low group, Station C and Station S being significantly higher with equal experimental averages. This ranking follows more closely that for protein content of kernels (table 16, Appendix) than for kernel content of seed (table 14, Appendix). The significance of the difference in protein content of seed between pickings, it is concluded, is a build-up, resulting from a positively associated variation of the partial composition factors. Protein in kernels and percentage of kernels in seed were both higher for the later picked crop. Similarly, the high protein content of seed found in 1943 was the result of a positively associated difference in protein in kernels as well as kernels in seed.

### TOTAL RESERVE CAPACITY

The combined percentages of protein and oil in cottonseed have been utilized to determine changes in cottonseed capacity as their percentages were combined to measure variations in kernel capacity for reserves. These were actually calculated by adding the percentage of oil to the percentage of protein in seed. From the practical viewpoint this can be considered as a product of the percentages of kernels in seed and the kernel capacity for storage reserves. On this basis it is seen that seed capacity would be high where the percentage of kernels in seed and the kernel capacity were both high. With only one of the values high and the other low, the seed capacity would be only average. Where percentage of kernels and kernel capacity were both low the composite value, seed capacity, would be found low.

Thus it was found that the increased kernel capacity associated with increase in potash supply showed even greater differences when this capacity was computed on a seed-content basis (see table 22). The increase from 20 to 80 pounds of potash per acre was associated with a 4.45 percent increase in reserves when measured as kernel capacity and a 6.4 percent increase in reserves when measured on a seed-capacity basis. The variations in kernel-to-hull ratio in the seed also caused significant differences in seed capacities among the four varieties where none were significantly different from the others on a kernel basis of measurement. As with treatments, the differences in kernel capacity and kernel-to-hull ratio were both in favor of the late picking. The percentages of kernels in seed was lower in 1942 than in 1943 so that total reserve capacity of seed is but little higher in 1943, despite the greater accumulations of reserves in the kernel for that year (table 19, Appendix).

### COTTONSEED GRADE

Of the foregoing measurements of the cottonseed the only values that actually entered into the calculation for grade (quantity index) were the percentages of oil in seed and the percentages of protein (actually used in the calculation as percentage of ammonia) in seed. Each of the other five measurements may contribute in some manner to the variation in grade but only as it influences the chemical content when expressed as a percentage in seed basis. From a physiological viewpoint, these percentages in seed are dependent upon the fractional variation in the structural parts of the seed. While the comparative commercial value per ton of seed is only determinable by grade, the measurement of influences upon biological activity and relationships is more logically calibrated in terms of chemical content of the kernel and the proportions of kernel, hull, and lint produced by the seed.

The experimental average grade of 94.0 points obtained in this study was considerably lower than the basis grade (100 points) for cottonseed (table 20). Basis grade for all four varieties was exceeded only in 1943, where the top crop was picked from the plots receiving 80 pounds of potash per acre. The lowest average for the four varieties of 84.0 points was found where seed were picked late in 1942 from the plots receiving 20 pounds of potash per acre. This gave a 17.1 point range in average varietal performance as influenced by the other experimental sources, while the average difference among varieties was 3.4 points. Only one variety, Station C, with an average grade of 91.6 points, was significantly different from the remaining three varieties that averaged from 94.5 to 95.0 points.

The main effect on grade of treatments (table 20, Appendix) was of very high significance, with an approximate 5-point increase for each increment of potash supply. The first increment, 20 pounds (increase from 20 to 40 pounds), gave twice the benefit in grade point increase, since it was only half the rate of increase in supply furnished by the second increment, 40 pounds (40 to 80 pounds).

There was a small but statistically significant increase of 2.4 points in grade value of seed from the 1942 to the 1943 crop year and an even smaller mean difference of 1.0 point in grade in favor of the second picking, but this 1.0 point grade difference was not significant. The time of picking had no influence on the 2-year averages for grade as influenced by variety or by year, but within the 1942 crop it was shown that treatments were significantly less effective in increasing grade in seed from the early picking than seed from the late picking. This relationship is one of the marked benefits of potash fertilization. Where potash supply was low, at 20 pounds per acre, the later picked seed suffered, but when the potash supply—40 or 80 pounds per acre—was adequate for maturation of seed over the entire plant, then the later picked seed gained in grade over the early seed. This interrelationship is also evident in the 1943 season but to a less marked degree, so that the 2-year results are nonsignificant.

Cottonseed grade and percentage seed capacity are each measures indicating adequacy of composition, but in this study their trend of variability is rather dissimilar. Both measurements were influenced primarily by the quantities of oil and protein in the seed, but while variation in each fraction could produce an equitable change in total reserve capacity it was the variability in oil content that accounted for about three-fourths of the change in grade values. The capacity values give the measure of total variability that most accurately represents changes in the gross synthesis and deposition of reserves in the cottonseed, while variation in grade represents the extent to which the accumulation of these reserves influence the dollar value of prime quality cottonseed.

### YIELD AND ACRE VALUE OF SEED

Seed cotton yields in this experiment were reported by Turner (*42*) to have been significantly increased in 1942 and again in 1943 with both the second and the third applications of potash (table 19). Station S produced significantly less seed cotton than the other three varieties in either of these 2 years. Data on yields of seed cotton at different pickings were not presented by Turner (*42*). A segregation for this source of variance with respect to acre yields is not presented here with respect to either yields of seed per acre or acre value of seed.

Yields of seed along with grade and acre value of seed are shown in tables 19 to 21, Appendix. In comparing the effects of potash on the change in the three commercial measurements—yield, grade, and acre value—of the four varieties, it is noted that yield rather than grade was of major influence in determining acre value of cottonseed. These results were from 2-year averages, but it was found that average yields for varieties differed little between years, only a 31-pound higher average yield of seed being obtained in 1942 than in 1943.

The value of seed per acre in this study was calculated on the assumption that the seed would be sold on a grade-point basis. The support price of the 1944-45 season ($56 per ton) has been used arbitrarily so that each point over or under the basis grade (100 points) will raise or lower the price per ton of seed to the extent of 1/100 × $56.00 or $0.56. This amount coincides with that accompanying a variation of 20 pounds, or 1/100 of a ton, of seed at basis grade ($56.00 × 20/2000 = $0.56).

Where experimentation has induced both a raise in point grade and an increase in yield of seed, the acre value will be increased even more markedly. It was observed that increase in potash application resulted in both an increased grade value (table 20, Appendix) and an increased yield for all varieties, so that the average increase in acre value of $6.98 associated with an increase of 60 pounds of potash per acre was expected (table 21, Appendix).

It is interesting to segregate the contribution to this increase in acre value as it is distributed between grade and yield. At the experimental mean (94 points), the additional 201 pounds of seed gained by fertilization were valued at $5.29 while the rise of 11 points in grade associated with treatment increased the value of the experimental mean of 593 pounds of seed to $1.75. The total increase in value assessed by partial computation equaled $7.04. This value was almost identical with the difference in mean based on the combined calculations, or $6.98.

The value per acre of the seed in 1942 was only $0.37 higher than that produced in 1943, the similarity being accounted for by the inverse relationship for differences in yield and differences in grade as influenced by years.

The varieties used in this study were shown to differ in average acre value of seed, Coker 4 in 1–4 and Station 21 heading the list at a $16.76 average for each, while Station S gave the least seed value per acre ($13.62). Station C was distinctly higher in acre value of seed than Station S and distinctly lower than Station 21 and Coker 4 in 1–4. These differences in acre value of seed among varieties were not all associated with proportionate differences in grade and yield of seed. Station S, for example, produced seed of the highest grade among these varieties, but was lowest in acre value because of its very low production of seed. Station 21, however, was near the top in grade and highest in yield of seed, and it was one of the two at the top of the list in acre value of seed. Furthermore, the increase in acre value obtained by potash fertilization with Station 21 was significantly greater than that for the other varieties.

The results in regard to acre values of seed demonstrate rather clearly that an increase in value of seed per ton can be nullified quickly by a reverse shift in yield of seed per acre, just as a better value of seed per acre can be nullified by lower value of lint per acre. All these things must be considered, but where lint values and seed yields per acre are comparable it is evident that varietal selection and adequate fertilization can be of monetary significance.

## Discussion and Conclusions

The results of the studies on the rate of potash fertilization are in close agreement with those obtained by O'Kelly and others (*28*) and to some degree with those obtained by White (*45*). The conclusions drawn in the reports by Garner and others (*14*), by Gieger (*15*), and by Seale (*36*) appear to indicate that potash fertilization has no influence on the variability of oil and other cottonseed products. These points of disagreement, it is felt, are related more closely to differences in experimental conditions than to any actual differences in principle with respect to the adequacy of potash in the comparative elaboration of cottonseed reserves. The study reported here, that by O'Kelly and others (*28*), and that by White (*45*) to a lesser degree, were all conducted where potash was inadequate. This, as suggested by O'Kelly and his associates, is best determined by the significance of any increase in crop production with added potash. The experiments of Seale (*36*) and Gieger (*15*) showed negligible change in yields of seed with the addition of potash to the sod.[10] Garner and his associates (*14*) reported minimum variations in seed production and capacity with increase in potash level, but if their data are classified with respect to increase in potash level the results are somewhat similar to those obtained in this experiment. That part of their data pertaining to potash is given in table 2. This table shows the means for potash levels and the results of the calculation of oil content from a basis of percentage in the kernel to a basis of percentage in the delinted seed.

TABLE 2.—*Results of tests with cotton at Manning, S. C., to determine the influence of fertilizers on the oil content of the seed* [1]

| Plot series No. | Plant food elements applied per acre | | | Yield of seed cotton per acre | Weight of 1,000 seed | Kernels in seed [2] | Oil in kernels | Oil in seed [3] |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen | Phosphoric acid | Potash | | | | | |
| | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Grams* | *Percent* | *Percent* | *Percent* |
| 1, 4, 7, 10 | 0 | 0 | 0 | 510 | 120.2 | 52.8 | 33.60 | 17.69 |
| 2 | 30 | 90 | 20 | 1,070 | 130.0 | 55.1 | 37.48 | 20.53 |
| 3 | 60 | 90 | 20 | 880 | 130.0 | 55.0 | 33.85 | 18.48 |
| Mean for 20 pounds of potash [4] | | | | 975 | 130.0 | 55.05 | 35.66 | 19.51 |
| 5 | 30 | 90 | 40 | 1,265 | 135.0 | 55.7 | 38.07 | 21.08 |
| 6 | 60 | 90 | 40 | 1,410 | 139.0 | 56.1 | 36.40 | 20.30 |
| Mean for 40 pounds of potash [4] | | | | 1,338 | 137.0 | 55.9 | 37.23 | 20.69 |
| 8 | 30 | 90 | 60 | 1,160 | 134.0 | 54.2 | 38.86 | 20.93 |
| 9 | 60 | 90 | 60 | 1,320 | 137.0 | 56.0 | 36.78 | 20.47 |
| Mean for 60 pounds of potash [4] | | | | 1,240 | 135.5 | 55.1 | 37.82 | 20.70 |

[1] Reproduced in part from table 12, p. 246, by Garner, Allard, and Foubert (*14*). Results are averages of duplicate plots, except for the control series, which represents averages for 16 plots.

[2] Calculated; the percentage of hulls had been given in the original table.

[3] Calculated; assuming 0.5 percent oil in hulls.

[4] Means were not presented by Garner et al.

[10] This must be determined in Seale's presentation from a comparison of percentages of oil with gallons per acre, since no yields of seed or seed cotton were presented.

These data, when recombined to show the mean variation associated with change in level of potash supply, present trends comparable to those obtained in the present study. Omission of the first increment, or reduction from 60 to 40 pounds of potash, has had less effect than omission of the second increment, from 40 to 20 pounds, on reduction in yield, seed weight, percentage of kernels, and oil content of kernels or seed. With respect to their experimental area and the additions of nitrogen and phosphoric acid it is seen that the deficiency in potash was nearly all corrected by an application of only 40 pounds per acre.

Garner's results were presented on a delinted-seed basis. The results presented by White (*45*) were on a fuzzy-seed basis, but show similar effects, although of lesser magnitude. The experimental area utilized by White was apparently even less deficient in potash with respect to additive and residual availability of the other elements of nutrient supply. Except in the case of yield, omission of one-half the normal potash in the fertilizer in White's study resulted in a slight increase (in seed weight, percentage of kernels, and percentage of oil content), but omission of potash from the fertilizer caused a slight but similar lowering on all four measurements.

The studies by Gieger (*15*) on highly fertile delta soils showed only a slight trend toward increase in yield of seed, a very slight increase in oil content, and a slightly lower nitrogen content as potash was increased. These changes were quite negligible and were not of statistical significance. Seale's studies (*13*) with sea-island cotton showed much the same trend in results as those presented by Gieger (*15*). Seale's experimental area apparently contained an optimum quantity of available potash in respect to the other elements of nutrient supply and to the variation in seed production and composition.

O'Kelly and associates (*28, p. 8*) stated: "The use of potash in the fertilizer mixture increases the oil content of cotton seed where its use also increases significantly the yield of seed cotton." This statement is not at variance with the results of other investigators that are discussed here. It would appear, however, that the statement should include a reference to the tendency for such potash applications to cause increased seed weight, increased seed capacity for both oil and protein, and increased percentages of kernel as well as increased oil content of seed, but only where a significant increase in crop production indicates that the residual supply of available potassium, before treatment of the soil, was inadequate.

## INFLUENCE OF VARIATION IN RATIO OF FERTILIZATION WITH NITROGEN, PHOSPHORUS, AND POTASSIUM

By W. H. Tharp, J. J. Skinner, and R. P. Bledsoe

### Experimental Plan and Procedure

This experiment was inaugurated in 1922 at Experiment, Ga., to study the effect of different fertilizer ratios on Cecil sandy clay loam on 3 crops: Cotton, corn, and wheat. Crops were grown in rotation, and each crop was grown each year, 3 tiers, or sets, of plots being used. The measurements presented in this bulletin represent production and composition values for the cottonseed grown during 3 consecutive years, 1941–43, allowing for measurement of cottonseed once from each of the 3 separate plots used in the rotation scheme. The "triangle system" of fertilizer experimentation (*34*) was used for 21 different ratios [11] of complete and incomplete combinations of nitrogen, phosphoric acid, and potash, all of the 15-percent plant food being applied at the rate of 500 pounds per acre. This system allows for 6 different levels—0, 3, 6, 9, 12, and 15 percent—of each element to be entered into the 21 different combinations composing the triangle. The triangle diagram on which these ratios are based is shown in figure 2. Each of the apices represent 100 percent of a single element, the sides represent varying combinations of 2 components, and the 6 central combinations represent the complete fertilizers.

The nitrogen in the fertilizers was composed of one-third each of nitrate of soda, ammonium sulfate, and cottonseed meal. Potash was from either muriate or sulfate, and phosphoric acid from superphosphates (acid phosphate). Two series of each tier of plots were grown each year, one limed and one unlimed. Otherwise there were no true replicate plots, except for the unfertilized check plots that were triplicated.[12] The Empire variety of cotton was grown in 1941, and Stoneville 2B in 1942 and 1943. This makes comparison among all 3 years subject to some confusion with effects of variety. Empire is closely related to Stoneville 2B with reference to composition of the seed, however, so that any large differences in seed composition occurring between average results of 1941 and those of 1942 or 1943 should not be considered as associated entirely with variety. The seed cotton was ginned and the cottonseed stored under uniform conditions. Samples of about one-eighth to one-fourth pound were submitted for cottonseed product analysis.

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[11] Analyses used in this bulletin are stated in the order ammonia, phosphoric acid, and potash. Although they were listed in the previous bulletin by Bledsoe and Skinner (*8*) in the order phosphoric acid, ammonia, and potash, the apices of the triangle figures have the same elements in the same positions in both this and the previous bulletin, allowing visual superimposing of diagrams for comparison of results.

[12] Triplicate check plots were included in the plan, and yield data were taken from each. However, only duplicate samples of seed were available from the year 1941.

In the absence of measurements of gin turn-out, lint was assumed to be 35 percent and the production of seed per acre was calculated as 65 percent of the seed cotton yields.

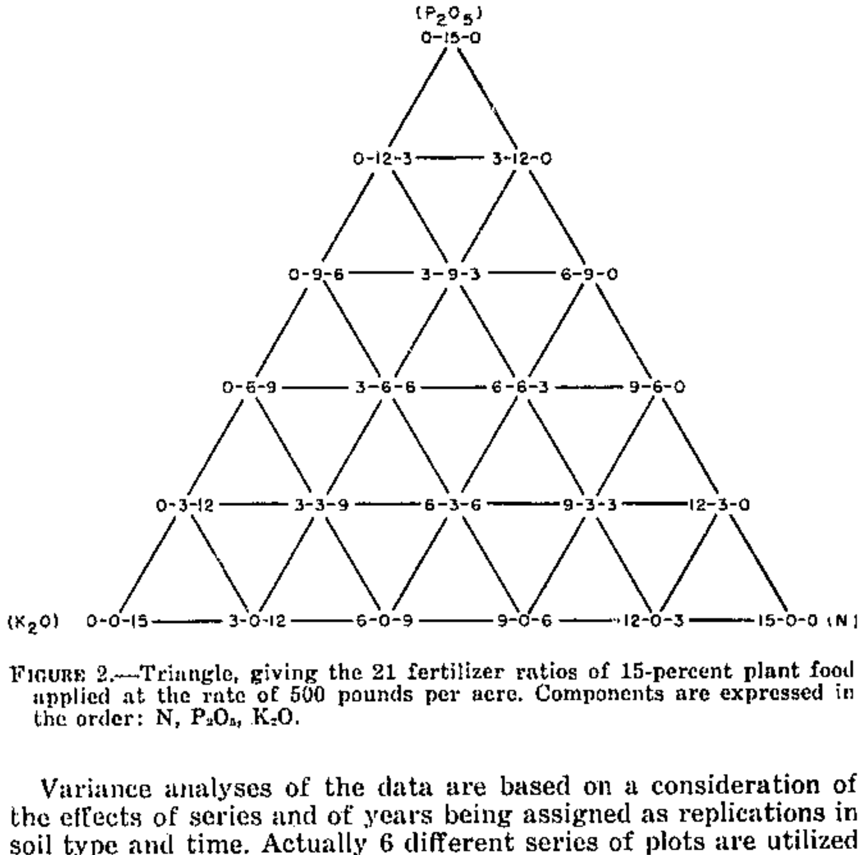



FIGURE 2.—Triangle, giving the 21 fertilizer ratios of 15-percent plant food applied at the rate of 500 pounds per acre. Components are expressed in the order: N, $P_2O_5$, $K_2O$.

Variance analyses of the data are based on a consideration of the effects of series and of years being assigned as replications in soil type and time. Actually 6 different series of plots are utilized in the 3-year study, each series within each year being on different blocks or tiers. Effects of years, of series, and of series within years are fully confounded with tiers (blocks of soil) and can be so considered in the analyses. The analyses (*40*) for 22 treatments (21 ratios of N-P-K and the mean of 3 check plots) by 6 replications are found in table 25, Appendix, with differences required for significance between treatment means included as footnotes in tables 26 to 36, Appendix. Because the effects associated with the period of the experiment and with liming are thoroughly confounded with blocks, no attempt was made to present or discuss these two sources of variance or any associated variation in seed production or composition.

The triangular system of fertilization is rather difficult to interpret, unless results are entered into the proper position in the composition triangle where trends can be seen and the relative effect of changes in ratio more exactly visualized. The mean values for treatments and checks are entered into the triangle figures

3 to 15. Other supporting data will be found in tables 25 to 36, Appendix.

## Experimental Results

### Production and Morphological Composition

The yield of cottonseed is usually presented in terms of net pounds of seed per acre. In this study the variations in yield have also been examined in terms of changes in the two contributing measurements: The unit weight of seed and the number of seed produced per acre. The yields have been examined further in relation to the contributions to change in weight that accrue through both the percentage and the per-seed weight variation of the three morphological parts of the seed—the fuzz, the delinted hull, and the kernel.

The average yield in terms both of pounds per acre (table 26, Appendix) and of number of seed per acre (fig. 3) was greatest in the plots wherein the total 15 parts of plant food was dis-

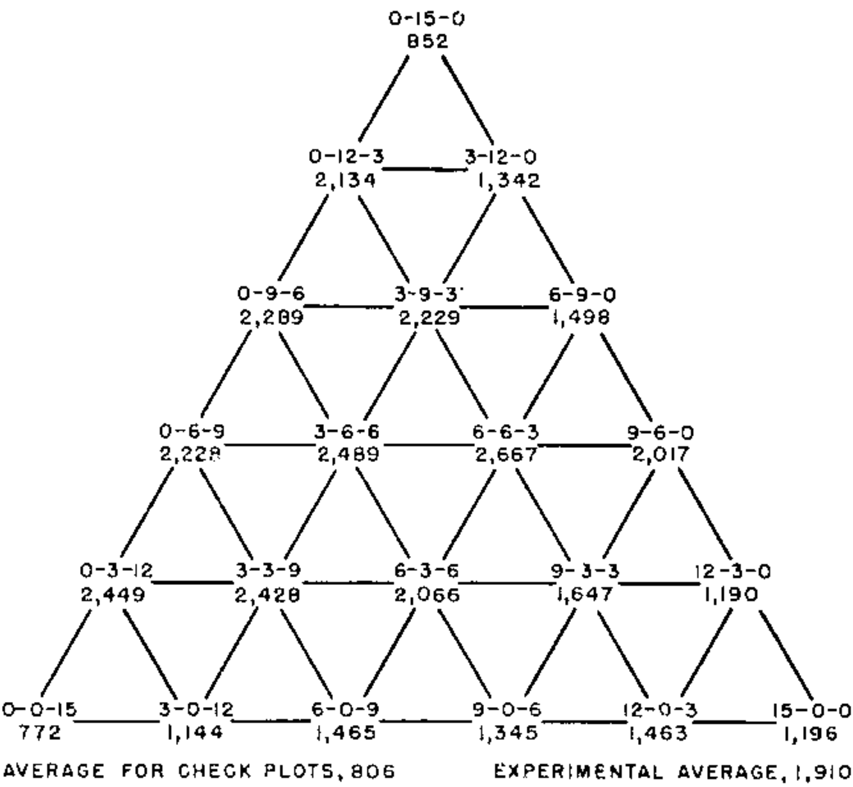



Figure 3.—Number of seed (× 1,000) per acre, as influenced by ratio of fertilization.

tributed in the ratio 6 : 6 : 3 for N, $P_2O_5$, and $K_2O$, respectively. When variations in seed weight (fig. 4) and seed per acre are examined, it is found that nearly all the contribution to change in pound yields resulted from variation in number of seed. The highest number of seed was found in the 6–6–3 plots wherein yield pounds was highest, but unit weight of seed, although high in 6–6–3 plots, was highest in 12–0–3 plots. The initiation of seed is thus seen to be favored by a nearly equal supply of all three fertilizer elements, whereas the optimum seed weight is attained only when phosphate is omitted from the mixture and nitrate is in excess of the potash supply.

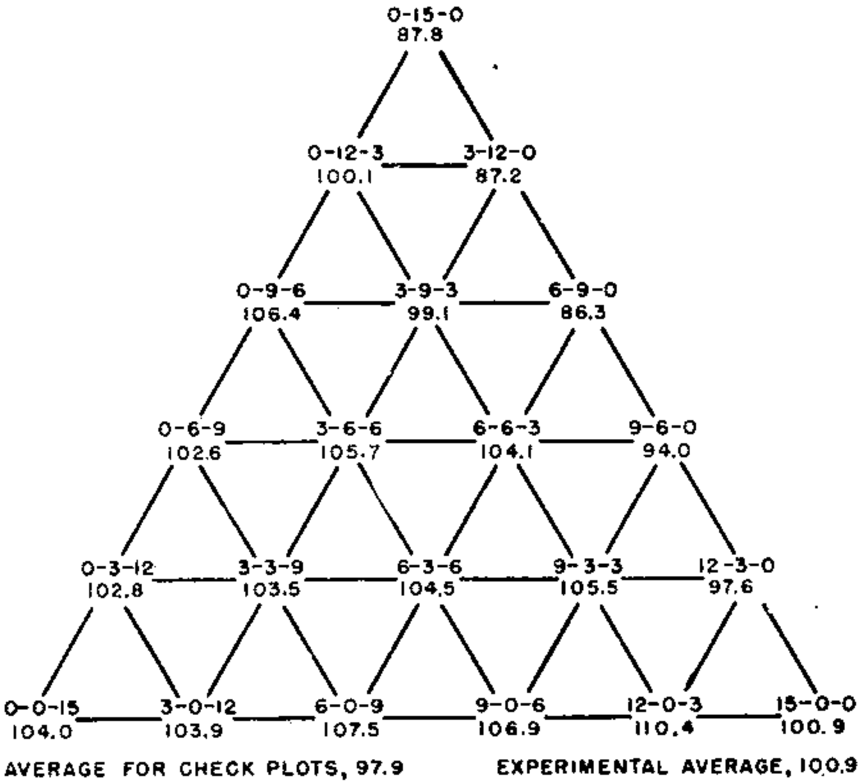



FIGURE 4.—Moisture-free weight (in grams) of 1,000 seed, as influenced by ratio of fertilization.

When the variations in partial composition of seed are examined the weight of fuzz (fig. 5), delinted hull (fig. 6), and kernel (fig. 7) are each highest where phosphate was omitted from the ratio. The high centers for kernel and hull weight were identical with the high center for weight per seed in the 12–0–3 plots. Development of grams of fuzz per seed, however, was highest where the 6–0–9 mixture was applied. The fertilizer combinations tending to increase weight of the seed are thus shown to have induced a closely associated change in weight of each part of the seed, the alterations in partial composition being similar to those induced in total weight per seed.

When induced variations in fuzz, hull, and kernel are examined as percentages of the fuzzy cottonseed (tables 27 and 28, Appendix), it is found that while percentage of fuzz was highest in the 6–0–9 plots (where grams fuzz per seed was highest) the percentage of kernels in seed was highest in the plots given the complete fertilizer combination (6–6–3) that was found most adequate for high acre yield of cottonseed. It is evident that all three elements are needed for optimum increase in initiation of seed and proportionate development of kernel, as compared with unfertilized plots, but the heaviest seed and the greatest per-seed production of each morphological part attained highest value

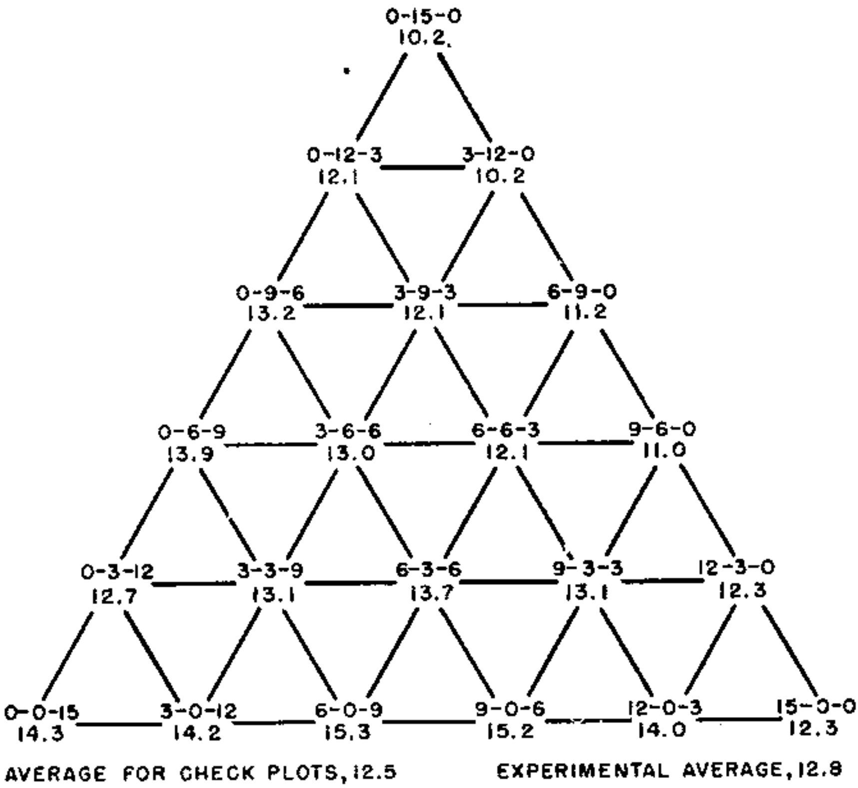



FIGURE 5.—Weight (in grams) of fuzz on 1,000 cottonseed, as influenced by ratio of fertilization.

where only nitrogen and potash were included in the mixture. Fuzz differs from kernel and hull weights per seed in that potash in slight excess of nitrogen favors fuzz, whereas the high nitrogen-to-potash combinations favor development of seed with heavier kernels and heavier hulls.

### OIL AND PROTEIN CONTENT

The measurements of oil and protein as percentages in kernel represent a basis for determining variation of proportionate development of reserve chemicals in the storage tissue of the seed. These measurements, presented as grams per seed, represent variations in net accumulations per unit of reproduction. The measurements based on proportion in the fuzzy seed are those customarily used for calibration of variation in such studies and are, in addition, those used directly to calculate variation in acre production values and cottonseed grade.

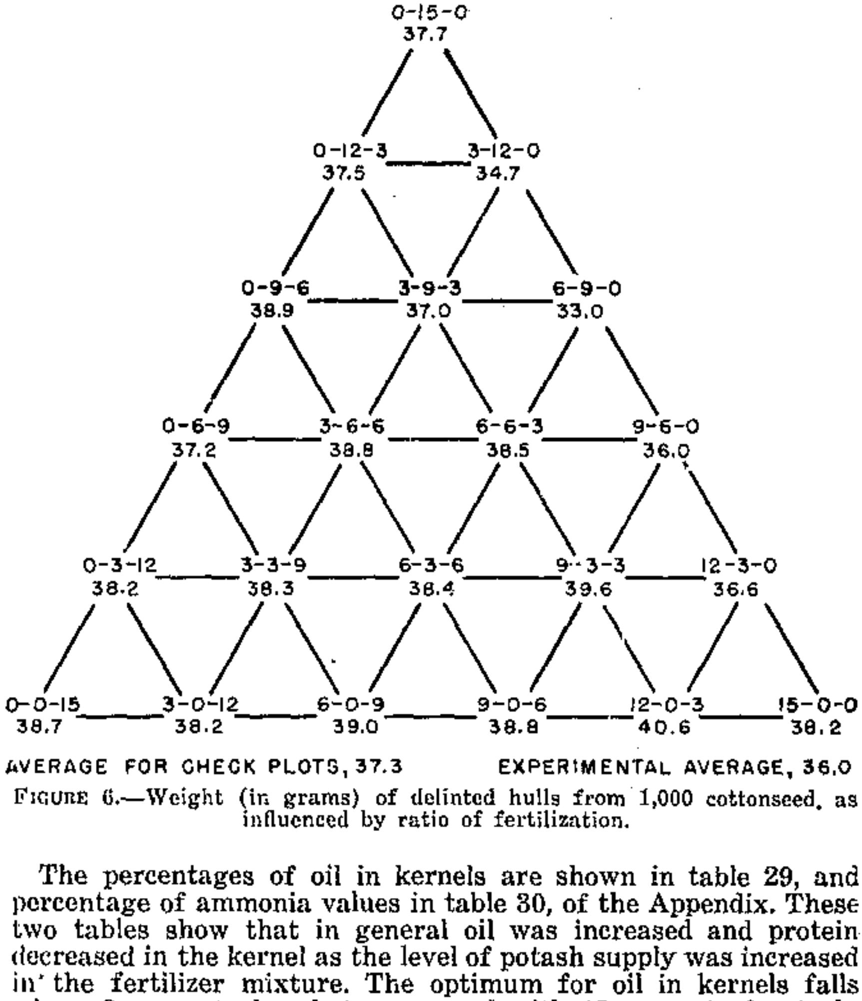



FIGURE 6.—Weight (in grams) of delinted hulls from 1,000 cottonseed, as influenced by ratio of fertilization.

The percentages of oil in kernels are shown in table 29, and percentage of ammonia values in table 30, of the Appendix. These two tables show that in general oil was increased and protein decreased in the kernel as the level of potash supply was increased in the fertilizer mixture. The optimum for oil in kernels falls where 3 percent phosphate was used with 12 percent of potash. Protein was found comparatively high in any 0-percent potash plots, but highest where 15-percent phosphate was used.

When these percentages in kernels are altered by conversion to percentages in seed there is no change in the general trends (tables 31 and 32, Appendix). Potash was again the controlling factor in the experiments on effect of varying ratios of fertilization on oil and protein content of seed. Highest oil percentage in seed was found in the 0-3-12 plots and highest protein toward the 100-percent phosphate apex along the 0-percent potash side of the triangle. When values are shown on the basis of grams per unit of reproduction of seed the trends are again similar, but a good many differences are seen with respect to the influence of specific fertilizer combinations. Grams of oil per 1,000 seed (fig. 8) was found to be highest in the 0-3-12 plots, its increase or decrease was controlled mostly by level of potash supply, and the oil was also distinctly reduced in plots receiving no potash with

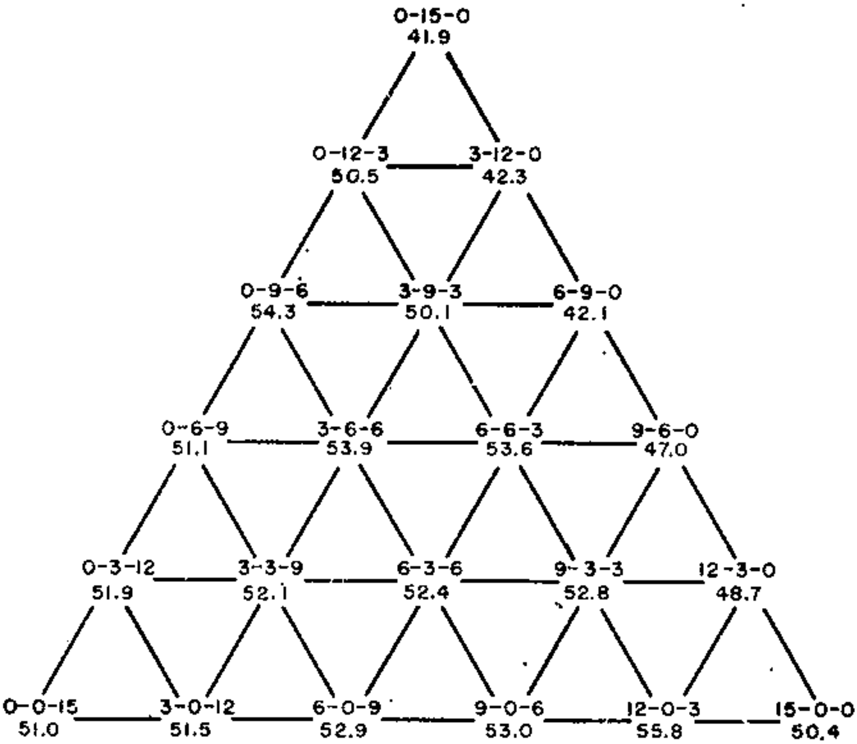



FIGURE 7.—Grams of kernel in 1,000 cottonseed, as influenced by ratio of fertilization.

phosphate in excess of nitrogen fertilization. A reasonably high weight of oil per seed was found in plots receiving complete fertilizers of nearly balanced ratios: 3 : 6 : 6, 6 : 6 : 3, and 6 : 3 : 6. Figure 9, which gives the variation in grams of protein per 1,000 seed, shows that weight of protein was highest in the plots given the 12 : 0 : 3 ratio of fertilization, which ratio was most conducive to highest weight of seed and highest per-seed weight of kernel and of delinted hull. The level of potash supply is, nevertheless, a controlling factor in the development of grams of protein per seed. The general trend is toward a decrease in protein per seed as the level of potash is increased in the fertilizer mixture.

#### ASSOCIATED VARIABILITY OF OIL AND PROTEIN

The records on capacities of cottonseed for oil and protein in this study reveal that total synthesis and deposition of seed reserves were favored by fertilizers conducive to the greatest per-seed production as well as the greatest increase in unit and partial seed weights. When measured as percentages of oil and protein in kernels the 6–6–3 and 12–0–3 mixture provided a relatively high capacity (table 33, Appendix).

When the measure is based on summation of percentage reserves in the fuzzy seed the same primary and secondary high

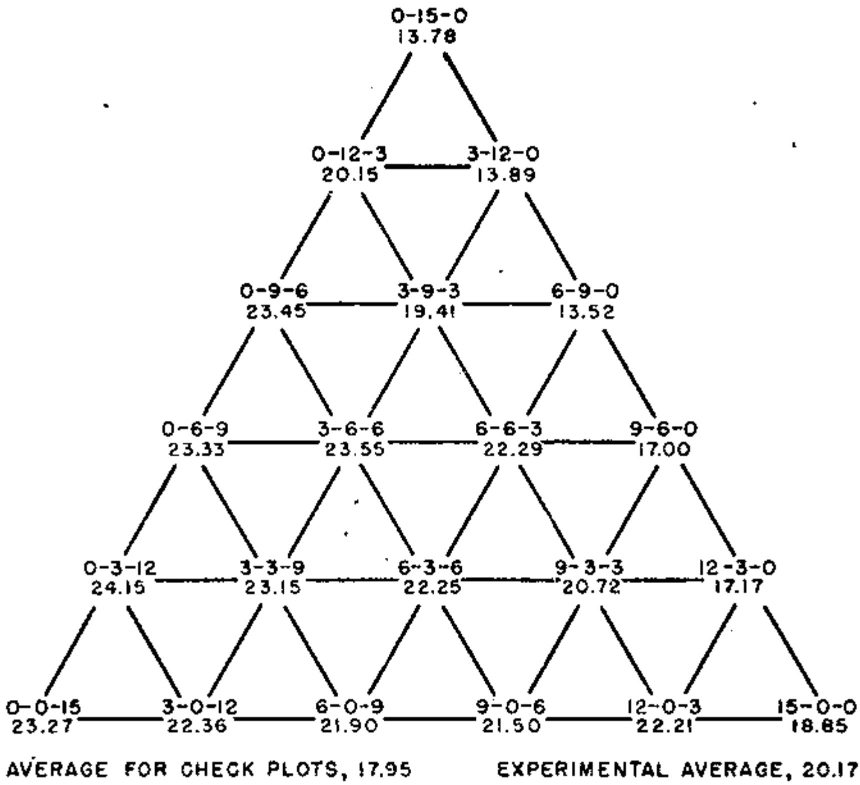



FIGURE 8.—Weight (in grams) of oil from 1,000 cottonseed, as influenced by ratio of fertilization.

centers are observed (table 34, Appendix). Measurement of this capacity in terms of grams per seed, rather than as percentages in seed, indicates again the same effects of fertilizers, but the 12–0–3 plots formed the primary high center and the 6–6–3 plots formed the secondary high center in the triangle (fig. 10). Total production of reserves, whether it is measured as percentage deposition or per-seed weight, thus is seen to be influenced by the fertilizers in a manner quite similar to production of the structural parts of the seed.

It has long been recognized that oil and protein elaboration in cottonseed vary in inverse relation in response to changes induced by alterations in the environment. From the measures of oil and protein content in this study this relationship is again demonstrated, but it was necessary to calculate these ratios (table 34, Appendix, and figs. 11 and 12) before the exact influence of fertilization on these changes could be determined. It was found that within the kernel, the locus of storage, the major shift is in response to increase in potash supply. The variation in ratio depends to a secondary degree also upon level of both nitrogen and phosphate supply. Tables 29 and 30, Appendix, show that at 0-percent potash supply an increase in nitrogen, as compared to phosphate, increased the oil-to-protein ratio. But when potash was present in any concentration, an increase in nitrogen with reduction in phosphate supply caused a decrease in the ratio between these two seed reserves. Thus the study showed that the elaboration and deposition of the lipides as compared to the nitrogenous reserves of the cottonseed depends definitely on the supply of all three fertilizer elements.

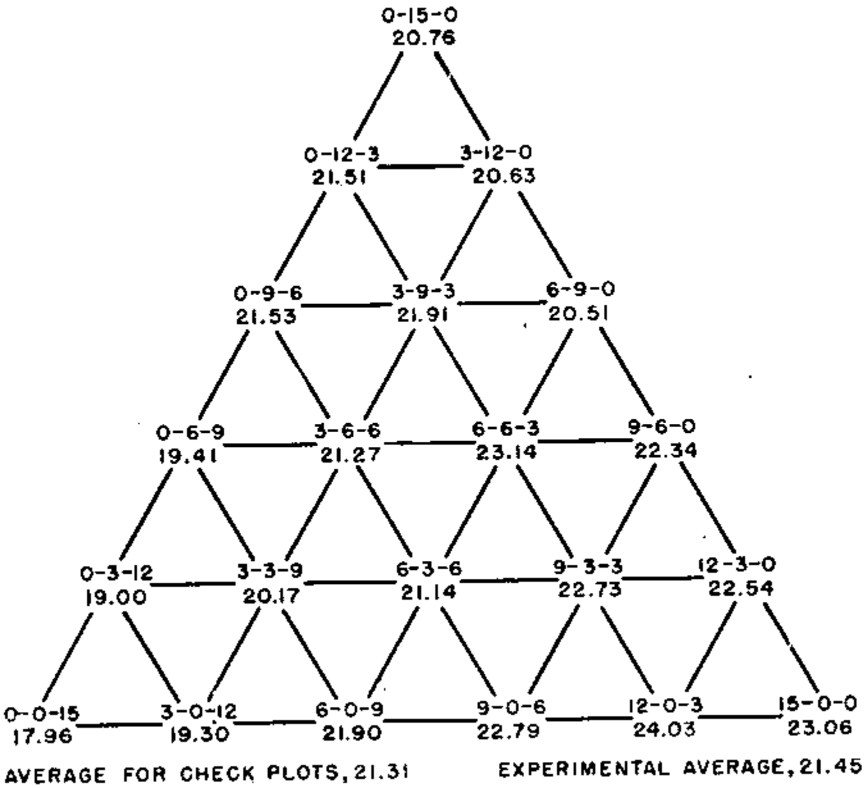



FIGURE 9.—Weight (in grams) of protein from 1,000 seed, as influenced by ratio of fertilization.

## MEASUREMENTS DETERMINING CROP VALUES

Available pounds of oil per acre (fig. 13) was highest where the fertilizer was most conducive to production of high oil content of seed—in the plots given the 0 : 3 : 12 ratio. Available pounds of cottonseed cake per acre (fig. 14) was highest in the plots receiving the 6 : 6 : 3 ratio, and plots thus treated also tended to show the highest rate of seed initiation and acre yield of cottonseed. It is not surprising to find that the available cake, representing about one-half the seed weight, varied as the yield, but it is interesting that, although available oil was highest in 0–3–12 plots, it was also quite high in the 6–6–3 plots, which were most conducive to highest acre yield of seed.

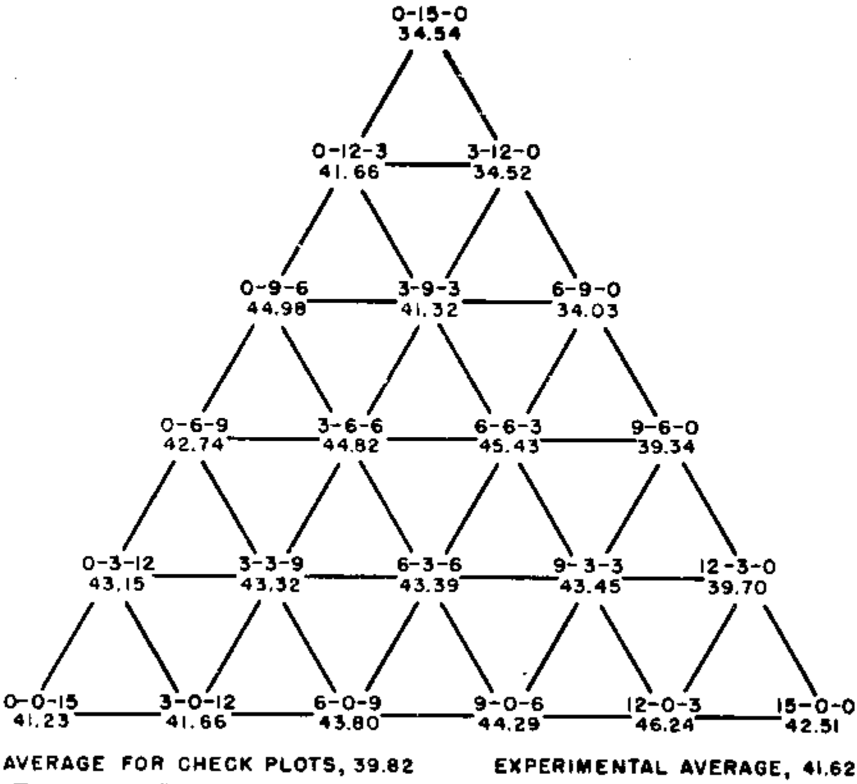



FIGURE 10.—Grams capacity for oil plus protein in 1,000 seed, as influenced by ratio of fertilization.

An examination of table 35, Appendix, shows that oil content of seed has had a predominant influence on variations in cottonseed grade, with those ratios conducive to high oil content (0–3–12) also productive of high grade seed. When acre value of seed is computed, however, it is seen that the effects of these fertilizers on yield have been greater than their effects on grade in altering the combined measure, acre value of seed (fig. 15). The high production plots (6–6–3) gave also the highest dollar return per acre, so that this ratio of fertilization must be considered as the best combination for a cotton farmer to use on this particular soil. Acre yield of seed is here the control in the determination of acre value of cottonseed.

## DISCUSSION

A summary of results from previous investigations was presented in the Review of Literature (p. 4). Studies in the variation in oil content of cottonseed, for example, show that additions of nitrogenous fertilizers lower oil content in most studies but raise oil content in the experiments reported by White (*45*). Additions of phosphates and of potash may result in increased oil, decreased oil, or may have no effect on the oil content; the result depends strictly upon the experiment. It is felt that such deviations are to be expected where results are reported from studies involving different soil types and, particularly, different residual supplies of nutritive elements in the experimental areas. Such studies are actually more concerned with the question of properly restoring or augmenting the nutrient supply in the soil to obtain a growth status most favorable to reproduction in the plant rather than with the question of determining the accurate effect of increase in any one element on quantitative variation in only one product of cotton-plant metabolism.

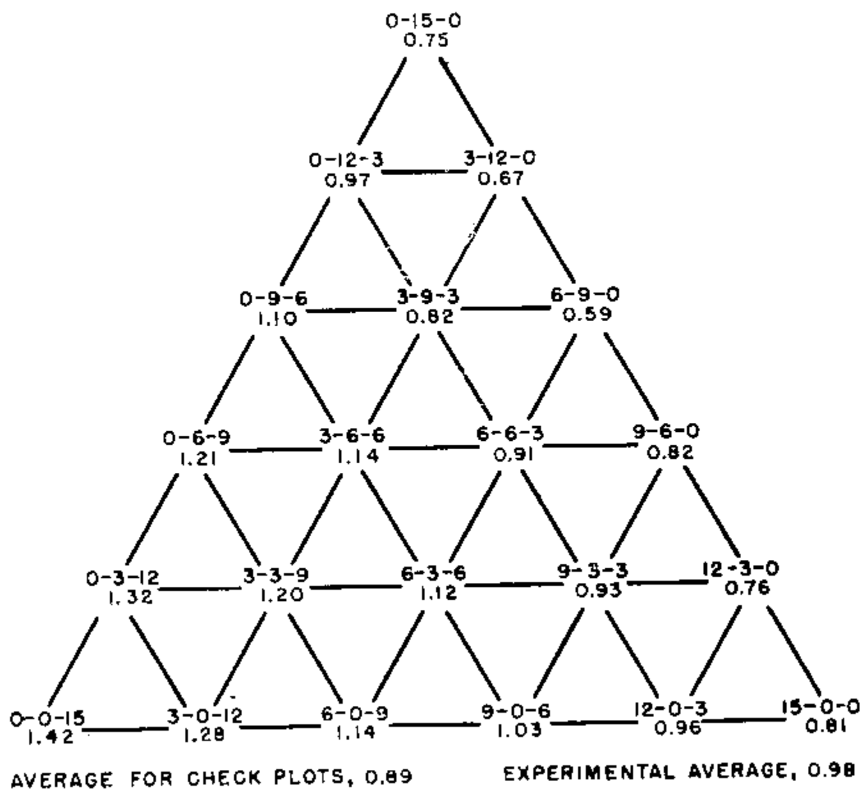



FIGURE 11.—Ratio of oil to protein, measured as percentages in kernels, as influenced by ratio of fertilization.

In this study, for example, the addition of potash alone (0–0–15) raised the oil content, phosphorus alone (0–15–0) lowered the oil content, and nitrogen alone (15–0–0) showed little effect. It should be borne in mind, however, that these are not the main effects of varying the elements of the fertilizer supply but the additive effects, in terms of the quantity and proportions of these three compounds available prior to fertilization.

The problem is perhaps best viewed in terms of the adequacy and the deficiency of fertilizer, and these factors, in turn, should

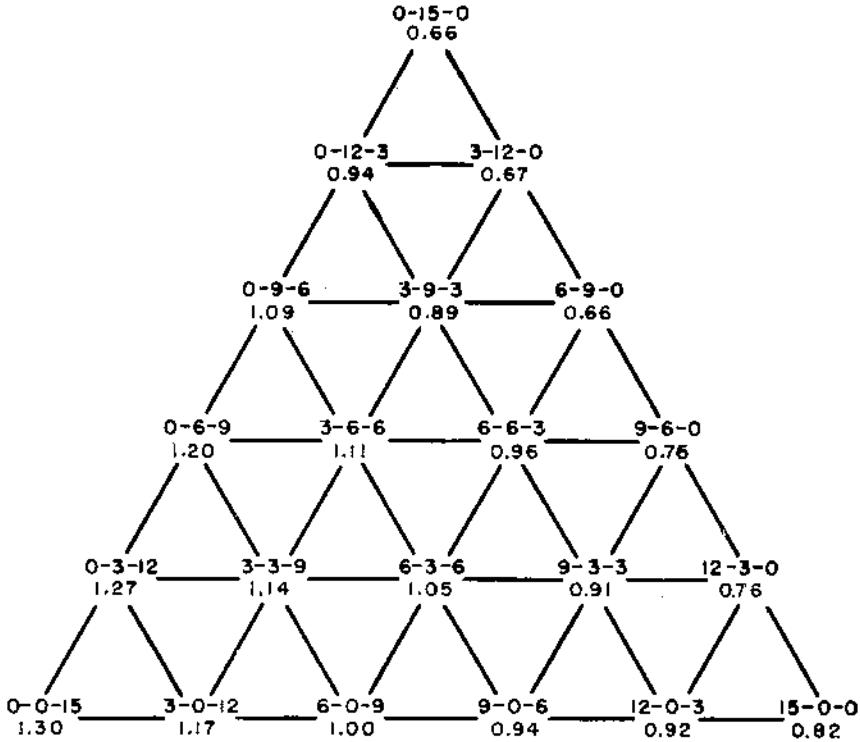
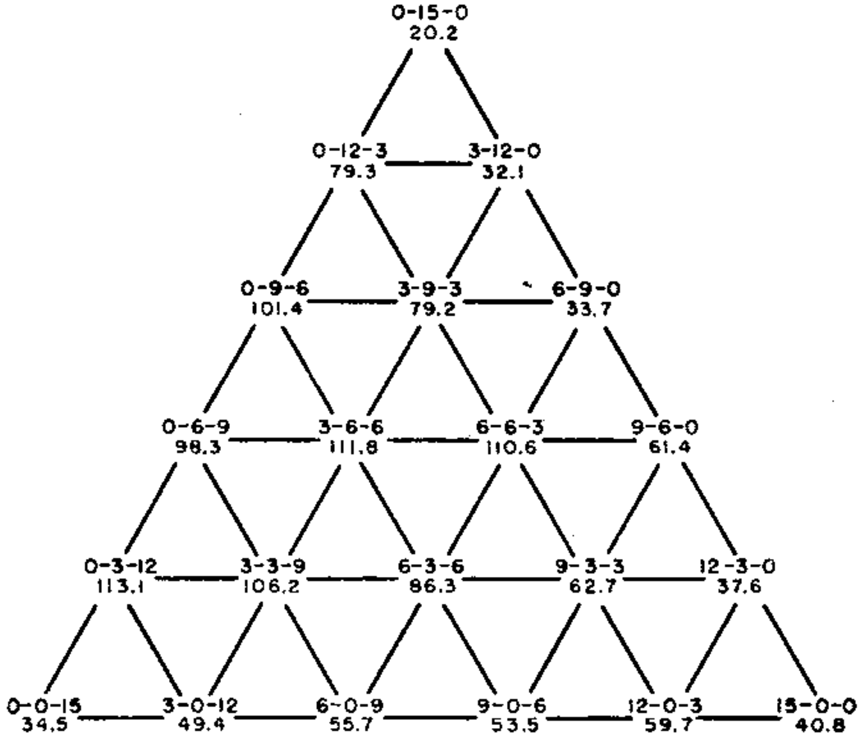



FIGURE 12.—Ratio of oil to protein, measured as percentages in seed (identical with ratio of grams oil to grams protein in seed), as influenced by ratio of fertilization.

be considered in terms of both optimum amount for production and chemical composition. When this chemical composition was considered as a sum of both oil and protein percentages, then the optima were found identical in this study with the 6–6–3 application. Omission of nitrogen, of phosphorus, or of potash resulted in reduced production and reduced percentage reserve capacity. The optimum weight of seed and of each compositional part was obtained with the 0–phosphate mixtures of fertilizers—at 12–0–3 (table 36), except for fuzz at 6–0–9 (table 27). Reduction in nitrogen, in potash, or in both, as phosphate was added, caused decreased weight of the whole seed and each of the parts. The chemical composition would be affected similarly with the grams-per-seed capacity receding through these same changes. Finally, the fertilizer most adequate for oil-to-protein ratio was one with all fifteen fertilizer parts applied as potash. In this experiment the increase in potash supply was the main controlling factor. At any level of potash supply, however, decided effects were obtained from phosphate-to-nitrogen applications. These ranged from a distinctly greater need for nitrogen at 0–potash supply to a need of high phosphate as the potash was increased in the fertilizer mixture, in order to increase the oil-to-protein ratio.




AVERAGE FOR CHECK PLOTS, 26.0 EXPERIMENTAL AVERAGE, 63.9

FIGURE 13.—Available oil (in pounds) per acre, as influenced by ratio of fertilization.

The nature of measurements of the influence of fertilization on production of cottonseed becomes of utmost importance. The per-seed production of kernels, hulls, and fuzz and the grams of oil and protein per seed are affected quite differently from the percentages of these various fractions in the fuzzy cottonseed. Were these results presented entirely as percentages it would indicate that one set of fertilizer adjustments was the most adequate. On the basis of per-seed weights of the different components, other fertilizer combinations are found most adequate.

In the consideration of contributions to variation in yield, increased weight of seed is of negligible influence in conditioning adequacy of seed production, since increased numbers of seed account for much greater changes in connection with the application of an N–P–K fertilizer. And finally, it should be emphasized that even a large variation in grade of cottonseed may be offset by only a small variation in acre yield of seed resulting from fertilization.

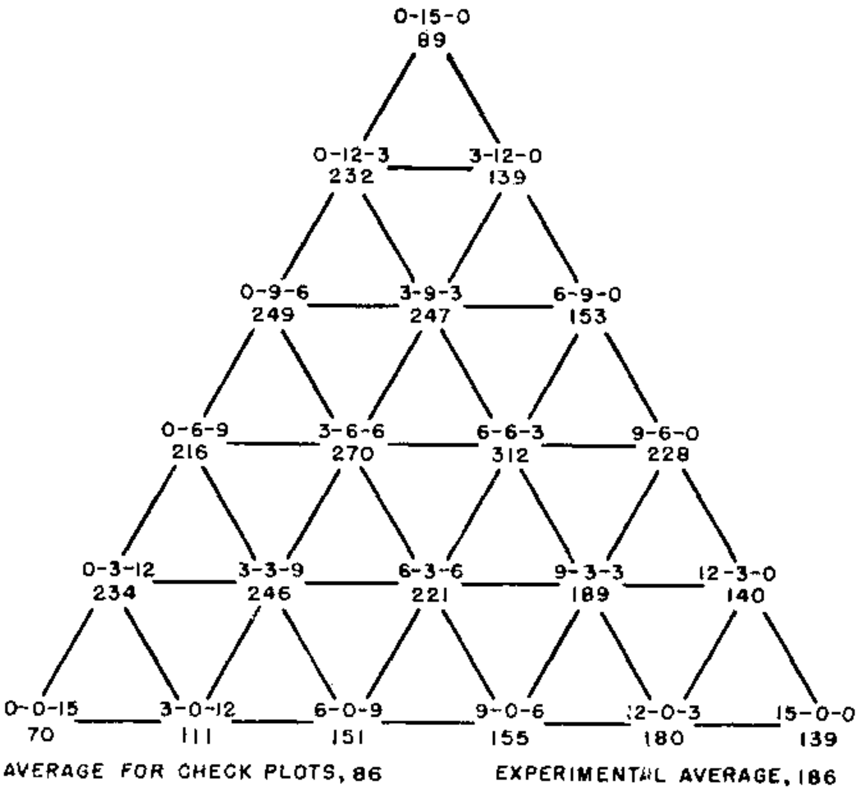



FIGURE 14.—Available cottonseed cake (8-percent ammonia content), as influenced by ratio of fertilization.

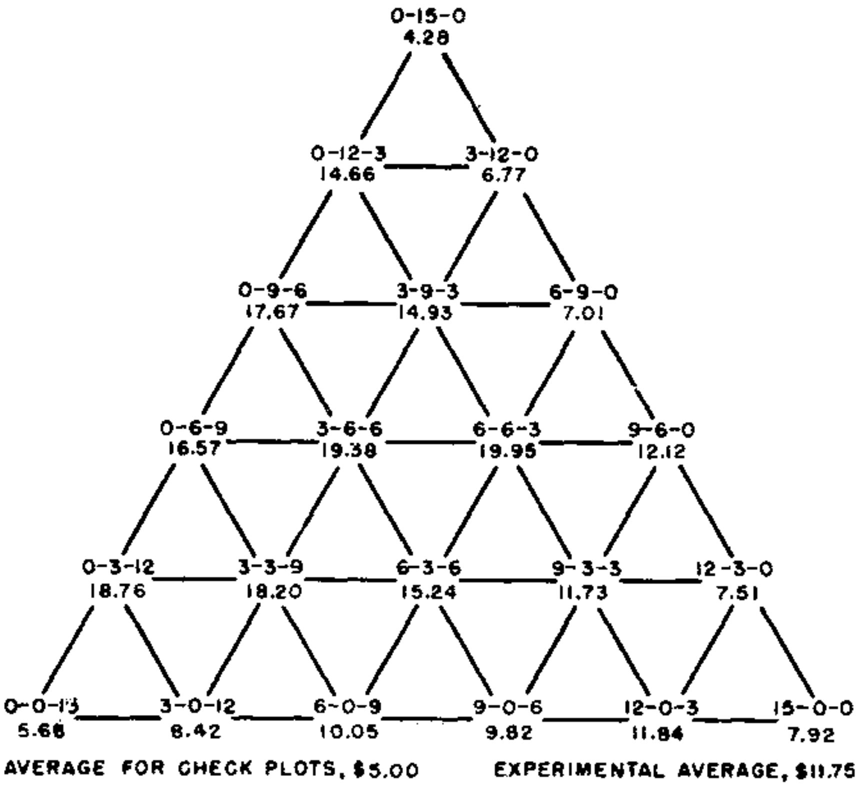



FIGURE 15.—Value per acre of cottonseed as influenced by ratio of fertilization. Calculated at $56 per ton for basis grade seed (100 points).

## EFFECT OF FERTILIZATION ON SEED FROM BOLLS OF KNOWN DEVELOPMENTAL HISTORY

By W. H. Tharp and H. B. Brown

### Experimental Plan and Procedure

In 1943 a small tract of old, fairly uniform Olivier silt loam soil on the Perkins Road Experiment Station Farm, near Baton Rouge, La., was chosen for cotton experiment 3. This soil was very low in natural fertility, especially in available phosphorus, a soil analysis showing only 17 parts per million. It was known that this land had not had any fertilizer for 15 years and had not been farmed during the greater part of that time. On the cut, 32 small plots, each 4 by 8 feet, were marked off, leaving vacant plots on the sides and at the ends.

Six inches of the topsoil was removed to a pile where it was mixed thoroughly. Then a layer of the subsoil a foot deep was removed to a separate pile and mixed by shoveling. After mixing, the subsoil was put back on the plots and tamped down somewhat. The topsoil was likewise returned to the plots. When the soil was put back on the plots, it formed low beds. On April 1 the fertilizers given in the list of treatments were put in small furrows along each side of the plots, except the barn manure. This was spread over the top of the bed and worked into the soil with hoes.

On April 26, Deltapine 6, a wilt-resistant, long-staple cotton, was planted in hills 2 feet apart, four hills per plot. The plants that emerged were thinned to two plants per hill. A perfect stand was maintained by transplanting a few plants while small. In transplanting, care was taken that the mass of soil about the roots was not disturbed. Deltapine 6 has been propagated as a pure line strain since 1934 and is very uniform.

Very similar methods of procedure were followed in 1944 except that a different cut of land was used. This was near the first tract and was similar, but had less fertile soil. Each year, at three different times during the blooming period, all the blooms that opened on two successive days were tagged and the tags dated; the idea being to use for comparison only the bolls that developed under the same weather conditions. Unfortunately in 1944 there was such a contrast between the plants of well-fertilized and poorly fertilized plots that there was not so much overlapping in bloom production as in 1943. This made it impossible to get as many bolls of comparable age as desired from plants on soil that had received the different treatments on the same date.

Bolls from all four replicate plots at each picking of treatment No. 7 in 1943 were carried through the analytical procedure as single-boll samples. The bolls from other treatments in 1943 were blended as to replicates within picking dates. In 1944 there were insufficient samples for analysis of all treatments at a third picking date, and at the first and second pickings many individual samples were too small for analysis. Where possible, the 1944 samples from replicates 1 and 2 and those from replicates 3 and 4 were blended to give two analytical samples (A and B) within each date for each treatment. In still other cases in 1944 no dated bolls were available from some of the replicates. In these instances all samples available within a treatment on a picking date were blended and split into laboratory subsamples A and B. There were not sufficient seed available from treatment No. 8 (either A or B) to give a reliable measure of seed composition for each picking date in 1944.

Oil and protein content were measured on kernels that had been separated by hand-cutting, then oven-dried and ground in an intermediate Wiley mill, using a 20-mesh screen.

Percentages of fuzz were measured on blends of all treatments within each picking date in 1943. The average, 9.82-percent fuzz on seed of 10-percent moisture content, was utilized in calculations where correction for percentages of fuzz were necessitated. Seed of the 1944 crop were delinted and measured for percentage of fuzz prior to separating hulls from kernels, so that corrections for weights of fuzz in this second year were applied by duplicate samples within treatments, within dates.

Boll weights were obtained for multiple-boll samples at the time of ginning and were reduced to weights of seed per boll by the percentages of seed determined at the time of ginning.

Single-boll samples from treatment No. 7 in 1943 were all counted as to numbers of seed. The average number and the range in number of seed were calculated for each replicate plot within each picking date. Four bolls were then selected for analyses from each replicate within each date, so that the average and range in number of seed were approximately that for all bolls submitted. This allows for a determination of variation in seed-product measurements associated with differences in number of seed per boll within plots and picking dates.

In plot 23 (replicate 3) 20 single-boll samples were available at the second picking date in 1943. All were analyzed to provide a measure of variability per boll within what would otherwise be a single, blended sample of seed. Seed-product measurements of single-boll samples were carried out in the same manner as were multiple-boll samples, except that protein in kernels was determined on the meal after the oil had been extracted. The samples were redried after extraction and reweighed before being analyzed for protein. Percentages of protein were calculated to a basis of oil-contained moisture-free meal.

Variance analyses have been carried out in 3 steps. The data in 1943 represented a complete design for 3 pickings, by 8 treatments, replicated 4 times—allowing for a straightforward analysis utilizing 96 observations. In 1944 the omission of the eighth treatment and the third picking and the necessity to pool replicates (that is, to select 2 samples from a blend) reduced the design to 7 treatments by 2 picking dates by 2 replicates—allowing for only 28 observations. The analyses for both years combined have been made on the mean responses of 7 treatments within the first 2 picking dates, allowing for 28 observations each year.

Since picking dates and years must be considered to a certain extent as replications in time, the analyses have been partitioned to allow for the appropriate and applicable subdivisions of error variance. It should be emphasized that partitioning has reduced the degrees of freedom for testing pickings in 1944 and in the combined analyses so that an unusually large variance ratio is required for significance. It is felt, however, that this partitioning was necessary to allow for testing treatment effects by only the applicable error.

The detailed data from experiment 3 are set forth in text tables 3 to 9, inclusive, and tables 37 to 45, Appendix, and the major trends are illustrated in figures 16 to 21.

### Experimental Results

The data from this experiment allow for comparisons on many different bases of measurement. The information is first presented from the standpoint of differences in composition of multiple-boll samples that are associated with experimental sources of variability. Results are next presented as to composition per seed, composition per boll, and the influence of number of seed per boll on the composition per seed and per boll. The analyses of single-boll samples of seed facilitates presentation of the extent of variability within the usual multiple-boll samples of cottonseed.

#### FRUITING BEHAVIOR

The effect of fertilizer treatment on the composition of cottonseed depends ultimately on the comparative growth status and fruiting behavior of the plant. In this study these average responses were not found particularly disproportionate from one season to the next, but specific effects of treatments on fruiting periodicity were distinctly different in the 2 years. In 1944 the period of most vigorous fruiting for fertilizer treatments producing only poor growth tended to come at a much later date than for the plants given fertilizers conducive to adequate growth. Bolls tagged at the same time in 1944 represented harvest from plants of increasing vigor with some treatments and others of almost a senile condition with other treatments. Some slight tendency in this direction was observed also in the first year (1943); effects were much more striking in the second year.

The foregoing discussion refers to the agronomic results that are given in detail elsewhere (*5, 6, 7*). This brief summary of growth and fruiting behavior has been presented here because the disproportionate response from fertilizer treatments from one season or one picking to the next could be reflected in the composition of cottonseed. The 2-year averages might, under these conditions, represent a compromise rather than a trend with respect to the comparative effects of these treatments on the composition of cottonseed. Certain data relative to treatment effects on fruiting behavior in 1943 as compared to 1944 are set forth in table 3, and the rates of blooming in plants given treatment NPK are shown for each year in figure 16.

This summary shows the quantitative differences in fertilizer effect in the 2 years. The periodicity of treatments within years is not shown, but it will suffice to remember that the treatments that resulted in comparatively poor boll production were on plants that reached their peak of bloom production and setting (reten-

TABLE 3.—*Effect of different fertilizer treatments on percentage of boll retention of Deltapine 6 cotton at Baton Rouge, La., 1943 and 1944*

| Treatment No. | Fertilizer | | 1943 | | | | 1944 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per acre | Constituent | Blooms | Bolls picked | Boll set | Seed cotton per acre [1] | Blooms | Bolls picked | Boll set | Diseased and defective bolls | Seed cotton per acre [1] |
| | *Pounds* | | *Number* | *Number* | *Percent* | *Pounds* | *Number* | *Number* | *Percent* | *Percent* | *Pounds* |
| 1 | 0 | | 1,103 | 567 | 51.4 | 1,950 | 518 | 199 | 38.4 | 18.1 | 629 |
| 2 | 1,000 | 5-10-4 | 1,684 | 938 | 55.7 | 3,226 | 1,534 | 888 | 57.9 | 7.0 | 3,199 |
| 3 | 50 | Nitrogen | 1,178 | 613 | 52.0 | 2,108 | 334 | 123 | 36.8 | 32.5 | 377 |
| 4 | 100 | Phosphoric acid | 1,327 | 733 | 55.2 | 2,444 | 1,185 | 689 | 58.1 | 7.0 | 2,431 |
| 5 | 40 | Potash | 1,232 | 663 | 53.8 | 2,280 | 425 | 177 | 41.6 | 22.6 | 558 |
| 6 | 50 | Nitrogen | 1,381 | 699 | 50.6 | 2,404 | 1,307 | 720 | 55.1 | 11.8 | 2,540 |
| | 100 | Phosphoric acid | | | | | | | | | |
| | 100 | do | | | | | | | | | |
| 7 | 40 | Potash | 1,662 | 944 | 56.8 | 3,246 | 1,657 | 985 | 59.4 | 3.2 | 3,621 |
| | [2] 20 | Manure | | | | | | | | | |
| SA | 1,000 | 5-10-4 [3] | 1,675 | 980 | 58.5 | 3,370 | 1,412 | 846 | 59.9 | 8.3 | 3,237 |
| SB | 1,000 | 5-10-4 [4] | 1,045 | 522 | 49.9 | 1,796 | | | | | |

[1] Yields are based on a count of the number of bolls produced, estimating 100 to a pound of seed cotton. The extra space around the plants increased yields considerably.

[2] Tons.

[3] Extra water.

[4] Arid conditions.

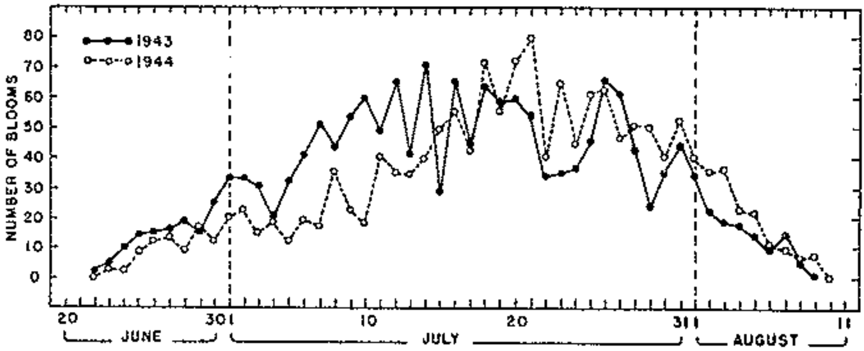



FIGURE 16.—Rate of blooming in Deltapine 6 cotton, fertilized at the rate of 60 pounds of nitrogen, 100 pounds of phosphoric acid, and 40 pounds of potash. Baton Rouge, La., 1943 and 1944.

tion) of bolls much later, particularly in the second year, than treatments that resulted in good boll production.

## COMPOSITION OF MULTIPLE-BOLL SAMPLES

### MORPHOLOGICAL COMPOSITION OF SEED

When effects of fertilizer treatments are considered in terms of any net benefit to partial morphological composition of the seed (tables 37–39, Appendix), no consistent improvement through treatment was found in the 2-year period of study. Certain treatments within each year produced significant increases in compositional measurements, but the 2-year averages showed no increases of significant proportions. The weather was quite different in each of the 2 years and affected the results with some of the fertilizer treatments in two distinct ways: It gave increases in the first and decreases in the second year.

Seed index, percentage of fuzz, and percentage of kernels in fuzzy seed were increased very little by any treatment in either year. Certain reductions were noted, but the inconsistency of results between years was of such magnitude that the 2-year average effects on morphological composition (seed index, percentage of fuzz, and percentage of kernels in seed) indicated a need for further study on the exact treatments that should be given at this location.

### CHEMICAL COMPOSITION OF KERNELS

Any treatment containing potash and treatments representing increases in phosphorus without nitrogen tended to increase oil content of kernels, while applications with nitrogen (N) alone tended to lower percentage of oil content. The general results were quite variable in magnitude each year and were not proportionate from one harvesting date to the next. Perhaps the most consistent effect of fertilizer treatment was that shown by the lowered oil content in plots where nitrogen and phosphorus with nitrogen were added to the soil (table 40, Appendix). Conversely, the percentage of protein content of kernels was increased by treatments containing nitrogen alone, but only in the first year (1943) (table 41, Appendix).

Since fertilization caused so little variation in either oil or protein content and because of the usual compensatory variability of the two fractions, the lack of significant treatment effects on percentage of reserve capacity of kernels was to be expected (table 42, Appendix). There is, however, a significant average difference in kernel capacity between years because of the greater average percentage content of both oil and protein in the kernels of seed grown in 1944 as compared to those of seed grown in 1943 (table 42, Appendix).

The percentage of oil content decreased and the percentage of protein increased with the delay of the time of boll initiation. This compensatory variability was not proportionate for the 2 years—the percentage of total reserves increased in 1944, whereas they decreased the previous year as the season advanced.

The ratio of oil to protein in the kernels (table 43, Appendix) was lowered with lateness of boll initiation in both years, the greater decrease occurring in the second year. The effects of fertilizer treatments on this ratio were quite inconsistent from one year to the next, as well as from one date of harvest to the next (table 43, Appendix). The treatment with nitrogen (N) alone favored protein elaboration, as did treatment NP, but treatments K and P each tended to favor deposition of oil, rather than protein, in the cottonseed kernel.

There is very little evidence, production effects excluded, that the morphological and chemical composition of cottonseed benefited from any of this series of fertilizer treatments. The highly disproportionate effects of fertilizers between the 2 years, 1943 and 1944, might be found unusual were the study continued several more years. It is apparent that an extension of the study must be made before the exact fertilizer treatments necessary to improve cottonseed production in this soil can be ascertained.

Although much of the published data relative to composition of cottonseed has been presented on a percentage basis, the more truly physiological measure of differences would be that of variation in composition expressed as grams per unit of seed reproduction. In order to furnish a basis for comparing variations in seed composition on both scales, the results within 1944, the year in which the more striking effects were apparent, are shown as partial percentage composition of moisture-free fuzzy seed (fig. 17) and as grams of each seed product per 100 seed (fig. 18). In these figures the term "fiber" is used in accordance with established practices in biochemical laboratories, even though, from a botanical point of view, there is no fiber in the kernel or in the hull.

The graph (fig. 17) showing the percentage basis indicates—as did the tabulated data and analyses—that fertilization has had very little effect in altering the proportions of oil, protein, kernel, hull, and fuzz in the seed. When the variations are considered in terms of grams per 100 seed the changes in composition are seen (fig. 18) to have been of considerably greater magnitude than those indicated on a percentage basis. The most important difference in method of measurement is that the fertilizer treatments increasing seed weight increase also each compositional part of seed when measured on the grams-per-seed basis. Even the oil and protein content that tended to vary inversely with fertilization (when measured as percentages in the kernel) now tend to vary in a positively associated manner, both increasing or decreasing as the seed weight increased or decreased by fertilizer treatment (table 44, Appendix).

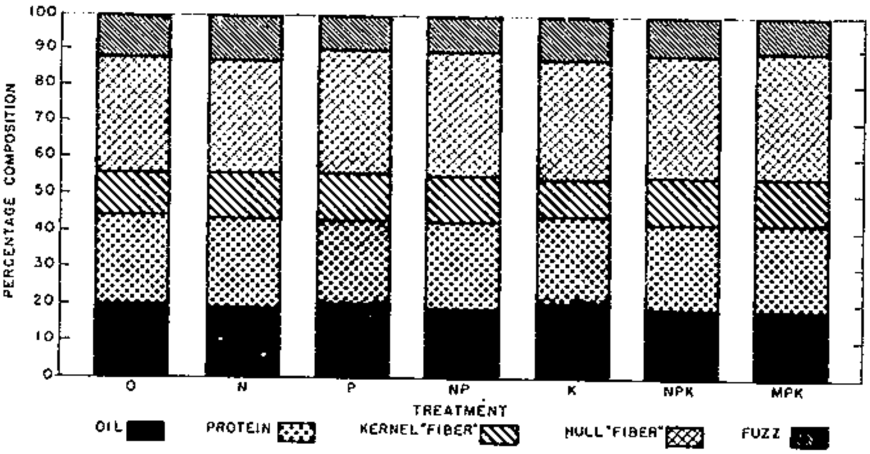



FIGURE 17.—Partial percentage of composition of moisture-free, fuzzy cottonseed, as influenced by fertilization, Deltapine 6 cotton, Baton Rouge, La., 1944.

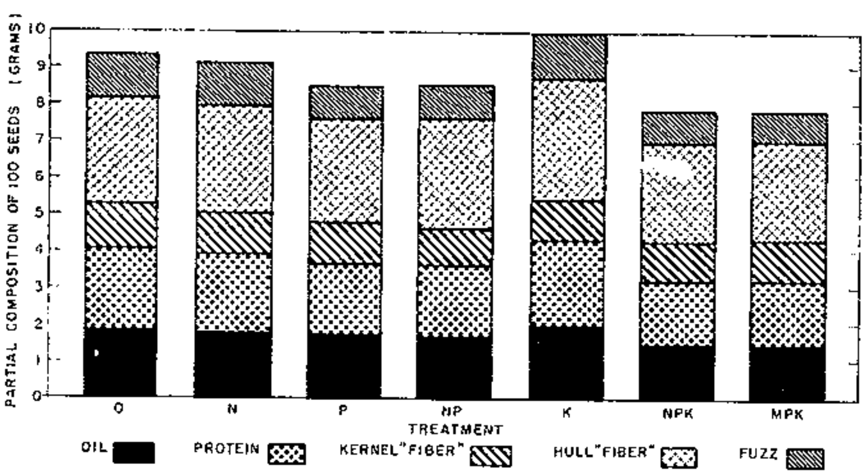



FIGURE 18.—Partial composition by weight (in grams) of 100 moisture-free, fuzzy cottonseed, as influenced by fertilization, Deltapine 6 cotton, Baton Rouge, La., 1944.

### CHANGES IN COTTONSEED GRADE

The manner in which changes in oil and protein content of seed, resulting from fertilizer treatment, have brought about changes in cottonseed grade is shown in table 44, Appendix. Seed grade is highest with treatment K and the next highest with treatment P at a point where oil and protein are both relatively high. Variation in oil content accounts for about three-fourths of the variation in grade, but the treatment with P brought about such a reduction in protein content that grade for this treatment, although it produced a higher percentage of oil content of fuzzy seed, was lower than with treatment K. In 1944 all treatments other than K and P (treatments 4 and 5) lowered the percentage of oil content or the percentage of protein content of seed to the extent that it tested to be a grade lower than that of seed from the check plots (0-0-0). On a 2-year basis, however, seed from plots given complete fertilizers, as well as those given treatments 4 and 5, had a grade slightly higher than that of seed from check plots (table 44).

### INFLUENCE ON ACRE YIELD AND VALUE

Changes in cottonseed grade as influenced by fertilization are shown in table 44 along with changes in yield of seed, in order that the partial effect of each of these component variables may be related to the variations in acre value of seed. It is obvious that a large increase in grade can be easily offset by only a small decrease in yield. In fact, the variations in yield of seed associated with fertilization in the second year of this study are of such magnitude that yield and acre value of seed have remained almost entirely proportionate. One slight exception occurs. Treatment with NP, by lowering grade, so lowered the unit value of seed that the acre value was less than for treatment P, whereas the yield of seed was slightly higher for treatment NP than for treatment P. With all other treatments the variations in yield and acre values remained closely proportionate in 1944.

This series of environmental changes has three distinct and separate sets of influence on the cottonseed: (1) On the percentage composition of seed; (2) on the weights of seed and weights of each seed product; and (3) on the number of units (seed) produced per plant or per acre of cotton. Combined influences of these three sets of variations are shown in figure 19, which indicates the pounds of each seed product,[13] lint included, that were produced by each treatment. The year 1944 is presented so that the variations given in figures 17, 18, and 19 are all on a comparable basis.

The most striking point brought out in figure 19 is the fact that percentage or grams-per-seed differences in composition (see figs. 17 and 18) that are not proportionate with yield variations have had negligible effect on altering the net pounds yield of each product per acre. For example, treatment K was associated with

[13] The following assumptions have been utilized in calculating the values for figure 19: 10 percent moisture is assumed for both seed and lint. In the seed fraction this moisture is shown and labeled as manufacturing loss (manufacturing loss will average closer to 5 percent of the moisture contained in weight of seed, but for comparison of treatments the proportionate 10 percent shown does not alter other relative results). Percentage of lint in seed cotton was not measured by treatments in 1944, so the average obtained for the entire study for 1943 (36.8 percent) was utilized in calculations for 1944. Available oil and available 8-percent $NH_3$ cake were calculated, following procedures stipulated in the Rules (*26*) of the National Cottonseed Products Association. While these data, given in figure 19, may not represent the actual pounds of these products available through commercial processing, they are comparable from one treatment to the next and entirely within limits of experimental deviation when acre yields are calculated from such small experimental plots.

relatively high percentages of oil, protein, and kernels in both years, yet the production of available oil and cake is almost wholly influenced by the low yield of seed cotton where the 0–0–4 fertilizer was applied.

This study of the specific effects of fertilizer treatments on values of seed products makes clear that a complete fertilizer is

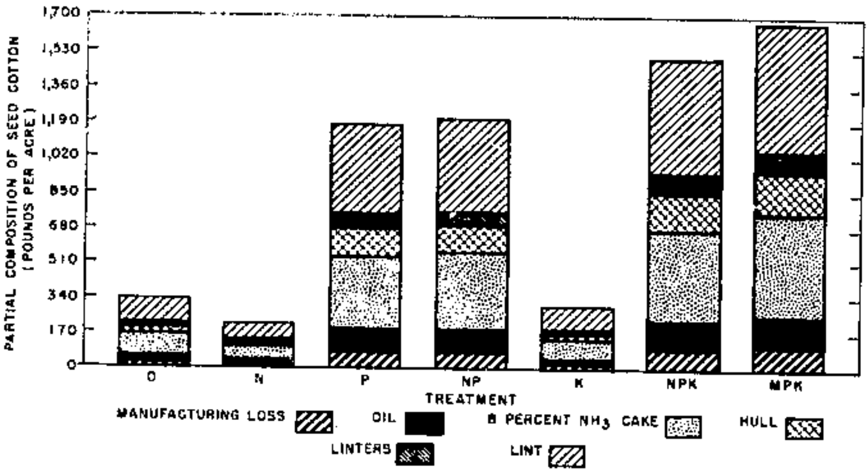



FIGURE 19.—Yields per acre of lint and of cottonseed products, as influenced by fertilization. Deltapine 6 cotton, Baton Rouge, La., 1944.

needed for this soil. The use of manure instead of nitrate gave slightly better results in both years (table 44). The P and NP fertilizers gave comparable increases in both years, but the addition of nitrogen to phosphoric acid caused a different reaction in the 2-year period, lowering production in 1943 and raising it in 1944. In neither year was either potash or nitrogen fertilization significantly effective until the availability of phosphate in the soil had been reestablished.

The main assumptions regarding deficiencies for production are similar for each of the 2 years, but plots receiving no phosphate suffered more severely in total and fractional production in the second year, causing a high disproportionate effect of fertilizers from one year to the next. It is particularly interesting that the effects of variation in proportionate composition and composition in grams of seed are almost wholly lost where products per acre are used as the basis of comparison.

### COMPOSITION PER BOLL AND PER SEED

Having obtained values for weight of seed, number of bolls, and percentage composition of seed in 1943 it has been possible to calculate both the per-boll and per-seed composition with respect to variation in weight of kernels, oil, and protein for that year. These data are presented as mean results associated with treatment in 1943 (table 4). On the per-boll basis of measurement it is found that the weight of seed, of kernels, and of oil is influenced in a proportionate manner by these fertilizers; treatments tending to raise one factor have a similar influence on other values.

TABLE 4.—*Mean effects of treatment on the composition of bolls and cottonseed in a selfed line of Deltapine 6 cotton grown at Baton Rouge, La., 1943*

| Treatment No. | Acre rate of fertilization with— | | | Composition per boll | | | | | Composition per seed | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Seed [1] | Weight of— | | | Capacity weight of oil and protein | Weight of— | | | Capacity weight of oil and protein | Ratio: Grams oil: grams protein |
| | N | $P_2O_5$ | $K_2O$ | | Kernels | Oil | Protein | | Kernels [1] | Oil | Protein | | |
| | *Pounds* | *Pounds* | *Pounds* | *Number* | *Grams* | *Gram* | *Gram* | *Grams* | *Gram* | *Gram* | *Gram* | *Gram* | |
| 1 | 0 | 0 | 0 | 26.5 | 1.29 | 0.410 | 0.534 | 0.944 | 0.0487 | .0155 | 0.0202 | 0.0357 | 0.77 |
| 2 | 50 | 100 | 40 | 26.7 | 1.41 | .464 | .568 | 1.032 | .0528 | .0174 | .0213 | .0387 | .82 |
| 3 | 50 | 0 | 0 | 28.4 | 1.27 | .391 | .547 | .032 | .0448 | .0138 | .0193 | .0331 | .72 |
| 4 | 0 | 100 | 0 | 27.9 | 1.38 | .418 | .550 | .969 | .0495 | .0162 | .0197 | .0359 | .82 |
| 5 | 0 | 0 | 40 | 27.0 | 1.41 | .469 | .568 | 1.037 | .0522 | .0174 | .0210 | .0384 | .83 |
| 6 | 50 | 100 | 0 | 28.7 | 1.25 | .382 | .533 | .919 | .0434 | .0133 | .0185 | .0318 | .72 |
| 7 | [2] 20 | 100 | 40 | 28.7 | 1.52 | .501 | .586 | 1.087 | .0531 | .0175 | .0205 | .0380 | .85 |
| 8A (2W) [3] | 50 | 100 | 40 | 28.3 | 1.66 | .544 | .659 | 1.203 | .0586 | .0192 | .0233 | .0425 | .82 |
| 8B (½W) [4] | 50 | 100 | 40 | 25.3 | 1.28 | .402 | .531 | .933 | .0506 | .0159 | .0210 | .0369 | .76 |

[1] All measurements calculated to a moisture-free basis.
[2] Tons of manure.
[3] Received twice the water falling on treatments 1 to 7.
[4] Received one-half the water falling on treatments 1 to 7.

Variations in weight of protein per boll are also fairly proportionate with changes in weight of other boll fractions. Variations in reserve capacity (protein plus oil) are similarly but not so closely associated. It is only the number of seed per boll that deviates distinctly from the general pattern of variability, and no direct or inverse correlative association was found for variability of numbers of seed per boll with weights of seed per boll or weights of the seed products per boll.

When composition is measured on a basis of weight per seed it is again noted that treatments tending to increase or to decrease one compositional factor tend also to increase or decrease, respectively, each of the other compositional factors. If the differences resulting from use of a complete fertilizer (as compared to none) are used as an example, it is evident that each seed from complete fertilizer plots (treatment No. 2) has a heavier kernel, containing more oil and more protein than seed from the untreated plots (treatment No. 1). In addition to having more oil and more protein each seed, as a result of using a complete fertilizer, has an increased oil-to-protein ratio as a result of the treatment. Measured on the basis of grams partial composition, effects are found to be additive, and increases in any one compositional part seem proportionate to increases in other parts of the seed. This proportionate trend of variability in seed composition was noted also where composition is expressed in terms of grams of each product per boll (table 4).

It is evident, with respect to the average effect of these treatments in 1943, that the number of seed per boll had no significant influence on the partial composition of seed.

## COMPOSITION OF SINGLE-BOLL SAMPLES

### BETWEEN-SAMPLE VARIABILITY

The numbers of seed per boll for all treatments but No. 7 (table 4) were calculated from boll counts, seed weights, and yield data, but actual measurements of composition were made from composited (multiple-boll) samples. In 1943 all tagged bolls harvested from treatment MPK (No. 7) were ginned and then submitted for seed analysis as single-boll samples and the number of seed in each of these samples was determined. From these values the range and average numbers of seed per boll were determined for each plot at each date.

Bolls were then selected from those submitted in order to approximate the range and the average number observed in each of the four replicate plots of treatment MPK at each of three dates. The numbers of seed per boll as found and as selected are presented in table 5.

By means of this selection it has been possible to study the relation between number of seed per boll as influenced by plot location (blocks), by dates of tagging and harvesting, and by seed-number groups. The differences found in average numbers of seed per boll between plots and between dates must be considered as associated with these two specific sources of experimental variability. On the other hand, the differences among the four seed number groups can be considered as that within what would constitute the usual carefully selected multiple-boll field sample.

**TABLE 5.**—*Number of seed per boll, as analyzed and as submitted, together with averages for series, picking dates, and plots. Study of variability per boll within one treatment, Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943*

| Picking date and plot No. | Seed in bolls chosen for self-product analysis: Series 1 | Series 2 | Series 3 | Series 4 | Mean | Seed in all bolls submitted: Range Low | Range High | Average | Bolls submitted (total) |
|---|---|---|---|---|---|---|---|---|---|
| First picking: | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | |
| 5 | 24 | 27 | 28 | 30 | 27.25 | 24 | 30 | 26.60 | 5 |
| 10 | 24 | 26 | 27 | 30 | 26.75 | 24 | 30 | 26.50 | 6 |
| 23 | 24 | 27 | 28 | 33 | 28.00 | 24 | 33 | 27.87 | 15 |
| 28 | 24 | 26 | 28 | 33 | 27.75 | 24 | 33 | 27.80 | 10 |
| Mean | 24.0 | 26.5 | 27.8 | 31.5 | 27.44 | | | 27.19 | 36 |
| Second picking: | | | | | | | | | |
| 5 | 26 | 29 | 31 | 34 | 30.00 | 26 | 34 | 29.85 | 13 |
| 10 | 25 | 27 | 29 | 31 | 28.00 | 23 | 36 | 28.07 | 14 |
| 23 | 27 | 29 | 31 | 35 | 30.50 | 27 | 37 | 30.80 | [1] 20 |
| 28 | 27 | 29 | 31 | 37 | 31.25 | 25 | 37 | 30.42 | 12 |
| Mean | 26.2 | 28.5 | 30.5 | 34.3 | 29.88 | | | 29.79 | 59 |
| Third picking: | | | | | | | | | |
| 5 | 32 | 34 | 36 | 38 | 35.00 | 32 | 38 | 35.14 | 7 |
| 10 | 25 | 29 | 34 | 37 | 31.25 | 22 | 37 | 31.00 | 7 |
| 23 | ([2]) | 32 | 39 | 41 | 37.33 | 32 | 41 | 37.33 | 3 |
| 28 | 26 | 30 | 31 | 37 | 31.00 | 26 | 37 | 31.00 | 4 |
| Mean | 27.7 | 31.3 | 35.0 | 38.3 | 33.40 | | | 33.62 | 21 |
| Averages for plots: | | | | | | | | | |
| 5 | 27.3 | 30.0 | 31.7 | 34.0 | 30.75 | | | 30.53 | |
| 10 | 24.7 | 27.3 | 30.0 | 32.7 | 28.67 | | | 28.52 | |
| 23 | 25.5 | 29.3 | 32.7 | 36.3 | 30.95 | | | 32.00 | |
| 28 | 25.7 | 28.3 | 30.0 | 35.7 | 29.92 | | | 29.74 | |
| Average | 25.8 | 28.7 | 31.1 | 34.7 | 30.07 | | | 30.20 | 116 |

[1] All 20 complete bolls received from the second picking, plot 23, were analyzed to obtain a measure of variability within a single plot at one date of tagging and picking.
[2] Cross reference means will not check because of this missing value.

To show the variations among the single bolls chosen for analyses, only the weights of seed and seed content of oil have been presented. In table 6 the results of analysis are shown by seed-number groups within picking dates, together with means for seed-number groups and the mean squares from the variance analyses of each of six measurements: Number of seed per boll, weight of seed per boll, weight of each seed, and oil content expressed as grams per boll, grams per seed, and percentage in kernels.

As the number of seed per boll increases among the four seed-number groups (selected as to number of seed per boll within each harvest), the total weight of all seed within each boll and the weight of oil per boll increases while the weight of each seed and the grams of oil in each seed decreases. When oil is measured on a percentage-in-kernel basis no definite association with numbers of seed in a boll is found. There were only small changes in the measures of variability between the seed harvested on first and second dates. At the third harvest date, however, the number of seed per boll had increased markedly and was associated with reduction in total weight of seed per boll, average weight of each seed, and reduction in each of three measures of oil content.

A further measure of the variability that might be associated with number of seed per boll was possible through analysis of all 20 bolls available from the second picking, plot 23, treatment

TABLE 6.—*Variation in composition of single-boll samples of cottonseed. Mean response within treatment number (1,000 pounds of 5–10–4) in Deltapine 6 selfed-line cotton as affected by picking and number of seed per boll, Baton Rouge, La., 1943*

EXPERIMENTAL DATA

| Picking and grouping by number of seed per boll | Means by groups within dates | | | | | |
|---|---|---|---|---|---|---|
| | Seed per boll | Weight of seed per boll | Weight per 100 seed | Oil content | | |
| | | | | Each boll | Each seed | In kernels |
| First picking: | *Number* | *Grams* | *Grams* | *Gram* | *Gram* | *Percent* |
| 1 | 24.0 | 2.36 | 9.8 | 0.511 | 0.0213 | 34.0 |
| 2 | 26.5 | 2.58 | 9.5 | .564 | .0213 | 35.3 |
| 3 | 27.8 | 2.76 | 9.9 | .584 | .0210 | 33.2 |
| 4 | 31.5 | 2.96 | 9.4 | .643 | .0204 | 34.7 |
| Mean | 27.4 | 2.67 | 9.6 | .576 | .0210 | 34.3 |
| Second picking: | | | | | | |
| 1 | 26.2 | 2.37 | 9.0 | .527 | .0201 | 34.3 |
| 2 | 28.5 | 2.80 | 9.8 | .641 | .0225 | 34.9 |
| 3 | 30.5 | 2.65 | 8.7 | .570 | .0187 | 33.7 |
| 4 | 34.3 | 2.88 | 8.4 | .662 | .0193 | 36.9 |
| Mean | 29.9 | 2.68 | 9.0 | .600 | .0202 | 34.9 |
| Third picking: | | | | | | |
| 1 | 27.7 | 2.31 | 8.1 | .471 | .0170 | 33.0 |
| 2 | 31.3 | 2.03 | 6.2 | .354 | .0113 | 28.5 |
| 3 | 35.0 | 2.09 | 5.9 | .399 | .0114 | 27.3 |
| 4 | 38.3 | 2.78 | 7.2 | .483 | .0126 | 29.6 |
| Mean | 33.1 | 2.30 | 6.9 | .427 | .0131 | 29.6 |
| Mean for groups: | | | | | | |
| 1 | 25.8 | 2.35 | 9.0 | .503 | .0195 | 33.7 |
| 2 | 28.7 | 2.47 | 8.5 | .520 | .0184 | 32.9 |
| 3 | 31.1 | 2.50 | 8.2 | .518 | .0170 | 31.4 |
| 4 | 34.7 | 2.87 | 8.4 | .596 | .0174 | 33.7 |
| Mean | 30.1 | 2.55 | 8.5 | .534 | .0184 | 32.9 |

**TABLE 6.**—*Variation in composition of single-boll samples of cottonseed. Mean response within treatment number (1,000 pounds of 5-10-4) in Deltapine 6 selfed-line cotton as affected by picking and number of seed per boll, Baton Rouge, La., 1948*—Con.

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean squares[1] | | | | | |
|---|---|---|---|---|---|---|---|
| Plots | 3 | **22.67 | *0.6316 | 2.9033 | 0.03299 | 0.1931 | 20.9745 |
| Groups | 3 | **147.00 | *.6219 | 1.5107 | .02065 | .1349 | 14.6453 |
| Plots × groups[2] | 9 | 1.56 | .1305 | .7552 | .00883 | .0771 | 6.6819 |
| Dates | 2 | **155.58 | .7291 | **33.7697 | *.13353 | **3.0857 | **136.6846 |
| Plots × dates[3] | 6 | 11.14 | .2828 | 1.9254 | .01751 | .1366 | 11.9702 |
| Groups × dates | 6 | 1.35 | .1540 | **6.7147 | .00893 | .1297 | 10.3147 |
| Plots × groups × dates[4] | 18 | .99 | .0806 | .7084 | .01563 | .0905 | 5.3052 |
| Total | 47 | | | | | | |

[1] * = Significant mean square, 5-percent level; ** = highly significant mean square, 1-percent level.
[2] Error A. [3] Error B. [4] Error C.

NPK. These samples were derived from what would ordinarily be considered a single-plot field sample. Results for analyses of these 20 bolls are presented in table 7 for the same 6 measurements utilized in the data given in table 6.

Variance analysis of these data is not possible, but means, ranges, and standard deviations are given for each of the other 6 measurements. Only 2 of the product measurements were found to vary in association with number of seed per boll: Weight of all seed in a boll and weight of oil from each boll were positively associated with the number of seed per boll. A highly significant increase in these 2 measures occurred as the number of seed per boll increased. Weight of each seed, weight of oil per seed, and percentage of oil in kernels each varied in a manner independent of the number of seed per boll in this series of 20 single-boll samples.

The 20 bolls represented in table 7 as well as the sets of 4 bolls per plot represented in table 6 can be assumed as components of the usual single-field sample in seed-composition experimentation. It has been shown in tables 6 and 7 that each seed has a tendency toward uniform composition regardless of number of seed per boll. It would seem, therefore, that the inherent capacity or potential for quantitative composition is vested in the seed rather than in the fruit (or boll) as the unit. This conclusion must be related solely to bolls set and matured under the same environment and at the same time, since in tables 5 and 6 it was shown that a larger seed load per boll occurring with advance in season was associated with a diminished weight of seed and a diminished oil content of each seed, as well as a lower percentage of oil content of kernels. This reduction in quantitative composition of seed with advance in season, however, is not all a result of increase in numbers of seed per boll but more probably is a reflection of environmental stresses limiting development of seed regardless of the number per boll.

TABLE 7.—*Variation in composition of single-boll samples of cottonseed within a single plot at one picking date (treatment No. 7, plot 28, second picking date), Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1948*

| Sample No. | Measurements in single-boll samples | | | | | |
|---|---|---|---|---|---|---|
| | Seed in each boll | Weight of seed per boll | Seed index (weight of 100 seed) | Oil content | | |
| | | | | Each boll | Each seed | In kernels |
| | *Number* | *Grams* | *Grams* | *Gram* | *Gram* | *Percent* |
| 1 | 27 | 2.49 | 9.25 | 0.546 | 0.0203 | 33.7 |
| 2 | 28 | 2.31 | 8.25 | .464 | .0166 | 31.8 |
| 3 | 28 | 2.63 | 9.39 | .587 | .0209 | 34.5 |
| 4 | 28 | 2.47 | 8.82 | .526 | .0188 | 33.7 |
| 5 | 29 | 2.91 | 10.04 | .689 | .0237 | 36.1 |
| 6 | 29 | 2.44 | 8.41 | .566 | .0194 | 36.5 |
| 7 | 29 | 2.44 | 8.41 | .596 | .0204 | 38.2 |
| 8 | 30 | 2.80 | 9.33 | .646 | .0215 | 35.7 |
| 9 | 30 | 2.68 | 8.93 | .553 | .0184 | 32.5 |
| 10 | 31 | 3.03 | 9.77 | .678 | .0220 | 38.8 |
| 11 | 31 | 3.04 | 9.81 | .704 | .0228 | 35.4 |
| 12 | 31 | 3.00 | 9.68 | .647 | .0209 | 33.2 |
| 13 | 31 | 2.81 | 9.06 | .581 | .0187 | 32.3 |
| 14 | 31 | 2.95 | 9.52 | .680 | .0219 | 36.0 |
| 15 | 32 | 3.07 | 9.59 | .672 | .0210 | 33.6 |
| 16 | 32 | 2.65 | 8.28 | .613 | .0192 | 36.5 |
| 17 | 32 | 2.65 | 8.28 | .567 | .0177 | 32.4 |
| 18 | 34 | 3.18 | 9.35 | .674 | .0198 | 33.7 |
| 19 | 35 | 3.47 | 9.91 | .798 | .0228 | 35.0 |
| 20 | 37 | 3.17 | 8.57 | .697 | .0188 | 34.7 |
| Mean | 30.75 | 2.81 | 9.13 | .624 | .0203 | 34.72 |
| Range: | | | | | | |
| Low | 27.00 | 2.31 | 8.25 | .464 | .0166 | 31.8 |
| High | 37.00 | 3.47 | 10.04 | .798 | .0237 | 38.8 |
| Standard deviation | ±2.510 | ±.306 | ±.601 | ±.076 | ±.0019 | ±1.94 |

WITHIN-SAMPLE VARIABILITY

The variability in each of the measurements recorded in table 8 can be viewed in terms of that which can occur within a single sample composed from a limited number of bolls, all of which flowered and matured within an identical-time environment. For this purpose a comparison of the extent of variability among the different measurements can be obtained through the relation of the standard deviation to the mean. In the case of number of seed per boll the standard deviation is 8.16 percent of the mean. It is 10.89 percent of the mean weight of seed per boll, 6.58 percent of the mean weight per seed, 12.18 percent of the mean weight of oil per boll, 9.36 percent of the mean weight of oil per seed, and 5.59 percent of the mean percentage of oil in the cottonseed kernels.

The consistency of the measurement, as judged by these relationships, is best for the percentage of oil content of cottonseed kernels and is also relatively low for the measurement of weight per 100 seed (seed index). It is encouraging to find variability of low order in these two measures, for they are from the list of measurements most often used in studies of cottonseed composition. In this study the plot consisted of 8 plants (4 hills of 2 plants each). The variety had been well selfed, the soil made homogenous throughout the plot, and the bolls were all tagged at flowering, so that it is logical to assume that variability by bolls is lower here than in most studies of cottonseed composition.

A great many more trials with different varieties and different environments would be necessary before the expected intrasample variability could be predicted. The findings in this study constitute merely one isolated determination of such heterogeneity. On the other hand the results indicate clearly that the experimenter may quite easily fail to obtain a sample that is truly representative of production in a single plot, unless he makes allowance to insure that the distribution of the bolls that compose the sample is also distribution of the probable range in seed composition represented within the plot or plots being measured.

### ASSOCIATED VARIATION IN STORAGE RESERVES

It has been assumed that conditions conducive to high oil content of cottonseed result in a lower deposition of protein, the one product varying in an inverse relationship to the other (*10, 16, 24, 31, 41, 43*). This relationship has been studied most often among a series of location or treatment means where the same variety or series of varieties have been grown. In this investigation a study was made of this associated variation as influenced by treatments, years, and time of harvest where the data result from analyses of multiple-boll samples. In addition, a study was made of the effect of the associated variability in storage reserves in cottonseed on composition of single-boll samples by treatments as well as by variation occurring among the single-boll components of the usual multiple-boll field sample.

Values for the correlation coefficient *r* are presented in table 8 as measured on the data from the analyses of oil and nitrogen content of the multiple-boll samples within each date of harvest and on the results with harvest dates pooled. These are shown for the relationship on a percentage-in-kernel basis and also on percentage-in-seed basis. Although correlated variation has been measured for oil and nitrogen content of cottonseed kernels in some previous experiments, it has been most often presented on the basis of percentages in the seed. Variation in the proportion of kernel (fuzz included with hulls) in seed is the main factor that produces differences in associated variation between a percentage-in-seed and a percentage-in-kernel basis of measurement.

It was found that percentages of kernels in seed were altered by treatment to only a small degree in this study. Yet these small changes have been sufficient to disrupt the uniformly significant inverse correlated variation of oil and nitrogen content measured as percentages in the storage tissue (kernel). Although there is a very highly significant negative correlation for oil and protein percentages in the kernel at all harvest dates, the correlation on a seed basis shifted from a barely significant negative association at the first and second picking dates to a highly significant positively correlated variation within the third date. The correlation of percentages in the seed for averages of dates was found to be nearly zero.

TABLE 8.—*Values of the correlation coefficient* r *for the associated variation of oil and nitrogen content of cottonseed*

MEASUREMENTS ON A PERCENTAGE-IN-SEED AND ON A PERCENTAGE-IN-KERNEL BASIS FROM ANALYSIS OF MULTIPLE-BOLL SAMPLES

| Variables | Degrees of freedom | Values of the correlation coefficient *r* | | | | | |
|---|---|---|---|---|---|---|---|
| | | Within dates | | | Average of all dates | Values required for significance | |
| | | First | Second | Third | | 5-percent level | 1-percent level |
| Percentages of oil and nitrogen in | | | | | | | |
| *Kernels* | 30 | −0.932 | −0.877 | −0.881 | −0.906 | ±0.349 | ±0.449 |
| Seed | 30 | −.380 | −.372 | .597 | .006 | ±.349 | ±.449 |

MEASUREMENTS OF PERCENTAGES OF OIL AND NITROGEN IN KERNELS FROM THE ANALYSIS OF SINGLE-BOLL SAMPLES GIVEN TREATMENT MPK

| *Source of measurements* | Degrees of freedom | Values of the correlation coefficient *r* | |
|---|---|---|---|
| | | Found *F* | Required for significance, 1-percent level |
| Percentages of oil and nitrogen in kernels — | | | |
| Within a single plot at one date (*treatment MPK, plot 23, second date*) | 18 | −0.904 | ±0.561 |
| Within the first picking date (4-boll number groups × 4 replications) | 14 | −.984 | ±.623 |
| Within the second picking date | 14 | −.936 | ±.623 |
| Within the third picking date | 14 | −.988 | ±.623 |
| Within all dates | 46 | −.955 | ±.368 |

The consistency of the high inverse correlation for percentage-of-oil and percentage-of-nitrogen variation in the kernel are examined further in table 8. The measurements recorded in this table are results from analysis of kernel content in single-boll samples. Measurements are presented by dates within the one treatment (MPK), then within all dates, and finally within the 20 bolls from

1 plot representing segregation within the normal field sample. All of these coefficients reach the value for $r$ of –0.900 or higher. This same trend has been found within the data presented in other publications in this series. Within a variety or series of varieties, it is felt that variation in the percentage of oil and nitrogen content of kernels will be found inversely associated throughout a series of environmental influences unless, perhaps, seed maturation is so adversely affected that depositions of reserves in the seed are severely inhibited. When this same association is measured on a basis of percentage in the seed the variations in the percentage of kernel content of seed can so alter the relationship that no significant association would be found.

When the oil and nitrogen content of cottonseed are expressed as grams in 100 seed the correlation measurement may not necessarily show an associated variation identical with that of percentages of these two chemicals in the kernel tissue. Data presented earlier, particularly in figures 17 and 18, show that, although percentage variations among seed reserves were negatively correlated, the production of each component in grams per seed (or per boll) tended to vary with seed size and a positive correlation would be expected. The inversely associated variation of oil and nitrogen was consistent only when measured on the basis of percentages of the cottonseed kernels.

The inversely associated variation in deposition of proteins and lipides in the seed is emphasized in this presentation more to explain the conditions under which it occurs than to explain the exact metabolic processes involved. Some of the steps in biosynthesis of these products are not thoroughly understood. Certain physical limits are operative, however, and a state of metabolism conducive to deposition of excessive quantities of protein in the protoplasm might possibly limit the available facility for storage of lipides, at least within the potentials of the variety studied. Even this limit is seen to be somewhat elastic since the environment may condition the capacity for adaptive deposition of both reserves, not only in terms or proportion of kernel tissue but also in terms of grams of oil plus protein in each kernel or seed.

## VARIATIONS IN OIL QUALITY

### FREE FATTY ACID

The determination of quality index of cottonseed is dependent upon the measurement of moisture content, foreign matter in the sample, and free fatty acid content of percolation-extracted oil. An excess of each of these fractions reduces the quality index and ultimate grade value of seed, depending on the magnitude of the excess. Cottonseed may not be judged superior quality (the premium grade) when there is more than one-half of 1 percent free fatty acids in the oil. Although high free fatty acid content is usually thought to be associated with high humidity during maturation and with particularly moist conditions of seed storage, the possibility cannot be overlooked that nutrient supply, time of flowering, and time of boll maturation are influencing factors. Free fatty acids were measured only in the first year of this study (table 45, Appendix). No variation associated with treatment or date was apparent except in the case of samples from the last picking. Samples from this picking, representing seed initiated and maturing toward the end of the season, showed considerable interplot irregularity with respect to free fatty acid content. There was a variability both between blocks and between treatments in these late-matured seed, and there was little evidence that fertilizer treatment had been effective in preconditioning a high rate of hydrolysis of the glycerides. It would seem more logical to assume that some samples were picked and/or stored in a more moist condition than others, in which case development of heat and resultant excessive free fatty acid formation would be quite possible.

REFRACTIVE INDEX

The degree of saturation of the component glycerides in vegetable oils is usually and most reliably determined by the iodine number. In flaxseed and in soybean oils it has been found (*47*) that the iodine number, or degree of unsaturation, increases as the refractive index of the glycerides increases. This relationship exists only where there has been no damage or deterioration of the seed.

The exact regression formulas for change in iodine number with change in refractive index of oil from sound cottonseed have not been presented. Cottonseed oils are in general composed of glycerides, the aggregate degree of unsaturation of which is less than that of soybean oils, which are even lower in this respect than are linseed oils. The inference from the above statements is that refractive index can be utilized as a yardstick for interpolating changes in degree of unsaturation in oils from sound cottonseed

The oils extracted by National Cottonseed Products Association methods from 1943 seed were measured for refractive index, and the results are set forth in table 45, Appendix, corrected to 25° C. The averages for all treatments on each date showed a slight lowering of refractive index as the season advanced, but the interplot variability (measured here for treatment 7 only) was too high for this small mean main effect to be of significant proportions. It is interesting here that the high free fatty-acid content of certain samples at the third picking date (treatments 6 and 7) had occasioned no sizable deviation in refractive index of these oils. The single-boll samples at the late date were highest in free fatty acid content and lowest in refractive index, but this relationship was not associated in measurements among the multiple-boll samples from treatments other than No. 7 (MPK). The results referred to above merely serve to indicate that, deterioration of oils excluded, there was little evidence that refractive index of oils was altered through differential fertilization.

## Discussion

Certain advantages and disadvantages exist for each of the possible methods of expressing partial composition of cottonseed. The accepted commercial procedure is to express oil and protein (ammonia) content as percentages of the fuzzy seed at the moisture content included in the base weight of the analytical sample. Any other method would be inadequate for the evaluation in the cottonseed industry, but experimentally this procedure falls short of that desired. Moisture and trash must first be eliminated by the experimenter or at least equalized, so that comparisons will not be influenced by this source of uncontrolled variability.

If the experimenter is interested solely in production, his measurements would most logically be expressed as pounds per acre of each of the four mill products of cottonseed: Available crude oil, available cake of specified protein content, available hulls, and available linters. Perhaps these products should all be compared with the lint in order to have the complete picture of production. On the other hand biologists, and particularly plant breeders, are interested in the fundamental principles of the plant processes involved.

Measurements of oil and protein must therefore be related to measurements of seed size and partial composition of each morphological part as well as partial chemical composition. It is true that production optima are the final objective, but an understanding of variations in inherent capacities and a true measurement of metabolic processes can seldom be had from a composite measure such as yield. Cottonseed oils and proteins are principally storage reserves of the reproductive unit. The embryo (kernel) of cottonseed is the new generation, and the hull with its lint and fuzz fibers is in reality the seed coat, representing development of the parent plant. Quantitatively, the embryo is only a little over one-half of the total ginned seed by weight.

If biosynthesis is to be calibrated, it is obvious that a measure involving variable quantities of hulls and fibers will fall short of representing accurate estimates of inherent or induced variation in deposition of oil and protein in the reproductive unit. The question then arises as to whether the percentages within the seed or the grams per seed of oil and protein constitute the better measure of reserve depositions. Perhaps both measurements are critical.

In this study measurements have been calculated to many different bases, and different comparative effects of treatments were demonstrated by altering the basis of expressing the results. It is not the purpose of this discussion to select the ideal basis of measuring cottonseed reserves in such studies. It is intended more to point out that different possibilities exist and that variation might be reported or disclaimed, depending on the basis of measurements. Perhaps the best comparative example contained in this study is that involving associated variation of oil and protein.

A very highly significant, negatively associated variation is shown in this study, but only where the measurements correlated are the percentages of oil and protein in the kernel. On a basis of percentages of oil and protein in the seed, this correlative association is obscured by percentages of kernel in the seed, which may vary independently of either oil or protein depositions in the kernel tissue. On a gram-per-seed basis the alterations in size of kernel influence the measurement of associated development of these two products. If the measurements are calculated as quantities of products per plant or per acre the association will often become a significant positive one, both oil and protein being increased or decreased as the size of seed and the number of seed are increased or decreased, respectively.

The complete picture with respect to production of cottonseed products is then only possible where the measurements are presented in terms of production of seed, partial morphological composition of the seed (by weight and by percentage), and chemical composition of the kernel.

The analytical sample of cottonseed is usually reduced from a large quantity of seed by prescribed methods (*26*) of blending and quartering. This procedure has been found adequate commercially, but the experimenter must often work with samples of quite small size. In fiber character studies, for example, a much utilized procedure is to collect 50 or 100 bolls for the single-plot sample. These are usually collected by experienced operators so that they represent bolls having the same number of locks and opening at approximately the same time.

In this study the use of single-boll analytical samples has allowed for a study of the heterogeneity that would exist within such samples. For example, a single large sample chosen to represent the average composition of seed given treatment No. 7 in 1943 could be assumed to have the average oil content of kernels of 32.94 percent with 1.65 percent oil required for a significant difference between this and other treatments. This estimate can be rewritten to show the limits for treatment No. 7 as 32.12 percent to 33.76 percent oil in kernels.

The possibility of arriving at this estimate from other methods of sampling can be examined first as between dates. The averages for the three dates were 34.3 percent, 34.9 percent, and 29.6 percent oil (table 6). None of these values fall within the limits of the estimate based on the average for all dates. The estimate can be further examined with respect to the range associated with selection, on a basis of number of seed per boll—33.4, 32.9, 31.4, and 33.7 percent oil in kernels for the four seed-number groups (table 6). Three of these values are within the proper limits. The variability associated with blocks deviates from 31.5 to 34.1 percent oil, with only two of the four blocks having mean values within the nonsignificant experimental range of value for treatment No. 7 in 1943.

A true estimate of the average effect of treatment No. 7 on oil content may have been missed by the selection of a very limited sample. The average for any single date fell outside of statistical limits; the averages for two of four blocks were outside of these limits, and the average for one of the arbitrary seed-number groups also fell outside the true limits of average oil content associated with treatment No. 7.

It is obvious that the most reliable measure of oil or protein content would be pilot-plant measurements, where all the oil and all the protein are measured and related to all the seed produced in a plot (interplot variability can be prorated in most studies). Such procedures are outside the facilities of most investigators.

The method of sampling becomes of critical importance. The small sample must be chosen with extreme care if the investigator wishes its composition to be a true measure of the average for the entire plot that represents the variety or the treatment being studied.

# EFFECTS OF FERTILIZERS AND OTHER ENVIRONMENTAL INFLUENCES FROM 23 COTTON CULTURAL EXPERIMENTS

In the foregoing sections of this bulletin emphasis has been placed on variability in many different measures of yield and composition. In this section only five of the measurements are emphasized: Percentage of oil in fuzzy seed, percentage of protein in fuzzy seed, cottonseed grade, acre yield of seed, and acre value of seed. These are the measurements bearing on the practicability of any selection of strains or cultural practice in cottonseed improvement. The results are given by source of variability, particular emphasis being placed on the general trends shown by the results of all 23 experiments. The presentation of these general effects is facilitated by the use of figures 20 to 37, showing the effect obtained in each of the experiments from which the results have a bearing on the particular source of variation and the particular product measurement being illustrated.

The numbers subtending the lines in each of the illustrations refer to the numbers of the contributive experiments: Nos. 1 to 23. Supplemental data for experiment 1 are given in tables 12 to 24, Appendix; for experiment 2, tables 25 to 36, Appendix; for experiment 3, tables 37 to 45, Appendix; and for experiments 4 through 23, tables 46 to 59, Appendix. Discussion of experiments 1, 2, and 3 have been presented in detail in the three previous sections of this bulletin. Methods and procedures are stipulated, in footnotes of tables, only where they differ from those in the general descriptions found under Analytical Methods (pp. 7 to 9).

## Nitrogen Supply

The oil content of cottonseed was raised by additions of nitrogen to the soil in two studies but lowered as a result of increasing nitrogen level in the remaining six experiments illustrated in figure 20. Induced variations are not large in any one experiment.

The greatest decrease in oil occurred in experiment 4 (table 46) with the addition of 80 pounds of nitrogen, which resulted in a decrease of 1.69 percent of oil content of fuzzy cottonseed. The changes associated with level of nitrogen supply are relatively small in comparison to the range for all studies—16.3 to 21.5 percent of oil in the fuzzy seed. The extent of this difference in oil content between experiments is mentioned at this point because the range of values for percentage of oil in this chart is that comprising the limits of variability for all 23 experiments reported in this publication. Similarly, wherever variability in any other measure of composition is illustrated it will always be represented on the same scale. The results associated with each of the different sources of variability are thus subject to visual comparison on identical scales.

Increase in level of nitrogenous fertilization was found by others (*10, 14, 15, 43, 45, 46*) to be influential in reducing rather than increasing the percentage of oil content of cottonseed. In only two cases in this study (experiments 2 and 19) was oil content increased. It was raised 0.31 percent in experiment 2 and 0.18 in experiment 19. These might well be considered instances of non-significant variation and not necessarily any refutation of the principle that increase in level of nitrogenous fertilization tends to lower percentage of oil content of cottonseed.

Percentage of protein [14] in cottonseed was increased by raising the level of nitrogenous fertilization in seven out of the eight experiments illustrated in figure 21. As with the two experiments

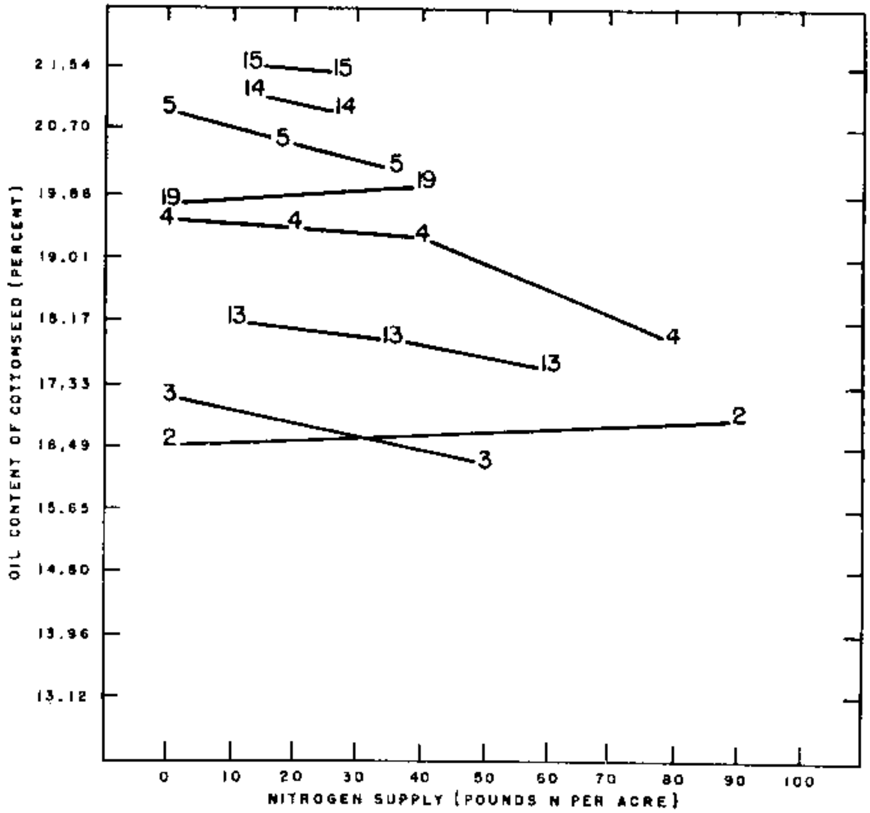



FIGURE 20.—Effect of increase in level of nitrogen supply on oil content of cottonseed.

wherein oil content was increased by nitrogenous fertilization, this one instance of decreased protein content indicates that only negligible change takes place, 0.26 percent, an amount that is usually considered within the limits of combined experimental error of sampling and chemical determination.

There can be little doubt that increase in nitrogen level in the soil tends to increase nitrogenous reserves in the cottonseed. In

[14] The discussion in this section relative to nitrogenous reserves of cottonseed is in terms of protein, but the data as tabulated in the Appendix show values for ammonia (protein divided by 5.13).

experiment 14 there was a slight decrease; in experiments 2, 3, and 15, this increase was small; but in the four remaining studies the increase was of considerable magnitude. The largest increase occurred in experiment 5, where the application of 36 pounds of nitrogen per acre resulted in a rise of 4.1 percent protein. This is an increase of 26.5 percent and is equivalent to a benefit of 188 pounds of available 8-percent ammonia meal (41.04 percent protein) per ton of cottonseed.

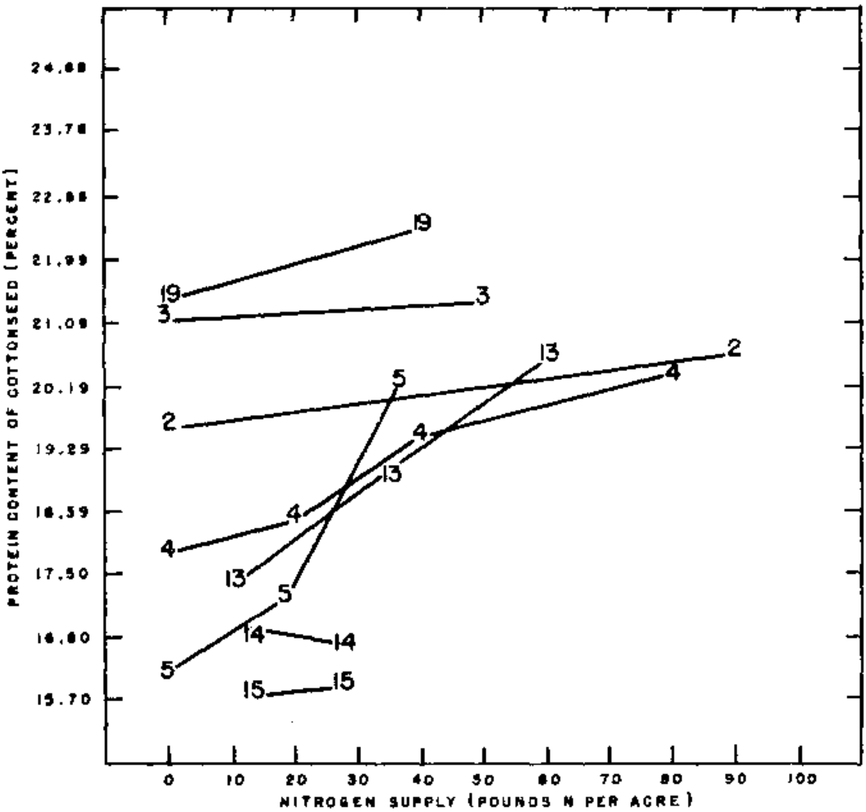



FIGURE 21.—Effect of increase in level of nitrogen supply on protein content of cottonseed.

In five of these studies it is seen that the protein content was increased while the oil content was reduced as the nitrogen supply to the plant increased. It is interesting that the variation in either chemical component in the excepted experiments 2, 14, and 19 is rather negligible. These three studies showed such low variation in chemical components that they might be considered as cases in which composition of seed was found to be affected comparatively little by nitrogen supply. The deduction from results of the other five studies would lead to the assumption that under conditions where change in level of nitrogen supply was effective in altering seed composition, the protein reserves would be increased at the expense of deposition of lipides (oil). It is evident, however, that protein is increased to a greater extent by nitrogen fertilizers than oil is reduced, and the total percentage of reserve or storage chemicals in the seed tends to be increased by nitrogenous fertilization. This must be assumed as applicable only where nitrogen is a limiting factor of the available fertilizer supply. The excepted experiments are, in all probability, cases where adequate supplies of nitrogen were present to insure the natural fertility levels of the soil.

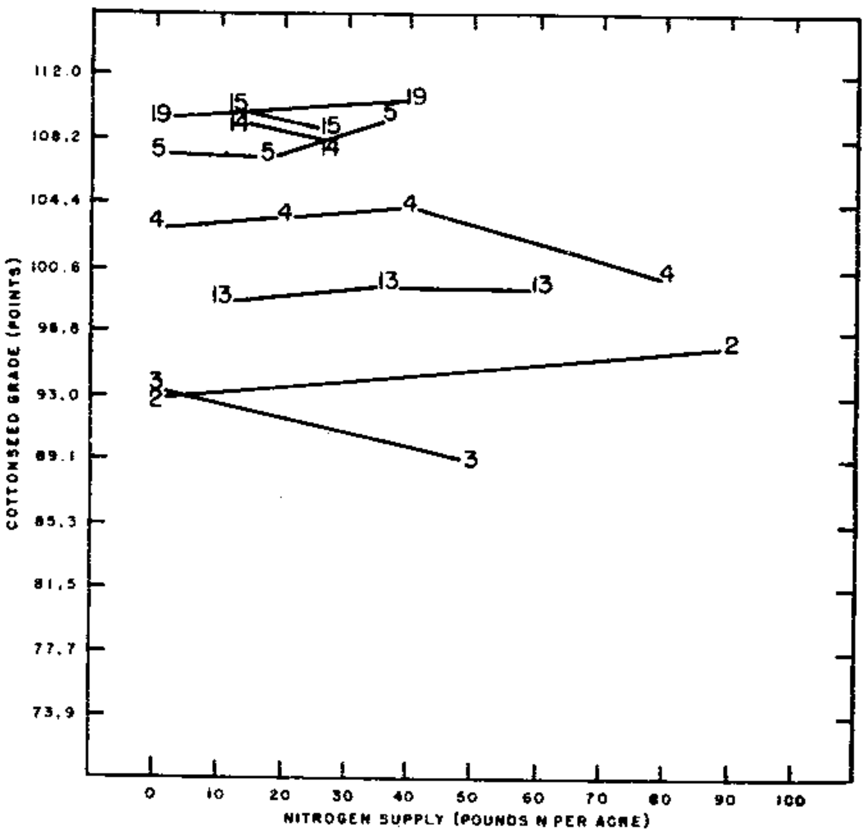



FIGURE 22.—Effect of increase in level of nitrogen supply on cottonseed grade (prime quality).

The increase in the total percentage deposition of reserves through nitrogen fertilizers would indicate a benefit from fertilizer. If both of the products, oil and protein, were of equal commercial value this would be the case. Cottonseed grade, however, is based on marketable values of the two reserves, and the variations in oil content are weighted to compensate for a higher unit price and to account for about three-fourths of the total grade value. It is thus found that variations in the grade of seed from these eight experiments (fig. 22) could have been predicted better from the variations in oil content than from trends induced in percentage of protein. The effects of increase in protein content through nitrogen fertilization are not without effect on grade, for it is seen that grade was increased in five experiments, whereas oil content was increased in only two, by the use of nitrogenous fertilizers. The reductions in grade become the exceptions.

Of those experiments where grade was reduced there were two in which increase in protein was negligible (experiments 2 and 15) and one in which both oil and protein content of the seed was reduced but to only a negligible degree. These are the cases which might lead to the conclusion that nitrogen was not a limiting factor of natural nutrient availability. Experiment 4 is rather interesting in that several continuous levels of nitrogen supply were tested. It is seen that the third level of increase (40 to 80 pounds of nitrogen) caused a more rapid decrease in oil and a less rapid rise in protein content than was caused by the initial supplements. This could represent a case in which the last addition of nitrogen was made to a soil in which nitrogen supply could no longer be considered a limiting factor of adequate cottonseed composition.

This trend is seen again in experiment 13 where the third application caused no change in grade as compared to the second, the extra 25 pounds being added in the presence of an adequate supply of nitrogen. The extra weighting given percentages of oil in the calculation of grade are nearly offset by the tendency for protein to be increased in the seed at a faster rate than oil is reduced through the application of nitrogen to soils lacking optimum quantities of this element in their available nutrient supply.

Cottonseed grade forms the basis of unit price per ton of seed as sold to the oil mills, but transactions between the grower and ginner are usually in consideration of the price for basis grade seed. In these latter cases the price is unaffected by chemical composition of the seed and any increased acre value must be derived from augmented yields. Figure 23 shows that nitrogen fertilization increased yields of seed in all [15] but experiment 3.

In experiments 5, 13, 14, and 15 the per-pound increase in cottonseed as compared to pounds of nitrogen applied leaves little doubt that the application would be financially beneficial and in excess of set costs. In experiment 4 the use of 20 pounds of nitrogen seems to have restored an adequate supply of that element to the available nutrients in the soil. The second and third additions had no effect and caused a reduction in yield. It is doubtful whether the 90 pounds were needed for the increase of about 100 pounds of seed in experiment 2, and no need for nitrogen applied alone is evident for the soil on which experiment 3 was conducted.

It has been suggested (*14*, *28*) that any increased chemical reserve content of cottonseed would be obtained under conditions in which an associated benefit in yield resulted through additions of an element of the nutrient supply. In testing this assumption it would be expected that variations in oil and protein content of seed would be most striking for additions of nitrogen in experiments 5 and 13. Figures 20 and 21 show that alteration of protein content of seed was most striking in these two studies and that

[15] Yield data were not furnished in all of the studies reported.

reduction in oil content occurred at about the highest rate found in any of the eight studies represented.

An examination of the remaining studies represented in figure 23 shows the degree of alteration in percentage of one or both seed reserves to be comparable to the induced alteration in yield of seed. Experiment 4, however, shows a condition in which the alterations in seed reserves occurred at a rate in excess of the alteration in yield of seed resulting from the addition of nitrogen to the soil. The assumption then fits these data in general, but exceptions must be recognized.

The alterations in oil content brought about by nitrogenous fertilizers could be utilized to predict the trends for grade, and, in the same manner, to show variations in yield closely parallel to the associated alterations in acre value of seed. Variations in acre value associated with increase in nitrogen supply are shown in figure 24, and are almost identical with the variations in yield (fig. 23) indicated by both between-experiment and within-experiment trends. Oil and protein content of seed as reflected in grade value have had little effect in altering the total acre value of seed.

Where nitrogen is a limiting factor to growth in the nutrient supply its addition will most likely increase significantly the per-

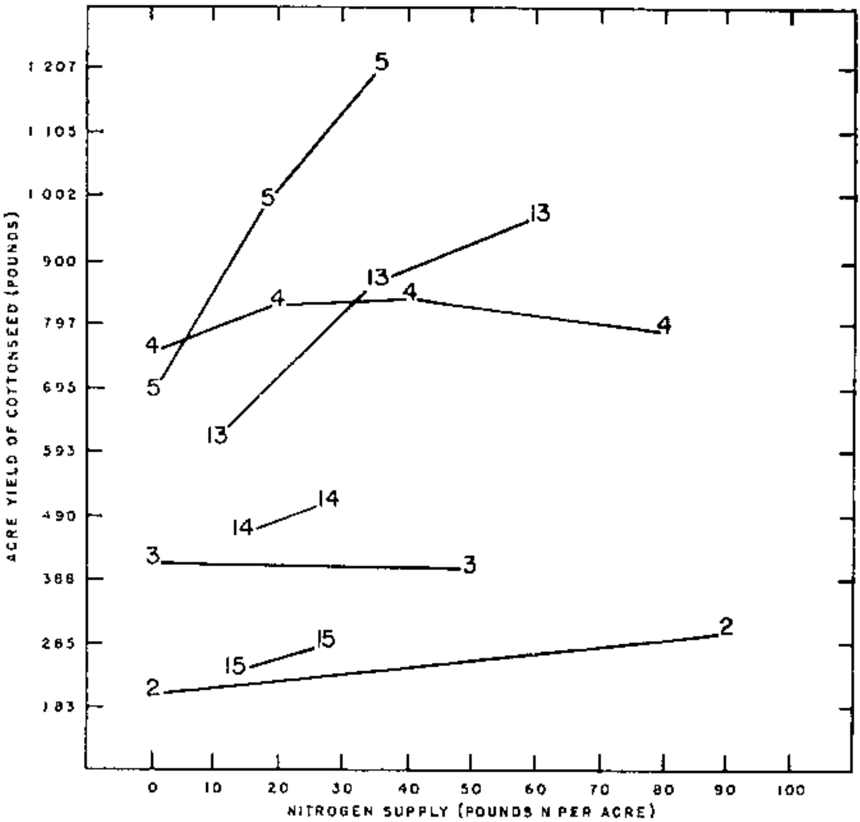



FIGURE 23.—Effect of increase in level of nitrogen supply on acre yield of cottonseed.

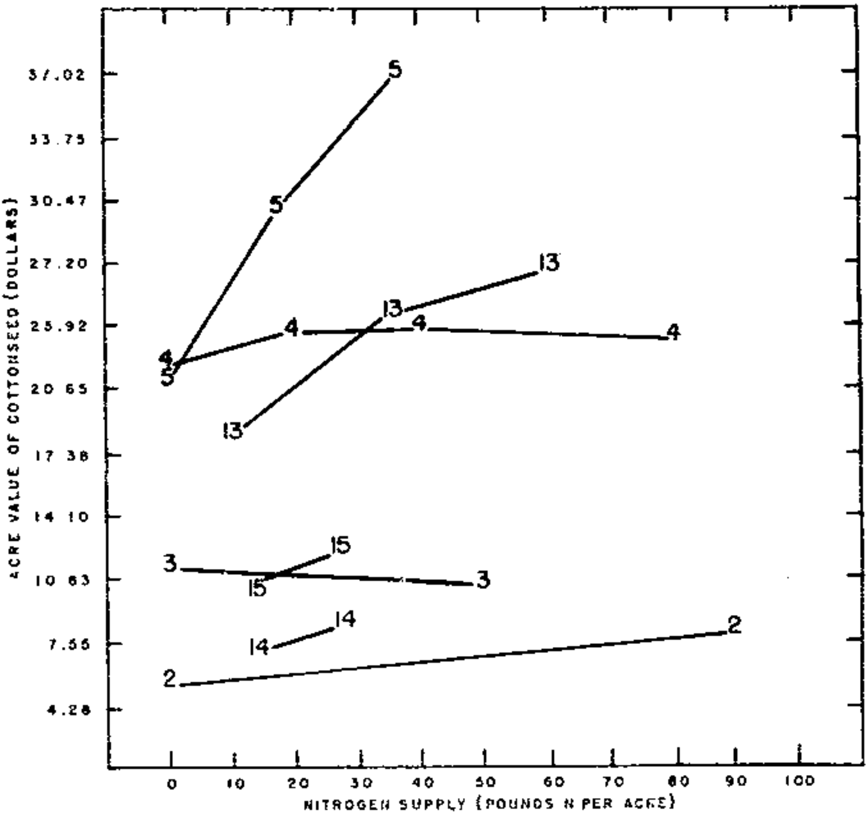



FIGURE 24.—Effect of increase in level of nitrogen supply on acre value of cottonseed ($56 per ton for basis-grade seed).

centage of protein content of seed, lower slightly or have little effect on the oil content of seed, and result in little or no alteration in the unit value of seed as incorporated in the measurement of grade. Exceptions to this generality will occur, as in the case of experiment 4 (table 46) but, where benefits of nitrogenous fertilization are to be assessed only in terms of increased income from cottonseed, it appears that the economy should be judged almost entirely from the adequacy of increase in pounds of cottonseed per acre.

### Phosphorus Supply

Six of the experiments (2, 3, 4, 13, 14, 15) involved variations in level of phosphorus supply. Each of these experiments also included variations in level of nitrogen and potash supply and allowed for examination of the effects of the different elements on a comparative basis.

Oil content of cottonseed was both reduced and increased as a result of phosphate fertilization, with the result dependent strictly upon the experiment (fig. 25). In experiment 2 the use of 80 pounds of phosphate per acre caused a marked reduction in the percentage of oil content, yet in experiment 3 the use of 90 pounds

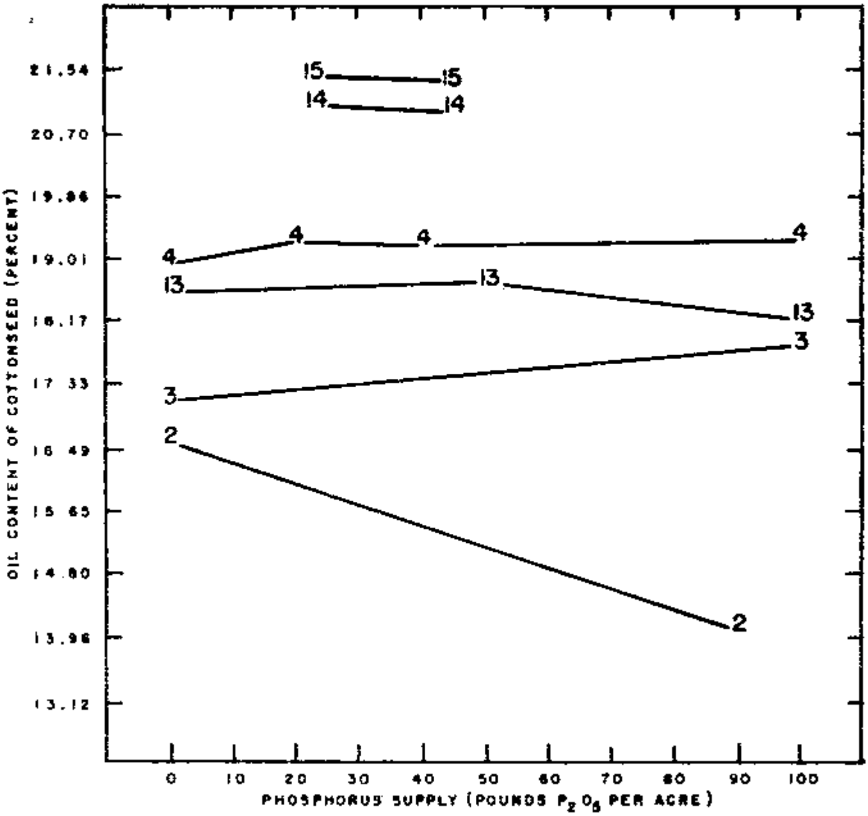



FIGURE 25.—Effect of increase in level of phosphorus supply on oil content of cottonseed.

per acre caused an increase in oil content. In the two experiments with sea-island cotton (14 and 15) a slight reduction in oil resulted, but in experiments 4 and 13 the first application resulted in increases and additional quantities of phosphate induced a lowered oil content of fuzzy cottonseed.

These six studies indicate that there is little or no tendency for oil content to be affected in a specific manner by increase in phosphate supply. The review of literature relative to the effects of phosphate shows comparable disparity in the effect of phosphorus on variation in cottonseed oil. Garner and coworkers (*14*) reported no effect. White (*45*) found that phosphorus fertilization increased oil content and Gieger (*15*) reported a slight increase, but Seale (*36*) reported no alteration in oil content resulting from additions of phosphate.

Judging from all experiments presented here and previously, it seems that oil content might not be affected significantly by level of phosphate itself. It would be more logical to believe that phosphate acts in an indirect manner to regulate the availability of other elements of the nutrient balance affecting the metabolism and translocation of seed reserves. This phase of interrelated effects will be discussed further, following a discussion of the main effects of the three principal fertilizer elements.

The influence of phosphorus fertilization on percentage of protein content of cottonseed is shown by figure 26 to be dependent strictly on the experiment, just as in the case of its effect on oil content. Some additions of phosphorus have raised, some have lowered, and others have had little effect on protein content of seed. A certain consistency in its effect is apparent, however, in that within an experiment the increase or decrease in protein is the inverse of that found for oil content as influenced by additions of phosphate. This inverse association in response to phosphate supply is found more nearly compensatory than the associated variation of oil and protein induced by nitrogenous fertilizers. Where nitrogen tended to increase protein reserves more rapidly than oil reserves were decreased, the inverse alterations induced by phosphate were of similar degree.

When variation in both oil and protein content are viewed simultaneously there is little evidence that the phosphate level in itself is influential. The variations in direction and degree of change in percentage composition of the seed are dependent upon the experimental conditions. In many studies no appreciable varia-

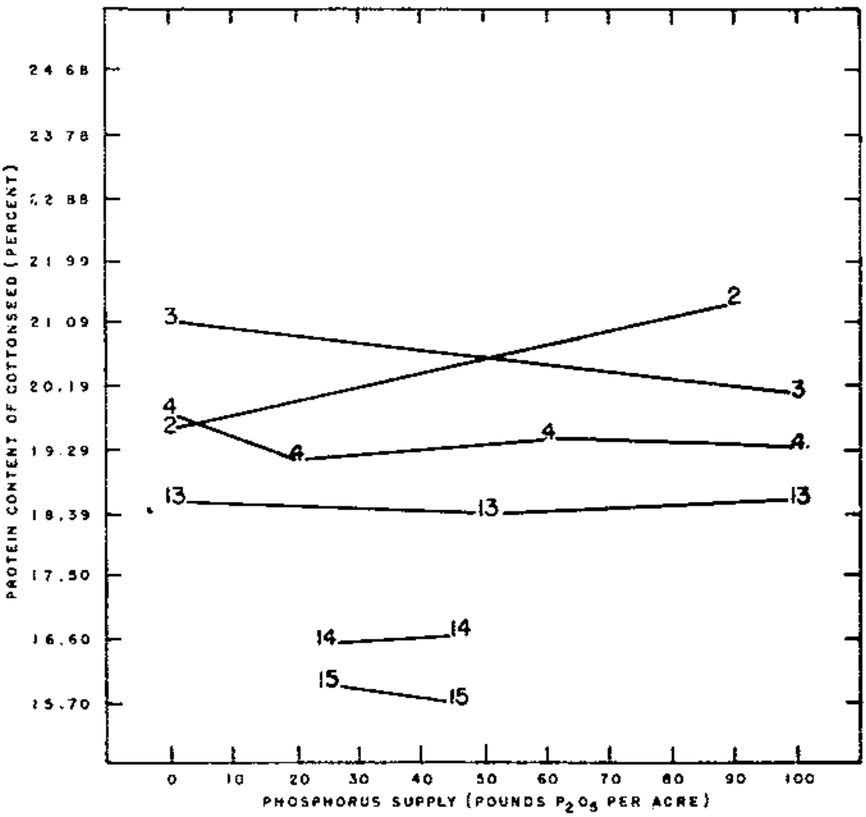



FIGURE 26.—Effect of increase in level of phosphorus supply on protein content of cottonseed.

tion is brought about. Any induced variation in one product is compensated by a reverse alteration in percentage composition of the other product. It again seems more probable that the role of phosphorus with respect to chemical composition of cottonseed is that of regulating the relative availability or activity of other elements, and these in turn directly affect deposition of reserve lipides and proteins in the cottonseed kernels.

The manner in which additions in phosphorus supply have altered the grade of cottonseed is shown in figure 27. Trends shown

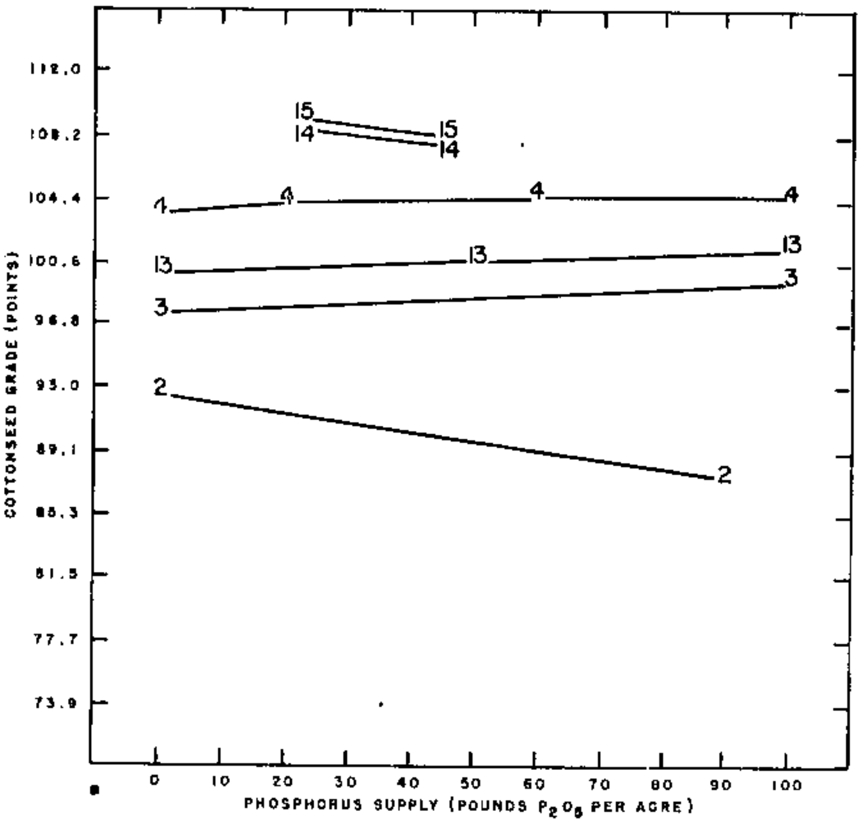



FIGURE 27.—Effect of increase in level of phosphorus supply on cottonseed grade (prime quality).

in this figure are almost identical with trends shown in figure 25, indicating the effects of phosphorus on oil content. In none of the experiments has there been any alteration in trends as compared in figures 25 and 27, and the differences between experiments remain nearly proportionate, as viewed on the two different scales.

Only in experiment 2 was there sufficient alteration in grade, as a result of applying different levels of phosphorus, to have a probable effect on acre value of seed (fig. 28) over and above the influence of alteration in acre yields of seed (fig. 29). The variations in grade in the other five studies are found quite proportionate with variation in yield. In this excepted experiment

(experiment 2) phosphate showed very little effect on yield and its effect on the grade factor resulted in an acre value of seed somewhat lower than would be expected from effects of phosphate on yield only. Any decision as to the probable increase in income to be expected from seed with phosphate fertilization should be based on whether or not the increased yield, calculated at basis grade, would warrant the expense of the fertilizer application. This is more true with phosphate than with nitrogen fertilization. Phosphorus had some influence on grade where variations were

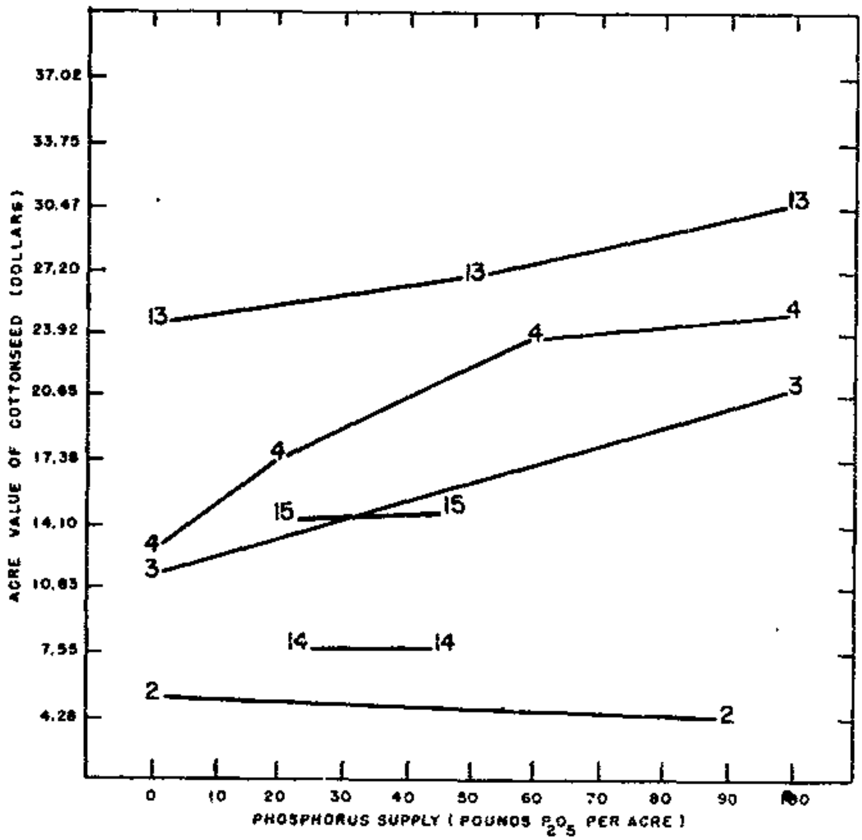



FIGURE 28.—Effect of increase in level of phosphorus supply on acre value of cottonseed ($56 per ton for basis grade seed).

associated with nitrogen fertilization, but there is little evidence that phosphate fertilization will be of much benefit through alteration of the grade factor.

## POTASSIUM SUPPLY

The manner in which oil content of cottonseed was influenced by additions of potash to the soil is shown in figure 30. In 16 of the 18 studies represented in this figure the percentage of oil content of seed was increased by potash fertilization. In experiment 18 potash was ineffective. In experiment 7 the use of 36 pounds of potash as compared to 24 pounds resulted in a decreased oil content. In experiments 16, 20, and 21 the initial applications resulted in increased oil, but further additions caused either slight or no further increase. A drop in the curve for experiment 4 is rather difficult to explain, since extension of the application was associated with further increase in oil content. In general, a marked increase in oil content occurs as the rate of potash supply is increased. In some of these studies the limit of effect was reached by the concentrations used, but in more than one-half the

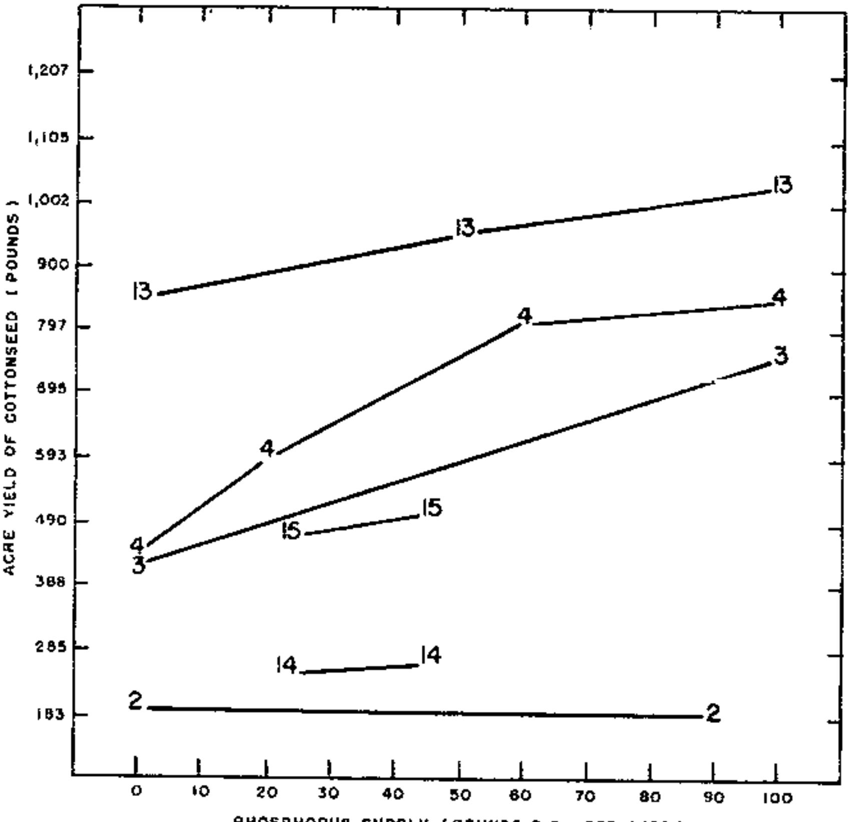



FIGURE 29.—Effect of increase in level of phosphorus supply on acre yield of cottonseed.

studies for which statistics are presented in figure 30 there is no indication that further additions would not give benefits.

The application of increased potash supply to the plants has resulted in reductions in the percentage of protein in seed in the majority of studies as shown in figure 31. These decreases in nitrogen reserves are in most cases of less proportionate degree than were the associated increases in oil reserves. In one experiment only (experiment 7) was there a decrease in both reserve chemicals with increase in potash fertilization. On the other hand rise in potash level resulted in increase in both storage reserves in several experiments. These were experiments 8 and 9, and to a lesser degree, 14 and 15. Increase in potash supply to the cotton plant has a tendency to increase oil to a greater proportionate extent than it has to reduce protein content of the seed. Potash, then, has a tendency to cause a slight increase in total reserve supply, an increase in oil content, and a decrease, but to a lesser comparative degree, of protein.

The influence of level of potash supply on grade of cottonseed is indicated in figure 32. The most important component of vari-

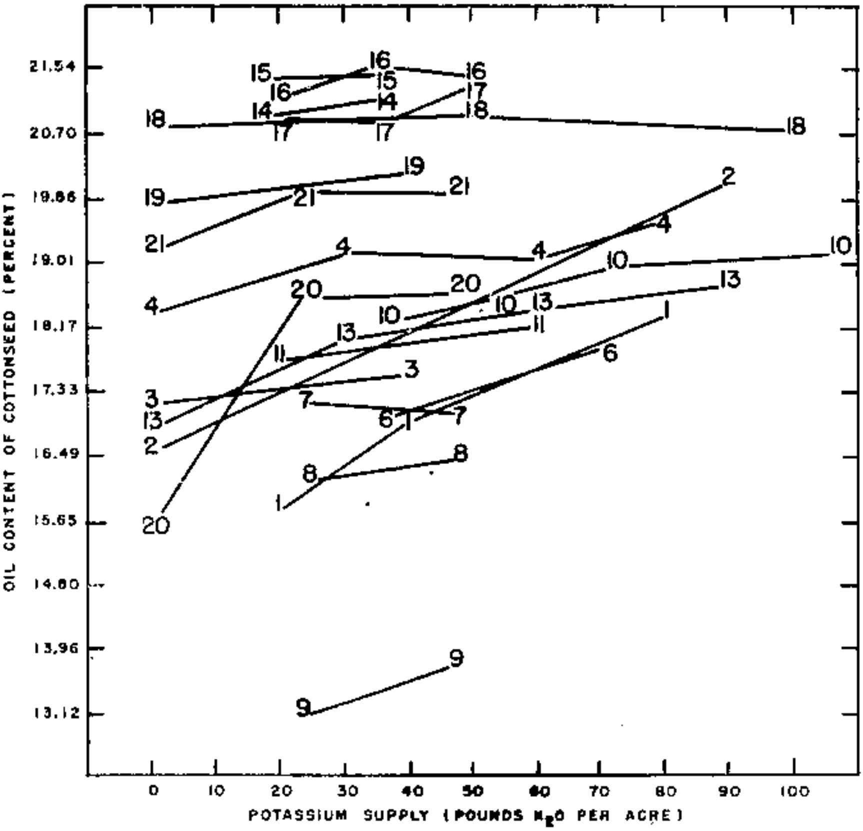



FIGURE 30.—Effect of increase in potassium supply on oil content of cottonseed.

ability of cottonseed in grade being oil content, it is expected that variation in grade as a result of potash application will be proportional with variation in percentage of oil content of seed brought about by potash supply. As indicated in figures 30 to 32, about the only changes recorded in average content of oil and protein resulted from between-test variability. The trends, otherwise, are quite similar.

As compared to the effects of nitrogen (fig. 22) and phosphate (fig. 27), it is found that potash has considerable influence on grade, causing quite marked increases in grade in most experiments and actual decreases only in experiment 7, where both oil and protein content of seed were reduced with increase in potash supply.

The influence of potash in altering the yield of cottonseed (fig. 33) depends on the experiment. No severe reductions were noted in any study, but there were few large increases in yield. In several experiments (experiments 4, 10, 13, 16, and 17) the extension of the fertilizer rate has given very slight reductions or has not been effective in altering yields.

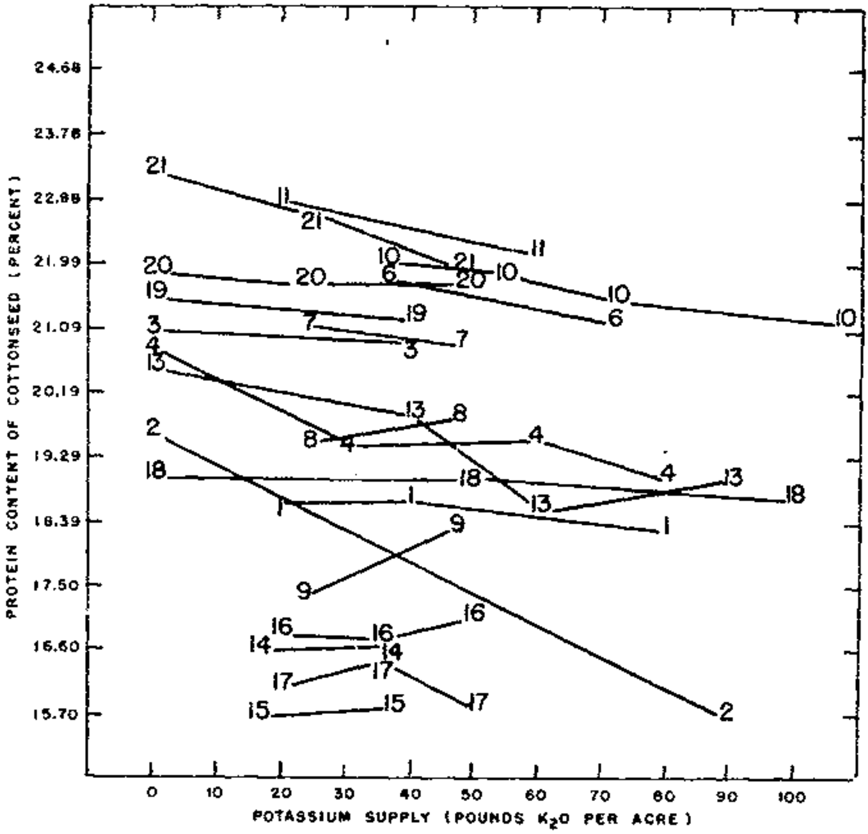



FIGURE 31.—Effect of increase in potassium supply on protein content of cottonseed.

The final benefit of potash fertilization is that it increases the acre value of seed (fig. 34). This figure shows that yield of seed is the predominant factor governing variability of acre value of cottonseed. With increase in potash the oil was found to increase, and, although there was a slight tendency for protein content to be depressed, the net effect was to increase grade. The effect of this increase in grade is to cause some increase in acre value, but in most experiments the influence of the grade factor seemed negligible unless it is viewed in the light of the detailed data. The changes indicated in figure 34 are so slight that with potash additions, as well as with nitrogen and phosphate, the grower would most likely be influenced by pound yield of seed, assuming equality in unit price.

An effort was made in this study to determine the manner in which oil and nitrogen content of seed may vary in their relation to yield, as each component of the nutrient supply (nitrogen, phosphorus, and potassium) is increased. When either nitrogen or phosphorus was used variation in seed composition could be expected most often where alterations in yields indicated definite

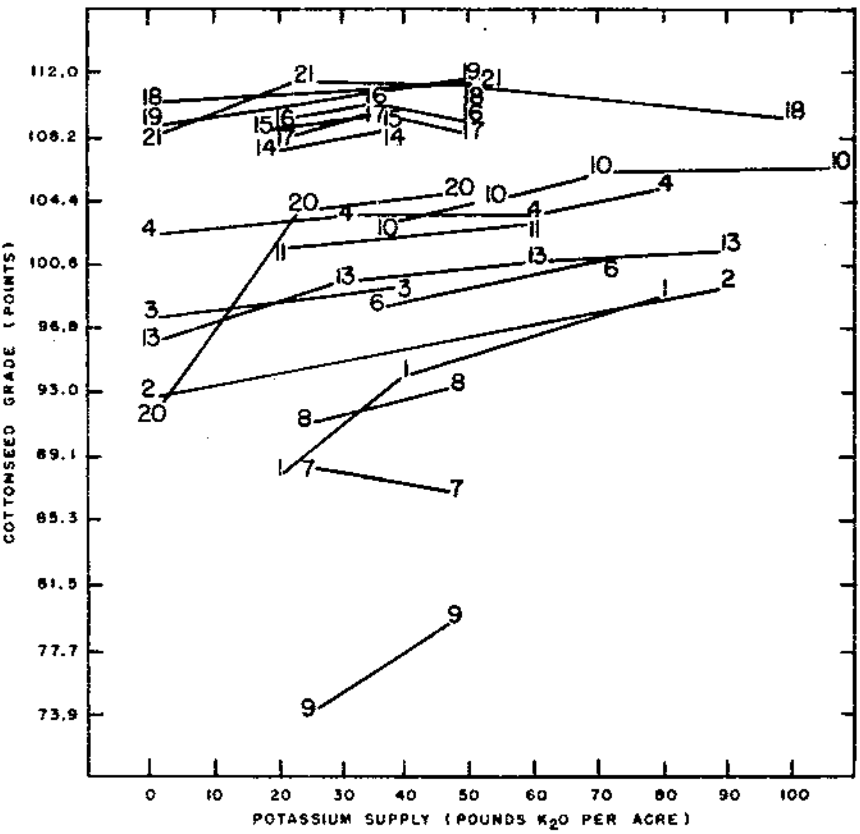



FIGURE 32.—Effect of increase in potassium supply on cottonseed grade (prime quality).

changes in rates of plant metabolism. This trend was again noticed when potash supply was increased. In most experiments wherein sizable alteration in storage reserves resulted from potash fertilization there was a comparable increase in yield of seed. Certain exceptions to this generality have been pointed out, but trends indicate that significant alterations in composition of seed would most likely result where the fertilizer applications are accompanied by significant alterations in total yield of cottonseed per acre.

## INTERRELATED EFFECTS OF N-P-K FERTILIZERS

Variations in level of all three main elements of fertilization were studied in six of the experiments included in this report. One of these was a triangular ratio study (experiment 2) and two were factorial studies (experiments 14 and 15), but in the others each element was varied at constant levels of the remaining two elements.

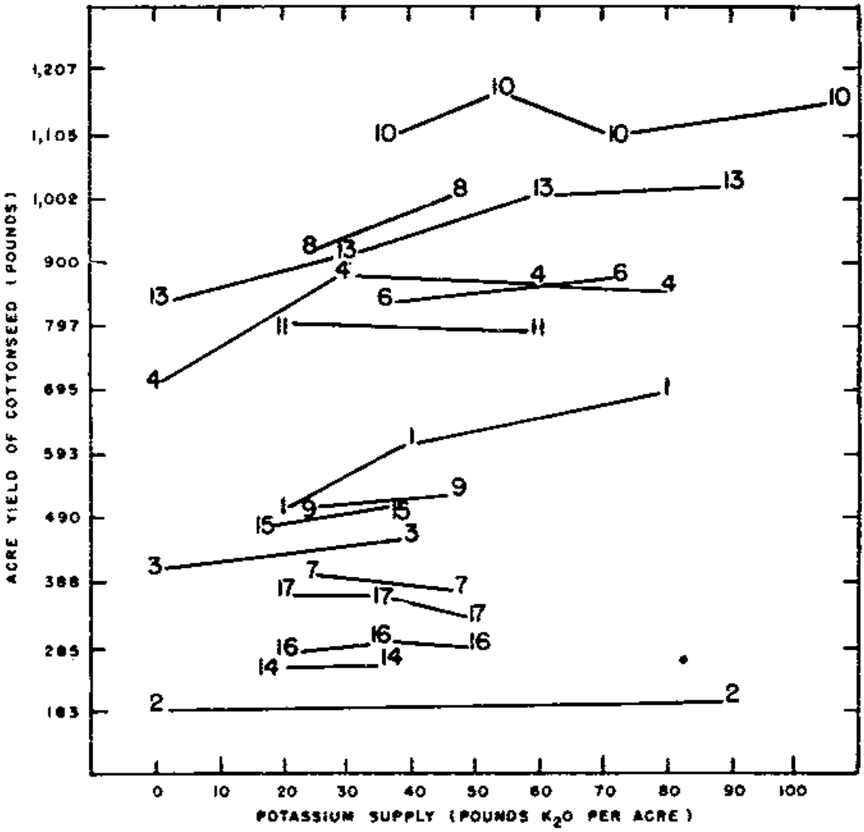



FIGURE 33.—Effect of increase in potassium supply on acre yield of cottonseed.

### NITROGEN AND PHOSPHORUS

In the triangle experiment 2, it was found that as the level of nitrogen was increased with simultaneous reduction in phosphate supply (at 0-potash level) the percentages of oil and protein in the seed were little affected as individual percentage components. Considered as a summation or total percentage of reserves, there was a tendency for seed to have a higher reserve capacity as the nitrogen was increased and phosphate was lowered in the fertilizer. In experiments 14 and 15 (table 53) the variations are of low magnitude, perhaps because other phases of the environment as well as natural nutrient supply tend to develop optimum chemical capacities of the seed. These main effects of elements in experiments 14 and 15 followed trends exhibited where more pronounced effects were obtained. These small variations, therefore, are of considerable interest, although they are of low magnitude. In experiment 14 the low nitrogen–low phosphate combinations gave highest oil and highest protein content of seed, and the same trend was found to a lesser degree in experiment 15.

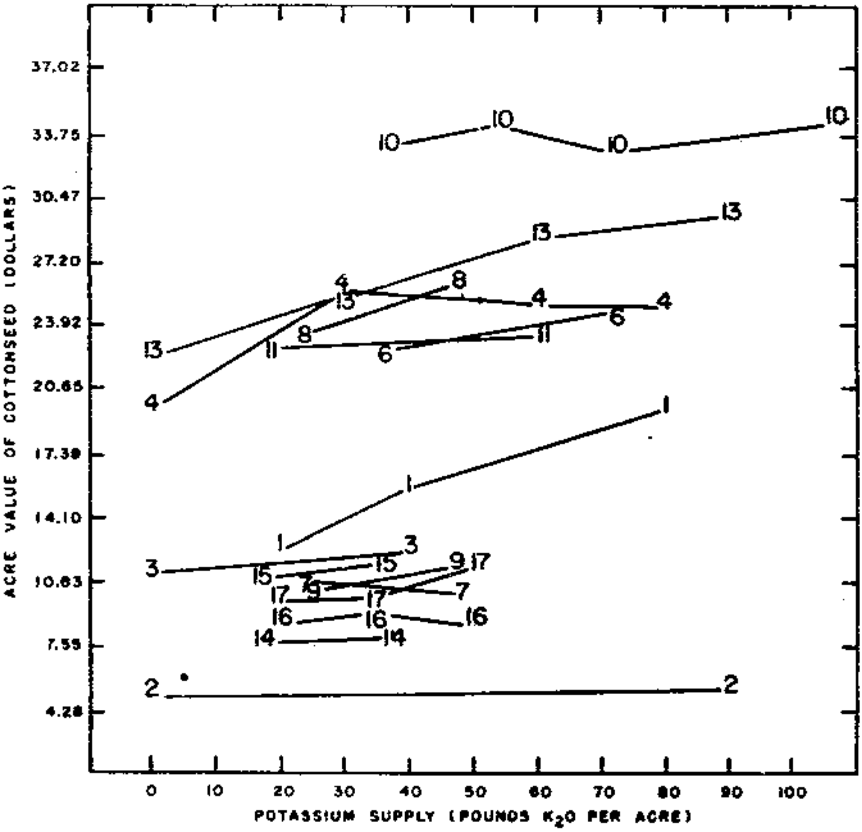



FIGURE 34.—Effect of increase in potassium supply on acre value of cottonseed ($56 per ton for basis grade seed).

These values are added up to show effects on total reserves as averages for both locations in experiments 14 and 15 as follows:

Nitrogen:

| | *Low P* (*Percent, total reserves*) | *High P* (*Percent, total reserves*) |
|---|---|---|
| Low N | 37.81 | 37.27 |
| High N | 36.79 | 37.30 |

At low nitrogen level there was a decrease in total reserves as phosphate was raised, whereas increase in phosphate raised the total percentage reserves of the seed at the higher nitrogen supply.

From other experiments there is certain evidence of interactive effects. In experiment 4 (table 46), for example, phosphate caused an initial rise in oil content that was but little altered by further increase until an excessive rate (4–16–4) was used and was accompanied by a decrease in oil content. Unfortunately, these experiments offer too little comprehensive evidence relative to the interactive effects of level of nitrogen and phosphorus nutrition. There is no doubt, however, that the effects of the two elements are related with respect to their influence on cotton plant metabolism, as indicated by percentage of deposition of seed reserves when the seed components are considered either singly or as total reserve depositions.

### NITROGEN AND POTASSIUM

When nitrogen is increased as the potash supply is lowered (at 0-phosphate level in the triangle study, experiment 2), the oil content is considerably lowered but the protein content of seed is raised to a greater extent than oil content is depressed. Reserve capacity of the seed (percent of oil + percent of protein) is raised by this shift from a high nitrogen–low potash to a high potash–low nitrogen fertilizer. Experiments 14 and 15 (table 53) on nitrogen-potassium variations showed only that increased nitrogen favored protein content where increased potash level favored higher oil content of seed. The variations are small but indicate an independent or compensatory effect. In experiment 19 (table 56) nitrogen fertilization decreased oil and protein content and additions of potash increased oil and depressed protein content of seed.

In experiment 19, when both nitrogen and potash were applied, the oil and nitrogen composition was essentially no different from that found for seed from potash-fertilized plots. Different levels of nitrogen and potash exerted either a compensatory or independent effect. Experiment 13 (table 52) also provided opportunity to study the combined effects of increased nitrogen and potash supply. These are summarized in table 9 for percentage of oil and of protein in seed, as well as percentage of total reserves. This summary showed an apparent compensatory influence of the two reserve components. As nitrogen level was increased, oil was decreased and protein increased at each level of potassium supply.

TABLE 9.—*Percentage reserve content of cottonseed, Coker 100, as influenced by different rates of fertilization with nitrogen and potash at Rocky Mount, N. C., 1944 (experiment 13)*

| Nitrogen per acre (pounds) | Oil reserves | | | Protein reserves | | | Total reserves | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 pound $K_2O$ | 30 pounds $K_2O$ | 60 pounds $K_2O$ | 0 pound $K_2O$ | 30 pounds $K_2O$ | 60 pounds $K_2O$ | 0 pound $K_2O$ | 30 pounds $K_2O$ | 60 pounds $K_2O$ |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 10 | 17.4 | 18.5 | 19.2 | 18.1 | 17.4 | 16.4 | 35.5 | 35.9 | 35.6 |
| 35 | 16.9 | 18.4 | 18.7 | 19.9 | 18.8 | 18.4 | 36.8 | 37.2 | 37.1 |
| 60 | 16.7 | 17.6 | 18.2 | 21.1 | 20.8 | 20.1 | 37.8 | 38.4 | 38.3 |

Exactly inverse effects—decrease in protein and increase in oil—resulted from increase in potassium level at each level of nitrogen supply. This interrelated effect is not an exact compensation, as can be seen in the variations resulting in reserve capacity or summation of percentage reserve chemicals in the seed. Increase in nitrogen level brought about higher deposition of protein than depletion of oil. Insofar as total percentage reserves are concerned, it is noted that the optimum was reached at the intermediate potash level for each level of nitrogen supply. The effect of nitrogen supply depends definitely on the level of potash.

#### PHOSPHORUS AND POTASSIUM

Increase in the phosphorus-to-potassium ratio at 0-percent nitrogen in experiment 2 resulted in a decided reduction in oil content (table 29) and an increase in protein content (table 30) of nearly equal magnitude. In this same experiment the reserve capacity was increased as the supply of phosphate was raised and the potash was reduced in the fertilizer mixture up to the 0–9–6 ratio, then reduced again as phosphate was increased to a 0–15–0 concentration (table 34). This represents a case in which excesses of either element were deleterious with respect to maximum percentage of deposition of reserves in the seed. In the two factorial studies (experiments 14 and 15) the interrelated increases in both of these elements seemed to show little change in either oil or protein content of the seed (table 53).

#### NITROGEN, PHOSPHORUS, AND POTASSIUM

The factorial studies usually offer the best means of interpreting probable interrelated effects of change in level of all three main fertilizer elements. In experiments 14 and 15 (table 53) the changes were of low order and offered little striking evidence in this respect. A summation of both experiments showed oil to be highest where potash was high and both nitrogen and phosphate were low. Further increase in either nitrogen or phosphate resulted in lower oil content. Percentage of protein in seed followed an inverse trend under these conditions, but was altered to a lesser degree than when nitrogen and phosphorus were low. In the triangular experiment (experiment 2) the oil content was highest at the 0–3–12 ratio; protein was highest where potash was absent and phosphate was high (0–15–0 and 3–12–0); while total percentage of reserves was highest where complete fertilizers were used (6–6–3 and 3–6–6).

Other studies have resulted in some information on the interrelated effects of the three fertilizer elements. The highest oil content in seed in experiment 4 (table 46) was obtained with the 0–8–4 application, the highest percentage of protein with the 4–8–0 ratio; and there was no difference in oil or protein content of seed for phosphate levels between 2 and 10 percent when phosphate was used with 4 percent each of nitrogen and potash. Phosphate, however, lowered oil content and caused a slight increase in percentage of protein when omitted or when used at the 16-percent level. In experiment 3 it was found that nitrogen fertilization lowered oil and increased protein content of seed; that phosphate and potash fertilization each tended to increase oil;

but that the effect of all three elements combined was not superior to the effect of either phosphate or potash used alone.

A very marked interactive effect was observed in experiment 18. Potash had very little effect at rates up to 100 pounds per acre, but when an application of 3–8–0 fertilizer was used the oil content was reduced 3 percent while protein in seed was raised only 0.31 percent as compared with unfertilized cottons.

As has already been indicated, certain trends were apparent for increased amounts of each of the fertilizing elements when used singly. These are the trends of increase from a nutrient supply where reduction in one element could cause it to be a limiting element and conversely its increase could so influence nutrient balance that one or more of the other nutrient elements would thereby become limiting. Finally, the conditions of nutrition likely to cause alterations in the percentages of chemical content of cottonseed are also those most likely to be associated with significant alterations in yield governed by variations in seed size and number of seed produced per plant or per acre.

## Sodium

The only information relative to the effects on seed composition of the use of soda was obtained from the results of experiments 16 and 17 (table 54), a study with sea-island cotton at two locations in Florida. Variations in composition of seed in these studies were mostly small and nonsignificant. There was a slight indication that potash fertilization increased oil content but failed to change protein content of seed; that soda in place of potash gave the same result with oil and increased also the protein content; and that increased rate of application of both potash and soda in the mixed fertilizer depressed rather than increased the seed content of oil and protein. No more examples are available for comparison, and it is doubtful whether results of this one study offer sufficient evidence for conclusion in regard to probable trends of sodium-application results.

## Lime and Gypsum

Several of the experiments have involved the use of lime and gypsum with other elements of fertilization. In experiment 2 one-half the plots in each of 3 years were given lime, the others none. In this particular study the mean main differences in seed composition between limed and unlimed series were not of statistical significance, although both oil and protein were slightly higher in unlimed series.

Lime and gypsum were both utilized along with potash in two of the North Carolina rotation studies. At Rocky Mount (experiment 6, table 48) the use of lime as well as gypsum produced seed of higher oil content than where no supplement was applied. At Weldon (experiment 7), where increase in rate of potash application depressed the oil content of cottonseed, the use of gypsum lowered both oil and protein content. This is in contrast to an increase in oil content that resulted where lime was applied or where no supplement was used. Protein content of seed was also lowered with use of gypsum.

In experiment 11 (table 50) the oil content of seed was lowered and the protein content was increased as the rate of application of lime was increased from 0 to 1/2, to 1, and to 2 tons per acre. The effects of these elements—lime and gypsum—undoubtedly result from the fact that they alter the relative pH value of the soil and thereby change ratio and quantity of available nutrients. It is felt that calcium in itself has no primary effect on composition of cottonseed; at least, in respect to applications made in this series of studies.

### MAGNESIUM

Neutral calcite, neutral dolomite, and two levels of magnesium sulfate and dolomite (neutral) were utilized in experiment 12 (table 51). Neutral calcite, the high level of magnesium sulfate, and the low level of dolomite gave seed of higher oil content than did the three remaining treatments. The highest oil content was 19.09 percent in seed, and the lowest 18.5 percent. Variations in protein content ranged from 20.3 to 21.8 percent in seed. It would seem, therefore, that the magnesium level has little effect on composition of cottonseed or at least that any effect which might occur would take place only at lower magnesium levels than prevailed in experiment 12. Before any true effect of this element can be determined it will be necessary to study results where additions of magnesium are made to a nutrient supply in which the quantity of magnesium is a limiting factor to growth. These conditions are obviously not included in experiment 12.

### MANURE

Barnyard manure was used as a cotton fertilizer in experiment 3. In this study the use of manure as compared to inorganic nitrogen (with phosphorus and potassium) tended to increase percentage of oil in seed as well as percentage of protein, and thereby produced an increased percentage of reserves.

### IRRIGATION

Experiments 3, 22 (table 58), and 23 (table 59) included different levels of soil-moisture supply. The results from these three studies of the variations in oil and protein content brought about by variations in soil-moisture supply are summarized in table 10. In 1943, in experiment 3, an increased oil content and a decreased protein content of cottonseed resulted from an increase in soil-moisture supply. A reduction in percentages of both oil and protein resulted from irrigation in experiment 22, although the decrease in protein content was negligible. Increased rate of moisture supply in experiment 23 caused a reduction in percentage of oil content of seed of both the S×P and the Acala varieties. The percentage of protein content of seed from experiment 23 decreased in S×P cottons but increased in Acala cottons as the moisture supply was increased.

In each of these studies involving variations in soil-moisture supply the exact effect was dependent to some extent on other experimental variables, particularly the level of fertility and the comparative lateness of initiation and maturation of the seed. Trends in the effects of irrigation were variable, and the expected effect can hardly be stated except in terms of related phases of the environment that limit nutrient supply, adjust metabolism, and condition translocation of reserves to the developing cottonseed.

TABLE 10.—*Oil and protein content of cottonseed as affected by rate of soil-moisture supply in experiments 3 (Baton Rouge, La.), 22 (College Station, Tex.),[1] and 23 (Sacaton, Ariz.)[2]*

| Irrigation | Experiment and cotton variety | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Experiment 3, Deltapine 6 | | Experiment 22, Stoneville 2B | | Experiment 23 | | | |
| | | | | | S × P | | Acala | |
| | Oil content | Protein content | Oil content | Protein content | Oil content | Protein content | Oil content | Protein content |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| Light (or none) | 17.0 | 21.5 | 17.2 | 20.3 | 21.6 | 22.4 | 17.0 | 21.9 |
| Medium | 17.3 | 20.5 | | | | ------ | 16.9 | 22.3 |
| Heavy | 17.2 | 20.6 | 16.3 | 20.0 | 21.4 | 21.4 | 16.2 | 22.5 |

[1] See table 58 for additional data on experiment 22.
[2] See table 59 for additional data on experiment 23.

## DISEASE

Results from experiments 20, 21, and 22 (tables 57 and 58), have been obtained in such a way as to allow for a determination of differences in composition of seed taken from diseased plants, as contrasted with seed from healthy plants growing under otherwise comparable conditions. In experiment 20 the seed from diseased plants were of varieties that differed from those furnishing the seed from healthy plants. In experiments 21 and 22 the varieties are the same for both diseased and healthy conditions. In experiments 20 and 21, a vascular disease, fusarium wilt, was the cause of the condition, and in experiment 22 the diseased plants were affected by Texas root rot, a disease of the cortical tissues of cotton roots. The results from these three studies with regard to effects on oil, protein, and reserve capacity of the seed are summarized on a fuzzy seed basis at 10-percent moisture content (table 11).

The diseases in the plants used in each of these studies had caused immaturity. The invasion of the organisms first interrupted absorption from the soil, then synthesis and translocation to the bolls. The seed on these plants were not necessarily diseased, but their normal maturity had been interrupted. In experiment 20 the incidence of wilt disease was more severe than in experiment 21, and the degree of immaturity, as indicated by reduced oil and reserve capacity, was less severe in the seed from the Orangeburg, S. C., study (experiment 21).

The diseased plants represented in experiment 22 were dead by the time all seed had been picked. All three studies indicated that oil content tends to be reduced considerably in plants suffering from severe infections of either fusarium wilt or Texas root rot. Percentage of protein content may or may not be reduced to a comparable degree, but the total percentage deposition of reserves (oil and protein) was lowered in each of the studies reported.

TABLE 11.—*Composition*[1] *of cottonseed as influenced by plant disease in experiments 20 (Hamlet, N. C.), 21 (Orangeburg, S. C.),*[2] *and 22 (College Station, Tex.)*[3]

| Experiment No. | Disease | Oil content | | Protein content | | Reserve capacity | |
|---|---|---|---|---|---|---|---|
| | | Healthy | Diseased | Healthy | Diseased | Healthy | Diseased |
| | | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 20 | Fusarium wilt | 19.8 | 15.3 | 20.9 | 22.7 | 40.7 | 38.0 |
| 21 | Do | 19.9 | 19.4 | 22.9 | 22.3 | 42.8 | 41.7 |
| 22 | Texas root rot | 18.0 | 15.5 | 20.2 | 20.0 | 38.2 | 35.5 |

[1] Results are calculated to a fuzzy seed basis at 10-percent moisture content.
[2] See table 58 for additional data on experiments 20 and 21.
[3] See table 59 for additional data on experiment 22.

## RELATIVE MATURITY

The period of blooming for cotton plants usually extends throughout several months, the greatest intensity occurring at the time of optimum growth, or in midseason. Seed from bolls initiated and matured early in the season are developed under a set of environmental conditions that may be entirely different from those occurring in midseason or for late-set and matured cottonseed. Changes in metabolism and translocation to the bolls and seed are likely to occur throughout the season, allowing for the possibility of differences in composition of the seed.

Seed from different harvest periods were analyzed for chemical composition in seven of the experiments discussed previously in this study. The exact time of flowering, length of maturation period, and time of boll opening are different for each of these studies. Location, soil type, season, and varieties are also different among the seven studies, so that trends rather than specific data will furnish the only basis for comparing results. In the special fiber study (experiment 3), comparisons were made from tagged and dated bolls. In the other studies the bolls were picked as bottom, middle, and top crops, that is, bolls set early, at midseason, and late, respectively.

The trends within these seven studies with respect to the influence on variation in percentage of oil content of seed are indicated in figure 35. The results during 2 years (3A for 1943 and 3B for 1944) in experiment 3 and for two varieties in experiment 23 (23A for S × P and 23B for Acala) are shown in this figure, allowing for nine graph lines. Five of these studies showed increased oil content of late-matured cottonseed. Seed from experiment 1 were hardly changed in oil content as the season advanced. The Acala seed picked early in experiment 23B were higher in oil content at early than at midseason pickings, but highest oil was found in the late-picked seed. The S×P seed from the western irrigated study (experiment 23A) were also found to have higher oil content in late as compared to early matured and harvested

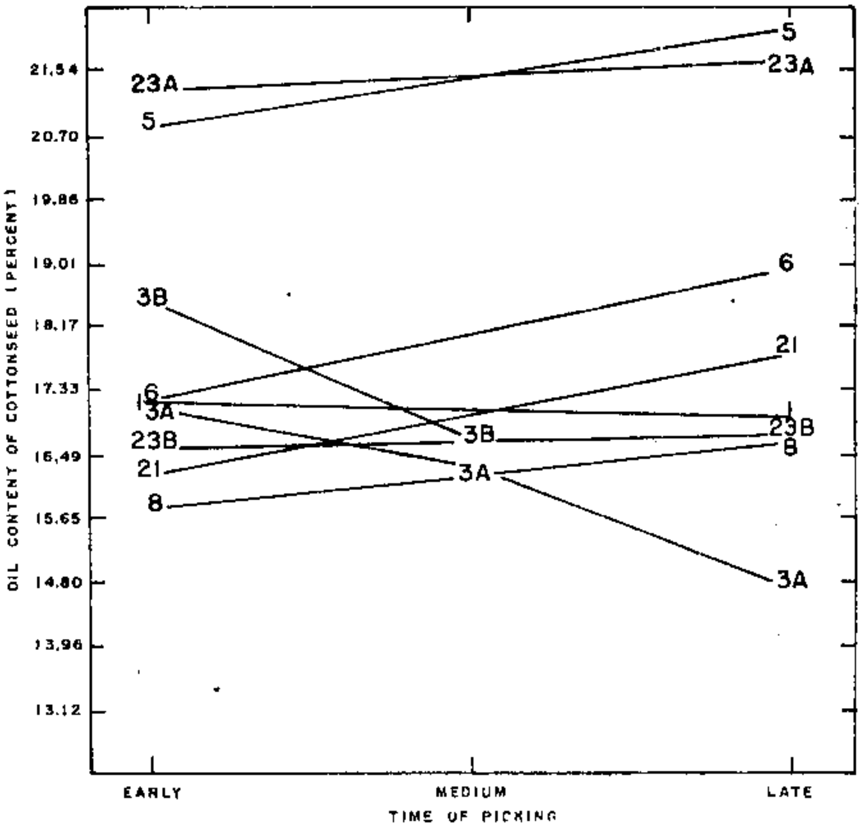



FIGURE 35.—Effect of time of harvest on oil content of cottonseed.

seed. In other studies there was a tendency for cottonseed to have a significantly higher oil content as the season advanced, seed from the later initiated and matured top crop being higher in this respect than seed from the early-set bolls comprising the bottom crop of cotton plants.

Changes in percentage of protein content of cottonseed resulting from advance in time of boll setting and maturity is shown in figure 36. There was a tendency for seed to develop a higher protein content when it was set later in the season. Only in experiments 6 and 3A (1943) was there no evidence of this trend. A comparison of figures 35 and 36 leads to the conclusion that there is a tendency for the seed to have increased total reserves with advance in time for seed initiation and maturation. This assumption can be better tested in figure 37, which shows the summation values of "total percentage reserve capacity." On this basis of total, rather than partial, percentage reserves, only one study (experiment 3) failed to produce seed of higher oil plus protein content at the later maturity dates.

Experiment 3 differs from all others in that flowers were dated and tagged when open and dated again when the bolls were fully

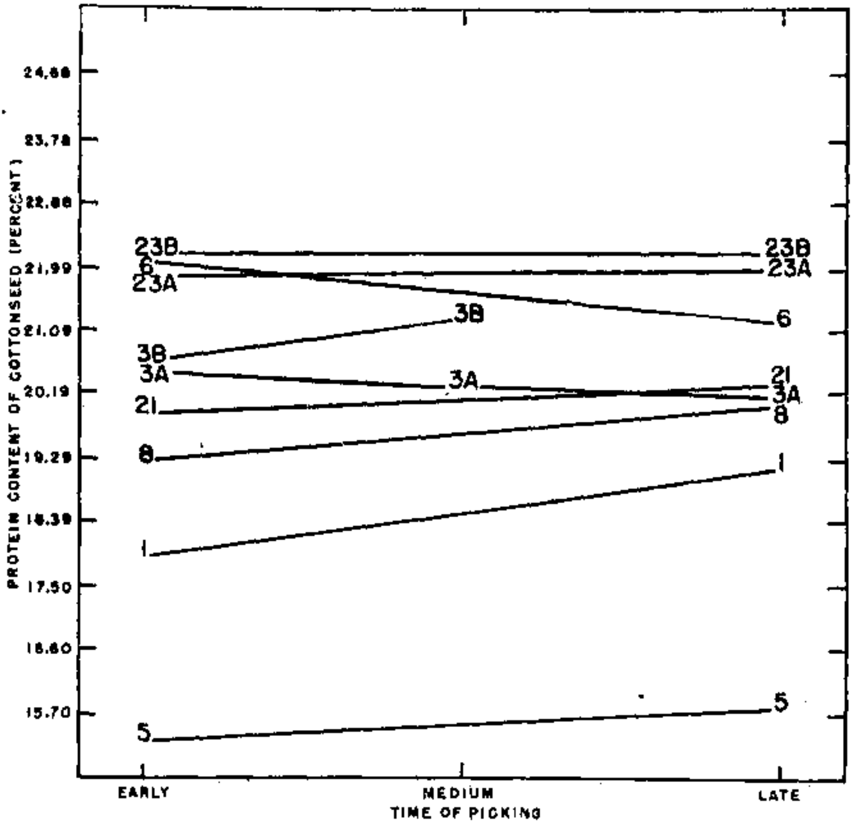



FIGURE 36.—Effect of time of harvest on protein content of cottonseed.

opened, at which time they were harvested. The period from flowering to open boll in this study was little different for early, midseason, and late-harvested bolls. These groups include only bolls initiated and matured at the same time. The other studies include bolls in each group (early, midseason, and late) that were initiated and matured over a considerable advance in time. As a result the time series difference is more sharply drawn in experiment 3 than in any of the others. This greater precision may have had some tendency to alter the result, but it is felt that the greater reason for deviation from the general trend shown for the remaining studies was in the peculiarities of variety, soil, and aerial environment at the location for experiment 3. This study was conducted on extremely infertile soil, and many of the fertilizer treatments accentuated rather than corrected the lack of adequate balance of nutrient supply.

In other studies as well as experiment 3 it has been shown that corrections in fertility balance, particularly where potash has been deficient, have resulted in higher kernel content of seed and

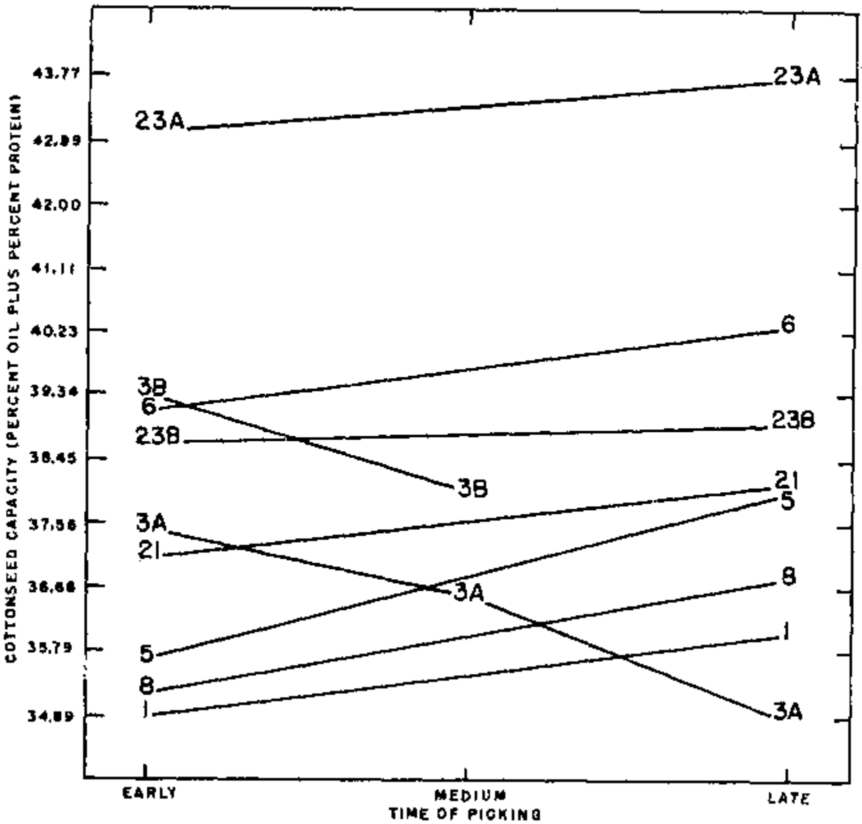



FIGURE 37.—Effect of time of harvest on percentage of reserve capacity (percent oil plus percent protein) in cottonseed.

higher resultant total reserve capacity of the seed. Many other interrelated effects tend to influence this trend of higher reserve content with advance in season.

Gallup (*13*), Seale (*36*), and others have shown that oil has a rapid period of development, whereas protein content increases gradually as the seed matures. The reserve capacity and partial composition could be altered in several different ways, and the nature of the combined environmental stress on plant growth would be dependent upon the time during the maturation period at which the stresses were most acute.

The results of a great many analyses of seed by commercial oil chemists, with respect to locality and date, have been compiled by Cresswell and Bidwell (*10*). These results indicate that there is a general tendency for seed to increase gradually in oil content as the normal harvest season advances. Some of the early harvested seed was low in oil content, protein content, and grade because of the higher moisture content of the seed in early season. Even when extra moisture was eliminated from the early seed there was a tendency for it to have a higher oil content as the season advanced. Experiment 3 showed low oil content is an exception, since the general or expected trend under advanced season conditions is toward an increased oil content.

Protein content may also increase, but its variability will depend to some extent on the rate of increase in percentage of oil content of the cottonseed. Toward the end of the growing season the weather often causes severe inhibition or complete cessation of growth, which results in immature seed. These immature seed would undoubtedly be comparatively low in percentages of oil or protein or perhaps in both reserve components of cottonseed. This immaturity is a terminal effect, just as high moisture content is an initial result. The trend between these two extremes will probably be a gradual increase in percentage of oil content with very little alteration in percentage of protein content and will result in an increased total percentage reserve capacity of the fuzzy cottonseed as the season advances.

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## APPENDIX

The detailed data resulting from analysis of seed and measurements of seed yields in the 23 experiments discussed in the text are tabulated in this section as follows: Tables 12 to 24 relate to data in experiment 1; tables 25 to 36 to experiment 2; 37 to 45 to experiment 3; 46 to experiment 4; 47 to experiment 5; 48 to experiments 6 to 9; 49 to experiment 10; 50 to experiment 11; 51 to experiment 12; 52 to experiment 13; 53 to experiments 14 and 15; 54 to experiments 16 and 17; 55 to experiment 18; 56 to experiment 19; 57 to experiments 20 and 21; 58 to experiment 22; and 59 to experiment 23.

**TABLE 12.**—*Seed index* [1] *(weight of 100 seed, in grams) as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Seed index with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom): | *Grams* | *Grams* | *Grams* | *Grams* |
| Coker 4 in 1-4 | 13.05 | 13.05 | 13.88 | 13.33 |
| Station 21 | 11.75 | 11.74 | 10.92 | 11.47 |
| Station C | 12.89 | 11.40 | 13.12 | 12.47 |
| Station S | 11.32 | 11.62 | 11.25 | 11.40 |
| Mean | 12.25 | 11.95 | 12.29 | 12.17 |
| Late (top): | | | | |
| Coker 4 in 1-4 | 10.94 | 12.57 | 12.60 | 12.04 |
| Station 21 | 8.54 | 9.79 | 8.73 | 9.02 |
| Station C | 11.22 | 11.29 | 11.36 | 11.29 |
| Station S | 9.59 | 8.81 | 9.62 | 9.34 |
| Mean | 10.07 | 10.61 | 10.58 | 10.42 |
| *1943* [3] | | | | |
| Early (bottom): | | | | |
| Coker 4 in 1-4 | 13.77 | 13.89 | 14.00 | 13.89 |
| Station 21 | 12.04 | 12.23 | 12.73 | 12.33 |
| Station C | 13.87 | 14.25 | 14.41 | 14.18 |
| Station S | 11.65 | 11.72 | 12.17 | 11.85 |
| Mean | 12.83 | 13.02 | 13.33 | 13.06 |
| Late (top): | | | | |
| Coker 4 in 1-4 | 12.15 | 11.90 | 12.45 | 12.17 |
| Station 21 | 10.43 | 11.15 | 10.91 | 10.83 |
| Station C | 12.20 | 12.22 | 12.46 | 12.29 |
| Station S | 10.21 | 10.82 | 10.64 | 10.56 |
| Mean | 11.25 | 11.52 | 11.61 | 11.46 |
| Mean for years: | | | | |
| 1942 | 11.16 | 11.28 | 11.44 | 11.29 |
| 1943 | 12.04 | 12.27 | 12.47 | 12.26 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 12.54 | 12.49 | 12.81 | 12.61 |
| Late (top crop) | 10.66 | 11.07 | 11.10 | 10.94 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 12.48 | 12.88 | 13.23 | 12.85 |
| Station 21 | 10.69 | 11.23 | 10.82 | 10.91 |
| Station C | 12.54 | 12.29 | 12.84 | 12.56 |
| Station S | 10.69 | 10.74 | 10.92 | 10.78 |
| Averages for treatments | 11.60 | 11.78 | 11.95 | 11.78 |

TABLE 12.—*Seed index* [1] *(weight of 100 seed, in grams) as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | **13.9078 | 0.478 | 0.648 |
| Treatments | 2 | .4952 | .413 | .561 |
| Varieties×treatments | 6 | .2486 | .827 | 1.122 |
| Pickings | 1 | **33.5336 | .338 | .458 |
| Varieties×pickings | 3 | .1404 | .676 | .916 |
| Treatments×pickings | 2 | .2204 | .585 | .793 |
| Varieties×pickings×treatments | 6 | .0930 | 1.168 | 1.585 |
| Years | 1 | **11.2328 | .338 | .456 |
| Error [5] | 23 | .3195 | | |

[1] Calculated on the basis of 10-percent moisture in the fuzzy seed.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] * = A significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

**TABLE 13.**—*Percentage of fuzz[1] (linters) on cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of fuzz with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942*[2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1-4 | 13.00 | 12.06 | 12.12 | 12.39 |
| Station 21 | 13.71 | 13.57 | 13.72 | 13.67 |
| Station C | 13.88 | 14.02 | 14.12 | 14.01 |
| Station S | 9.56 | 10.66 | 10.52 | 10.25 |
| Mean | 12.54 | 12.58 | 12.62 | 12.58 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 11.38 | 12.43 | 12.55 | 12.12 |
| Station 21 | 12.39 | 12.39 | 12.16 | 12.31 |
| Station C | 12.78 | 12.23 | 12.47 | 12.49 |
| Station S | 10.85 | 10.03 | 10.17 | 10.35 |
| Mean | 11.85 | 11.77 | 11.84 | 11.82 |
| *1943*[3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1-4 | 12.52 | 12.68 | 13.68 | 12.96 |
| Station 21 | 14.47 | 14.31 | 14.17 | 14.32 |
| Station C | 14.71 | 14.74 | 14.27 | 14.57 |
| Station S | 10.44 | 10.84 | 10.25 | 10.51 |
| Mean | 13.03 | 13.14 | 13.09 | 13.09 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 13.02 | 10.43 | 12.42 | 11.96 |
| Station 21 | 14.35 | 12.80 | 11.07 | 12.74 |
| Station C | 13.41 | 13.25 | 13.04 | 13.23 |
| Station S | 10.32 | 9.70 | 11.06 | 10.36 |
| Mean | 12.77 | 11.54 | 11.90 | 12.07 |
| Mean for years: | | | | |
| 1942 | 12.19 | 12.17 | 12.23 | 12.20 |
| 1943 | 12.90 | 12.34 | 12.49 | 12.58 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 12.79 | 12.86 | 12.86 | 12.83 |
| Late (top crop) | 12.31 | 11.66 | 11.87 | 11.95 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 12.48 | 11.90 | 12.69 | 12.36 |
| Station 21 | 13.73 | 13.27 | 12.78 | 13.26 |
| Station C | 13.69 | 13.56 | 13.47 | 13.58 |
| Station S | 10.29 | 10.31 | 10.50 | 10.37 |
| Averages for treatments | 12.55 | 12.26 | 12.36 | 12.39 |

**TABLE 13.**—*Percentage of fuzz [1] (linters) on cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | **25.0342 | 0.053 | 0.071 |
| Treatments | 2 | .3474 | .46 | .62 |
| Varieties×treatments | 6 | .4438 | .91 | 1.24 |
| Pickings | 1 | **9.4697 | .37 | .51 |
| Varieties×pickings | 3 | 1.4331 | .74 | 1.01 |
| Treatments×pickings | 2 | .5613 | .65 | .88 |
| Varieties×treatments×pickings | 6 | .2693 | 1.29 | 1.75 |
| Years | 1 | *1.7560 | .37 | .51 |
| Error [5] | 23 | .3874 | ---------- | ---------- |

[1] Calculated on the basis of 10-percent moisture in the fuzzy seed.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] *=A significant mean square, 5-percent level; **=a highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

**TABLE 14.**—*Percentage of kernels [1] (meats) in seed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of kernels with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1–4 | 46.33 | 48.00 | 48.53 | 47.62 |
| Station 21 | 46.74 | 46.81 | 46.90 | 46.81 |
| Station C | 47.47 | 46.22 | 47.48 | 47.06 |
| Station S | 49.90 | 49.25 | 50.50 | 49.88 |
| Mean | 47.61 | 47.57 | 48.35 | 47.84 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 48.63 | 48.90 | 49.40 | 48.98 |
| Station 21 | 47.57 | 48.53 | 52.15 | 49.42 |
| Station C | 48.42 | 50.12 | 49.49 | 49.34 |
| Station S | 49.03 | 49.13 | 50.37 | 49.51 |
| Mean | 48.41 | 49.17 | 50.35 | 49.31 |
| *1943* [3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1–4 | 46.03 | 46.83 | 46.66 | 46.51 |
| Station 21 | 45.04 | 45.24 | 46.40 | 46.56 |
| Station C | 46.10 | 46.15 | 46.48 | 46.24 |
| Station S | 47.71 | 48.15 | 49.24 | 48.37 |
| Mean | 46.22 | 46.59 | 47.19 | 46.67 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 45.34 | 46.61 | 47.28 | 46.41 |
| Station 21 | 44.15 | 45.58 | 45.74 | 45.16 |
| Station C | 46.04 | 47.07 | 47.65 | 46.92 |
| Station S | 47.24 | 48.82 | 49.96 | 48.67 |
| Mean | 45.69 | 47.02 | 47.65 | 46.79 |
| Mean for years: | | | | |
| 1942 | 48.01 | 48.37 | 49.35 | 48.58 |
| 1943 | 45.96 | 46.81 | 47.43 | 46.73 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 46.92 | 47.08 | 47.77 | 47.26 |
| Late (top crop) | 37.05 | 48.10 | 49.01 | 48.05 |
| Mean for strains: | | | | |
| Coker 4 in 1–4 | 46.58 | 47.58 | 47.97 | 47.38 |
| Station 21 | 45.87 | 46.54 | 47.80 | 46.74 |
| Station C | 47.01 | 47.39 | 47.77 | 47.39 |
| Station S | 48.47 | 48.84 | 50.02 | 49.11 |
| Averages for treatments | 46.98 | 47.59 | 48.39 | 47.65 |

TABLE 14.—*Percentage of kernels [1] (meats) in seed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | **12.4161 | 0.69 | 0.93 |
| Treatments | 2 | **7.9548 | .62 | .85 |
| Varieties×treatments | 6 | .3620 | 1.25 | 1.69 |
| Pickings | 1 | **7.5684 | .51 | .69 |
| Varieties×pickings | 3 | 1.2619 | 1.02 | 1.38 |
| Treatments×pickings | 2 | .3410 | .88 | 1.20 |
| Varieties×treatments×pickings | 6 | .7928 | 1.75 | 2.38 |
| Years | 1 | **40.9961 | .51 | .69 |
| Pickings×years | 1 | *5.4406 | .69 | .93 |
| Error [5] | 22 | .7280 | | |

[1] Calculated on the basis of 10-percent moisture in the fuzzy seed.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] *=A significant mean square, 5-percent level; **=a highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

**TABLE 15.**—*Percentage of oil*[1] *in kernels of cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of oil in kernels with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942*[2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1–4 | 32.95 | 35.36 | 41.27 | 36.53 |
| Station 21 | 35.19 | 35.78 | 36.73 | 35.90 |
| Station C | 31.59 | 34.67 | 37.66 | 34.64 |
| Station S | 32.76 | 34.92 | 35.19 | 34.29 |
| Mean | 33.12 | 35.18 | 37.71 | 35.34 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 31.91 | 34.02 | 40.03 | 35.32 |
| Station 21 | 32.26 | 37.24 | 36.02 | 35.17 |
| Station C | 26.88 | 30.44 | 33.82 | 30.38 |
| Station S | 28.90 | 35.47 | 34.53 | 32.97 |
| Mean | 29.99 | 34.29 | 36.10 | 33.46 |
| *1943*[3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1–4 | 35.86 | 35.65 | 38.25 | 36.59 |
| Station 21 | 35.39 | 36.91 | 38.33 | 36.88 |
| Station C | 34.24 | 36.13 | 36.37 | 35.58 |
| Station S | 33.68 | 35.34 | 35.94 | 34.97 |
| Mean | 34.78 | 36.01 | 37.22 | 36.00 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 35.99 | 37.17 | 39.46 | 37.54 |
| Station 21 | 33.47 | 37.49 | 40.87 | 37.28 |
| Station C | 32.83 | 35.26 | 37.85 | 35.31 |
| Station S | 32.19 | 34.52 | 37.00 | 34.57 |
| Mean | 33.62 | 36.11 | 38.79 | 36.17 |
| Mean for years: | | | | |
| 1942 | 31.55 | 34.74 | 36.91 | 34.40 |
| 1943 | 34.20 | 36.02 | 38.01 | 36.08 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 33.95 | 35.56 | 37.47 | 35.66 |
| Late (top crop) | 31.80 | 35.20 | 37.45 | 34.82 |
| Mean for strains: | | | | |
| Coker 4 in 1–4 | 34.18 | 35.46 | 39.75 | 36.47 |
| Station 21 | 34.08 | 36.85 | 37.99 | 36.30 |
| Station C | 31.38 | 34.12 | 36.42 | 33.98 |
| Station S | 31.87 | 35.06 | 35.66 | 34.20 |
| Averages for treatments | 32.88 | 35.38 | 37.46 | 35.24 |

TABLE 15.—*Percentage of oil [1] in kernels of cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | **21.5347 | 1.17 | 1.59 |
| Treatments | 2 | **84.1803 | 1.02 | 1.38 |
| Varieties × treatments | 6 | 2.6184 | 2.02 | 2.74 |
| Pickings | 1 | *8.7467 | .83 | 1.12 |
| Varieties × pickings | 3 | 2.9923 | 1.66 | 2.25 |
| Treatments × pickings | 2 | 5.1610 | 1.44 | 1.95 |
| Varieties × treatments × pickings | 6 | .7112 | 2.87 | 2.90 |
| Years | 1 | **34.2563 | .83 | 1.12 |
| Pickings × years | 1 | *12.6177 | 1.17 | 1.59 |
| Error [5] | 22 | 1.9264 | | |

[1] Based on 10-percent moisture content of the fuzzy seed and 0.5-percent oil content of hulls.

[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.

[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.

[4] * = A significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.

[5] Error variance measured as the mean of all interactions with years.

**TABLE 16.**—*Percentage of ammonia [1] in kernels of cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of ammonia in kernels with $K_2O$ at acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1-4 | 6.32 | 6.36 | 5.79 | 6.16 |
| Station 21 | 6.50 | 6.24 | 6.35 | 6.36 |
| Station C | 6.80 | 7.68 | 6.73 | 7.07 |
| Station S | 6.38 | 6.51 | 6.54 | 6.48 |
| Mean | 6.50 | 6.70 | 6.35 | 6.52 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 7.10 | 7.64 | 7.53 | 7.42 |
| Station 21 | 7.45 | 7.81 | 7.01 | 7.42 |
| Station C | 8.02 | 7.79 | 7.73 | 7.85 |
| Station S | 7.77 | 7.86 | 7.53 | 7.72 |
| Mean | 7.58 | 7.77 | 7.45 | 7.60 |
| *1943* [3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1-4 | 7.51 | 7.32 | 7.11 | 7.31 |
| Station 21 | 7.51 | 7.47 | 7.06 | 7.35 |
| Station C | 8.06 | 8.09 | 8.08 | 8.08 |
| Station S | 8.38 | 7.80 | 7.81 | 8.00 |
| Mean | 7.86 | 7.67 | 7.51 | 7.68 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 7.67 | 7.37 | 7.04 | 7.36 |
| Station 21 | 7.87 | 7.52 | 7.61 | 7.67 |
| Station C | 8.50 | 8.05 | 7.59 | 8.05 |
| Station S | 8.06 | 7.77 | 7.52 | 7.78 |
| Mean | 8.02 | 7.68 | 7.44 | 7.71 |
| Mean for years: | | | | |
| 1942 | 7.04 | 7.23 | 6.90 | 7.06 |
| 1943 | 7.94 | 7.67 | 7.48 | 7.70 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 7.18 | 7.18 | 6.93 | 7.10 |
| Late (top crop) | 7.80 | 7.72 | 7.45 | 7.66 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 7.15 | 7.17 | 6.87 | 7.06 |
| Station 21 | 7.33 | 7.26 | 7.01 | 7.20 |
| Station C | 7.84 | 7.90 | 7.53 | 7.76 |
| Station S | 7.65 | 7.48 | 7.35 | 7.49 |
| Averages for treatments | 7.49 | 7.45 | 7.19 | 7.38 |

TABLE 16.—*Percentage of ammonia* [1] *in kernels of cottonseed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— 5-percent level | 1-percent level |
|---|---|---|---|---|
| Varieties | 3 | **1.1597 | 0.23 | 0.31 |
| Treatments | 2 | **.4384 | .19 | .26 |
| Varieties × treatments | 6 | .0136 | .39 | .53 |
| Pickings | 1 | **3.7408 | .16 | .22 |
| Varieties × pickings | 3 | .0633 | .32 | .43 |
| Treatments × pickings | 2 | .0132 | .28 | .37 |
| Varieties × treatments × pickings | 6 | .0746 | .55 | .75 |
| Years | 1 | **4.9024 | .16 | .22 |
| Pickings × years | 1 | **3.3392 | .23 | .31 |
| Error [5] | 22 | .0717 | | |

[1] Based on 10-percent moisture in the fuzzy seed and 0.5-percent $NH_3$ content of hulls.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] ** = A highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

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**TABLE 17.**—*Kernel capacity* [1] *as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Kernel capacity with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1-4 | 65.37 | 68.02 | 70.97 | 68.12 |
| Station 21 | 68.53 | 67.78 | 69.31 | 68.54 |
| Station C | 66.47 | 74.07 | 72.18 | 70.91 |
| Station S | 65.49 | 68.32 | 68.74 | 67.52 |
| Mean | 66.46 | 69.55 | 70.30 | 68.77 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 68.33 | 73.21 | 78.66 | 73.40 |
| Station 21 | 70.48 | 77.30 | 71.98 | 73.25 |
| Station C | 68.02 | 70.40 | 73.47 | 70.63 |
| Station S | 66.19 | 75.74 | 73.16 | 71.70 |
| Mean | 68.25 | 74.16 | 74.32 | 72.24 |
| *1943* [3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1-4 | 74.39 | 73.20 | 74.72 | 74.10 |
| Station 21 | 73.91 | 75.23 | 74.55 | 74.56 |
| Station C | 75.59 | 77.63 | 77.82 | 77.01 |
| Station S | 76.62 | 75.35 | 76.00 | 75.99 |
| Mean | 75.12 | 75.35 | 75.77 | 75.42 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 75.34 | 74.98 | 75.57 | 75.30 |
| Station 21 | 73.84 | 76.07 | 79.91 | 76.61 |
| Station C | 76.43 | 76.56 | 76.79 | 76.59 |
| Station S | 73.54 | 74.38 | 75.58 | 74.50 |
| Mean | 74.79 | 75.50 | 76.96 | 75.75 |
| Mean for years: | | | | |
| 1942 | 67.36 | 71.86 | 72.31 | 70.51 |
| 1943 | 74.96 | 75.42 | 76.37 | 75.58 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 70.80 | 72.45 | 73.04 | 72.09 |
| Late (top crop) | 71.52 | 74.83 | 75.64 | 74.00 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 70.86 | 72.35 | 74.98 | 72.73 |
| Station 21 | 71.69 | 74.09 | 73.94 | 73.24 |
| Station C | 71.63 | 74.66 | 75.06 | 73.78 |
| Station S | 70.46 | 73.45 | 73.37 | 72.42 |
| Averages for treatments | 71.16 | 73.64 | 74.34 | 73.05 |

TABLE 17.—*Kernel capacity* [1] *as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | 4.2701 | 1.93 | 2.63 |
| Treatments | 2 | **44.6731 | 1.67 | 2.27 |
| Varieties × treatments | 6 | 1.4310 | 3.35 | 4.56 |
| Pickings | 1 | **43.4531 | 1.37 | 1.86 |
| Varieties × pickings | 3 | 9.3351 | 2.73 | 3.71 |
| Treatments × pickings | 2 | 4.2125 | 2.37 | 3.22 |
| Varieties × treatments × pickings | 6 | 3.5052 | 4.73 | 6.43 |
| Years | 1 | **309.1182 | 1.37 | 1.86 |
| Pickings × years | 1 | *29.6259 | 1.93 | 2.63 |
| Error [5] | 22 | 5.2106 | | |

[1] The sum of the percentage of oil plus the percentage of protein (5.13 × percentage of $NH_3$) in the kernel.

[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.

[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.

[4] * = A significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.

[5] Error variance measured as the mean of all interactions with years other than those components found significantly higher than the mean of the remainder.

**TABLE 18.**—*Percentage of oil [1] in seed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of oil with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1–4 | 15.39 | 17.10 | 20.15 | 17.55 |
| Station 21 | 16.75 | 16.87 | 17.35 | 16.99 |
| Station C | 15.12 | 16.15 | 18.01 | 16.43 |
| Station S | 16.47 | 17.32 | 17.95 | 17.25 |
| Mean | 15.93 | 16.86 | 18.36 | 17.05 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 15.64 | 16.76 | 19.90 | 17.43 |
| Station 21 | 15.47 | 18.20 | 18.91 | 17.53 |
| Station C | 13.14 | 15.38 | 16.86 | 15.13 |
| Station S | 14.28 | 17.55 | 17.52 | 16.45 |
| Mean | 14.63 | 16.97 | 18.30 | 16.63 |
| *1943* [3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1–4 | 16.63 | 17.24 | 17.97 | 17.28 |
| Station 21 | 16.87 | 16.82 | 17.91 | 17.20 |
| Station C | 15.91 | 16.80 | 17.03 | 16.58 |
| Station S | 16.17 | 17.14 | 17.82 | 17.04 |
| Mean | 16.39 | 17.00 | 17.68 | 17.03 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 16.44 | 17.45 | 18.76 | 17.55 |
| Station 21 | 16.59 | 17.21 | 18.82 | 17.54 |
| Station C | 15.24 | 16.72 | 18.16 | 16.71 |
| Station S | 15.33 | 16.98 | 18.61 | 16.97 |
| Mean | 15.90 | 17.09 | 18.59 | 17.19 |
| Mean for years: | | | | |
| 1942 | 15.28 | 16.92 | 18.33 | 16.84 |
| 1943 | 16.15 | 17.04 | 18.13 | 17.11 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 16.17 | 16.93 | 18.02 | 17.04 |
| Late (top crop) | 15.27 | 17.03 | 18.44 | 16.91 |
| Mean for strains: | | | | |
| Coker 4 in 1–4 | 16.02 | 17.14 | 19.19 | 17.45 |
| Station 21 | 16.42 | 17.28 | 18.25 | 17.31 |
| Station C | 14.85 | 16.26 | 17.52 | 16.21 |
| Station S | 15.56 | 17.25 | 17.97 | 16.93 |
| Averages for treatments | 15.72 | 16.98 | 18.23 | 16.98 |

TABLE 18.—*Percentage of oil*[1] *in seed as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Con.

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square[4] | Least significant differences between means at— 5-percent level | 1-percent level |
|---|---|---|---|---|
| Varieties | 3 | **3.7218 | 0.59 | 0.80 |
| Treatments | 2 | **25.3640 | .51 | .69 |
| Varieties×treatments | 6 | .5166 | 1.02 | 1.38 |
| Pickings | 1 | .1900 | .42 | .56 |
| Varieties×pickings | 3 | .6669 | .83 | 1.13 |
| Treatments×pickings | 2 | *1.8872 | .72 | .98 |
| Varieties×treatments×pickings | 6 | .2086 | 1.44 | 1.95 |
| Years | 1 | .8480 | .42 | .56 |
| Error[5] | 23 | .4839 | | |

[1] Calculated on the basis of 10-percent moisture in the fuzzy seed.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] *=A significant mean square, 5-percent level; **=a highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

TABLE 19.—*Acre yield of cottonseed as influenced by rate of potash application in four varieties of cotton in 1942 and 1943,*[1] *at Tifton, Ga.*

| Year and variety | Acre yield of cottonseed with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| 1942: | *Pounds* | *Pounds* | *Pounds* | *Pounds* |
| Coker 4 in 1-4 | 538 | 640 | 728 | 635 |
| Station 21 | 539 | 666 | 800 | 668 |
| Station C | 541 | 603 | 696 | 613 |
| Station S | 420 | 529 | 612 | 520 |
| Mean | 509 | 609 | 709 | 609 |
| 1943: | | | | |
| Coker 4 in 1-4 | 526 | 620 | 694 | 613 |
| Station 21 | 459 | 600 | 729 | 596 |
| Station C | 517 | 604 | 672 | 598 |
| Station S | 394 | 514 | 603 | 504 |
| Mean | 474 | 585 | 675 | 578 |
| 2-year averages: | | | | |
| Coker 4 in 1-4 | 532 | 630 | 711 | 624 |
| Station 21 | 499 | 633 | 764 | 632 |
| Station C | 529 | 603 | 682 | 605 |
| Station S | 407 | 521 | 607 | 512 |
| Mean | 491 | 597 | 692 | 593 |

[1] Refer to Appendix table 24 for variance analysis applicable to these data.

**TABLE 20.**—*Cottonseed grade[1] as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Cottonseed grade with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942* [2] | | | | |
| Early (bottom crop): | *Points* | *Points* | *Points* | *Points* |
| Coker 4 in 1-4 | 83.8 | 92.5 | 103.2 | 93.2 |
| Station 21 | 90.7 | 90.6 | 93.0 | 91.4 |
| Station C | 83.7 | 90.8 | 96.9 | 90.5 |
| Station S | 90.2 | 94.3 | 97.4 | 94.0 |
| Mean | 87.1 | 92.1 | 97.6 | 92.3 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 87.7 | 92.0 | 104.7 | 94.8 |
| Station 21 | 87.4 | 101.3 | 103.1 | 97.3 |
| Station C | 77.8 | 89.1 | 96.0 | 87.6 |
| Station S | 83.0 | 99.1 | 98.6 | 93.6 |
| Mean | 84.0 | 95.4 | 100.6 | 93.3 |
| *1943* [3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1-4 | 92.5 | 95.6 | 97.5 | 95.2 |
| Station 21 | 89.6 | 92.8 | 97.0 | 93.1 |
| Station C | 90.6 | 94.8 | 96.2 | 93.9 |
| Station S | 93.5 | 96.8 | 100.1 | 96.8 |
| Mean | 91.5 | 95.0 | 97.7 | 94.7 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 93.0 | 94.9 | 100.7 | 96.2 |
| Station 21 | 92.0 | 95.1 | 101.0 | 96.0 |
| Station C | 88.4 | 94.9 | 100.1 | 94.5 |
| Station S | 88.3 | 96.2 | 102.7 | 95.7 |
| Mean | 90.4 | 95.3 | 101.1 | 95.6 |
| Mean for years: | | | | |
| 1942 | 85.5 | 93.7 | 99.1 | 92.8 |
| 1943 | 91.0 | 95.1 | 99.4 | 95.2 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 89.5 | 93.5 | 97.7 | 93.5 |
| Late (top crop) | 87.2 | 95.3 | 100.9 | 94.5 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 89.2 | 93.7 | 101.5 | 94.8 |
| Station 21 | 89.9 | 94.9 | 98.5 | 94.5 |
| Station C | 85.1 | 92.4 | 97.3 | 91.6 |
| Station S | 88.7 | 96.6 | 99.7 | 95.0 |
| Averages for treatments | 88.3 | 94.4 | 99.3 | 94.0 |

**TABLE 20.**—*Cottonseed grade* [1] *as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | *30.7161 | 2.3 | 3.1 |
| Treatments | 2 | *486.3425 | 2.0 | 2.7 |
| Varieties×treatments | 6 | 6.7011 | 4.0 | 5.4 |
| Pickings | 1 | 11.0241 | 1.6 | 2.2 |
| Varieties×pickings | 3 | 18.9114 | 3.2 | 4.4 |
| Treatments×pickings | 2 | *30.4792 | 2.8 | 3.8 |
| Varieties×treatments×pickings | 6 | 6.6522 | 5.6 | 7.6 |
| Years | 1 | **68.6442 | 1.6 | 2.2 |
| Treatment×years | 2 | *29.3242 | 2.8 | 3.8 |
| Error [5] | 21 | 7.2950 | | |

[1] Based on measurement of quantity index with prime quality assumed at 10-percent moisture content of the fuzzy seed.

[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.

[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.

[4] *=A significant mean square, 5-percent level; **=a highly significant mean square, 1-percent level.

[5] Error variance measured as the mean of all interactions with years.

**TABLE 21.**—*Acre value* [1] *of cottonseed as influenced by rate of potash application in four varieties of cotton in 1942 and 1943,* [2] *at Tifton, Ga.*

| Year and variety | Acre value of cottonseed with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| 1942: | *Dollars* | *Dollars* | *Dollars* | *Dollars* |
| Coker 4 in 1–4 | 12.91 | 16.52 | 21.17 | 16.87 |
| Station 21 | 13.43 | 17.89 | 21.14 | 17.49 |
| Station C | 12.24 | 15.18 | 18.79 | 15.40 |
| Station S | 10.19 | 13.72 | 16.80 | 13.57 |
| Mean | 12.19 | 15.83 | 19.48 | 15.83 |
| 1943: | | | | |
| Coker 4 in 1–4 | 13.66 | 16.50 | 19.22 | 16.46 |
| Station 21 | 11.65 | 15.77 | 20.21 | 15.88 |
| Station C | 12.95 | 16.06 | 18.46 | 15.82 |
| Station S | 10.04 | 13.89 | 17.10 | 13.68 |
| Mean | 12.08 | 15.56 | 18.75 | 15.46 |
| 2-year averages: | | | | |
| Coker 4 in 1–4 | 13.28 | 16.51 | 20.20 | 16.67 |
| Station 21 | 12.54 | 16.83 | 20.68 | 16.67 |
| Station C | 12.59 | 15.62 | 18.62 | 15.61 |
| Station S | 10.21 | 13.80 | 16.95 | 13.62 |
| Mean | 12.14 | 15.70 | 19.12 | 15.64 |

[1] Based on the 1944 support price of $56 per ton for basis grade seed.

[2] Refer to Appendix table 24 for variance analysis applicable to these data.

**TABLE 22.**—*Cottonseed capacity*[1] *as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Cottonseed capacity with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942*[2] | | | | |
| Early (bottom crop): | *Grams* | *Grams* | *Grams* | *Grams* |
| Coker 4 in 1-4 | 31.50 | 33.41 | 36.53 | 33.81 |
| Station 21 | 32.96 | 32.52 | 33.25 | 32.91 |
| Station C | 32.30 | 34.98 | 35.04 | 34.11 |
| Station S | 33.45 | 34.40 | 35.08 | 34.31 |
| Mean | 32.55 | 33.83 | 34.97 | 33.78 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 34.00 | 34.05 | 37.08 | 35.33 |
| Station 21 | 32.76 | 38.25 | 38.30 | 36.44 |
| Station C | 33.71 | 36.06 | 37.12 | 35.63 |
| Station S | 34.44 | 37.97 | 37.63 | 36.68 |
| Mean | 33.72 | 36.58 | 37.53 | 35.95 |
| *1943*[3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1-4 | 34.99 | 35.45 | 35.56 | 35.33 |
| Station 21 | 35.08 | 34.77 | 35.35 | 35.07 |
| Station C | 35.56 | 36.60 | 36.93 | 36.38 |
| Station S | 37.31 | 37.04 | 38.19 | 37.51 |
| Mean | 35.75 | 35.96 | 36.51 | 36.07 |
| Late (top crop): | | | | |
| Coker 4 in 1-4 | 34.91 | 35.71 | 36.46 | 35.69 |
| Station 21 | 35.06 | 35.42 | 36.67 | 35.72 |
| Station C | 35.96 | 36.78 | 37.31 | 36.68 |
| Station S | 35.49 | 37.09 | 38.51 | 37.03 |
| Mean | 35.35 | 36.25 | 37.24 | 36.28 |
| Mean for years: | | | | |
| 1942 | 33.14 | 35.20 | 36.25 | 34.87 |
| 1943 | 35.55 | 36.11 | 36.87 | 36.18 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 34.15 | 34.90 | 35.75 | 34.93 |
| Late (top crop) | 34.54 | 36.42 | 37.38 | 36.11 |
| Mean for strains: | | | | |
| Coker 4 in 1-4 | 33.85 | 34.65 | 36.41 | 34.97 |
| Station 21 | 33.97 | 35.24 | 35.89 | 35.03 |
| Station C | 34.39 | 36.10 | 36.60 | 35.70 |
| Station S | 35.17 | 36.62 | 37.35 | 36.38 |
| Averages for treatments | 34.34 | 35.66 | 36.56 | 35.52 |

TABLE 22.—*Cottonseed capacity*[1] *as influenced by rate of potash fertilization in four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Con.

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square[4] | Least significant differences between means at— 5-percent level | 1-percent level |
|---|---|---|---|---|
| Varieties | 3 | *3.2679 | 0.73 | 0.99 |
| Treatments | 2 | **19.8865 | .63 | .86 |
| Varieties×treatments | 6 | .3599 | 1.26 | 1.72 |
| Pickings | 1 | **16.8507 | .51 | .70 |
| Varieties×pickings | 3 | 1.1003 | 1.03 | 1.40 |
| Treatments×pickings | 2 | 1.9054 | .89 | 1.21 |
| Varieties×treatments×pickings | 6 | 1.1256 | 1.78 | 2.43 |
| Years | 1 | **20.6194 | .51 | .70 |
| Treatment×years | 2 | *3.7133 | .89 | 1.21 |
| Pickings×years | 1 | **11.4661 | .73 | .99 |
| Error[5] | 20 | .7278 | | |

[1] The sum of percentage of oil and percentage of protein (5.13 × percentage of $NH_3$) in fuzzy seed, 10-percent moisture content.

[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.

[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.

[4] * = A significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.

[5] Error variance measured as the mean of all interactions with years other than those components found significantly higher than the mean of the remainder.

TABLE 23.—*Percentage of ammonia[1] in seed as influenced by rate of potash fertilization of four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*

EXPERIMENTAL DATA

| Year, picking, and variety | Percentage of ammonia in seed with $K_2O$ applied at the acre rate of— | | | Mean |
|---|---|---|---|---|
| | 20 pounds | 40 pounds | 80 pounds | |
| *1942*[2] | | | | |
| Early (bottom crop): | *Percent* | *Percent* | *Percent* | *Percent* |
| Coker 4 in 1–4 | 3.14 | 3.18 | 2.93 | 3.08 |
| Station 21 | 3.16 | 3.05 | 3.10 | 3.10 |
| Station C | 3.35 | 3.67 | 3.32 | 3.45 |
| Station S | 3.31 | 3.33 | 3.43 | 3.36 |
| Mean | 3.24 | 3.31 | 3.19 | 3.25 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 3.58 | 3.37 | 3.35 | 3.43 |
| Station 21 | 3.37 | 3.91 | 3.78 | 3.69 |
| Station C | 4.01 | 4.03 | 3.95 | 4.00 |
| Stations S | 3.93 | 3.98 | 3.92 | 3.94 |
| Mean | 3.71 | 3.82 | 3.75 | 3.76 |
| *1943*[3] | | | | |
| Early (bottom crop): | | | | |
| Coker 4 in 1–4 | 3.58 | 3.55 | 3.43 | 3.52 |
| Station 21 | 3.55 | 3.50 | 3.40 | 3.48 |
| Station C | 3.84 | 3.86 | 3.88 | 3.86 |
| Station S | 4.12 | 3.88 | 3.97 | 3.99 |
| Mean | 3.77 | 3.70 | 3.67 | 3.71 |
| Late (top crop): | | | | |
| Coker 4 in 1–4 | 3.60 | 3.56 | 3.45 | 3.53 |
| Station 21 | 3.60 | 3.55 | 3.48 | 3.54 |
| Station C | 4.04 | 3.91 | 3.74 | 3.90 |
| Station S | 3.93 | 3.92 | 3.88 | 3.91 |
| Mean | 3.79 | 3.74 | 3.64 | 3.72 |
| Mean for years: | | | | |
| 1942 | 3.48 | 3.56 | 3.47 | 3.50 |
| 1943 | 3.78 | 3.72 | 3.65 | 3.72 |
| Mean for pickings: | | | | |
| Early (bottom crop) | 3.51 | 3.51 | 3.43 | 3.48 |
| Late (top crop) | 3.76 | 3.78 | 3.69 | 3.74 |
| Mean for strains: | | | | |
| Coker 4 in 1–4 | 3.47 | 3.41 | 3.29 | 3.39 |
| Station 21 | 3.42 | 3.50 | 3.44 | 3.45 |
| Station C | 3.81 | 3.87 | 3.72 | 3.80 |
| Station S | 3.82 | 3.78 | 3.80 | 3.80 |
| Averages for treatments | 3.63 | 3.64 | 3.56 | 3.61 |

TABLE 23.—*Percentage of ammonia* [1] *in seed as influenced by rate of potash fertilization of four varieties of cotton picked early (bottom crop) and late (top crop) in 1942 and 1943, at Tifton, Ga.*—Continued

ANALYSIS OF VARIANCE

| Source of variation | Degrees of freedom | Mean square [4] | Least significant differences between means at— | |
|---|---|---|---|---|
| | | | 5-percent level | 1-percent level |
| Varieties | 3 | **0.5736 | 0.10 | 0.14 |
| Treatments | 2 | .0288 | .09 | .12 |
| Varieties × treatments | 6 | .0113 | .17 | .24 |
| Pickings | 1 | **.8294 | .07 | .10 |
| Varieties × pickings | 3 | .0108 | .14 | .20 |
| Treatments × pickings | 2 | .0006 | .12 | .17 |
| Varieties × treatments × pickings | 6 | .0193 | .25 | .33 |
| Years | 1 | **.5354 | .07 | .10 |
| Pickings × years | 1 | **.7779 | .10 | .14 |
| Error [5] | 22 | .0142 | | |

[1] Calculated on the basis of 10-percent moisture in the fuzzy seed.
[2] Observations in 1942 represent determinations on a blend of the 4 replicate samples.
[3] Observations in 1943 represent the mean of determinations on 4 replicate samples.
[4] ** = A highly significant mean square, 1-percent level.
[5] Error variance measured as the mean of all interactions with years.

**TABLE 24.**—*Analyses of variance of cottonseed product measurements for the replicate samples in 1943, Tifton, Ga.*

ANALYSES WITH RESULTS FOR PICKING DATES SEGREGATED

| Source of variation | Degrees of freedom | Mean square[1] for analysis of — | | | | | |
|---|---|---|---|---|---|---|---|
| | | Seed index | Fuzz | Kernels | Oil in seed | Ammonia in seed | Cottonseed grade[2] |
| | | | *Percent* | *Percent* | *Percent* | *Percent* | *Points* |
| Replications | 3 | 0.1983 | 3.711 | **2.8525 | *0.9971 | 0.0024 | *22.52 |
| Varieties | 3 | **25.6036 | **59.1080 | **41.4972 | **2.8266 | **1.2541 | *21.95 |
| Treatments | 2 | **2.1507 | 2.8822 | **17.4035 | **33.5780 | **.1340 | **569.59 |
| Varieties × treatments | 6 | .0579 | 3.0550 | .5527 | .1734 | .0081 | 8.71 |
| Pickings | 1 | **59.4878 | **26.0906 | .3589 | .9680 | .0012 | 18.03 |
| Varieties × pickings | 3 | .2870 | 1.9260 | *1.3157 | .3151 | .0232 | 15.89 |
| Treatments × pickings | 2 | .0499 | 3.5696 | **2.5117 | **3.4464 | .0115 | **44.88 |
| Varieties × treatments × pickings | 6 | .2359 | 2.1293 | .3249 | .1253 | .0240 | 5.01 |
| Error | 69 | .1391 | 1.4922 | .3328 | .3523 | .0142 | 7.20 |
| Total | 95 | | | | | | |

ANALYSES WITH RESULTS FOR PICKING DATES AVERAGED

| Source of variation | Degrees of freedom | Mean square[1] for analysis of — | | |
|---|---|---|---|---|
| | | Acre yield of seed | Cottonseed grade[2] | Acre value of seed[3] |
| | | *Pounds* | | *Dollars* |
| Replications | 3 | **12,982.30 | *11.0514 | **8.5919 |
| Varieties | 3 | **29,941.19 | *11.0858 | **17.9757 |
| Treatments | 2 | **161,160.89 | **284.3715 | **178.1325 |
| Varieties × treatments | 6 | 2,689.90 | 4.2114 | **5.4982 |
| Error | 33 | 2,658.66 | 2.8702 | 1.2286 |
| Total | 47 | | | |

[1] * = A significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.
[2] Cottonseed grade calculated as quantity index with prime quality assumed.
[3] Based on the 1944 support price of $56 per ton for basis grade cottonseed.

TABLE 25.—*Mean squares obtained in the analysis of variance of 10 different measurements of cottonseed production and composition as influenced by ratio of fertilization in limed and unlimed series,[1] Experiment, Ga., 1941–43*

| Source of variation | Degrees of freedom | Mean squares[2] for analysis of — | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cotton-seed yield | Seed index | Fuzz | Kernels | Capacity of kernels | Oil in kernels | Ammonia in kernels | Oil in seed | Ammonia in seed | Cotton-seed grade |
| | | *Pounds* | | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Points* |
| Treatments | 21 | **151,178 | **3.3099 | **3.1850 | *4.7595 | 5.3312 | **91.2218 | **3.0837 | **26.6560 | **0.6055 | **199.09 |
| Components of blocks[1] | 5 | | | | | | | | | | |
| Years | 2 | **251,392 | **17.7707 | **98.3372 | **36.2365 | **103,7574 | *13.5239 | **6.8823 | .1326 | **2.9917 | 142.75 |
| Series (limed vs. unlimed) | 1 | **648,482 | .0001 | **13.7676 | 8.7009 | .2902 | .1909 | .0300 | .5668 | .1176 | 32.20 |
| Series within years | 2 | 25,199 | .0990 | 3.8072 | .5203 | 1.8731 | 1.6331 | .0136 | .7258 | .0009 | 22.77 |
| Error (blocks × treatments) | 105 | 27,705 | .4766 | .9824 | 2.4139 | 3.8703 | 3.7229 | .1562 | 1.0550 | .0487 | 50.19 |

[1] Each series within each year was in a separate tier of plots so that there were 6 tiers of plots or blocks. The 5 degrees of freedom for comparison of years, series, and years × series are thus fully confounded with block location. These 5 degrees of freedom are removed from error term for testing treatments, but any significance among these effects is due in part to location, and the residual influence of years or series is not separable.

[2] * = Significant mean square, 5-percent level; ** = a highly significant mean square, 1-percent level.

TABLE 26.—*Yield of cottonseed*[1] *per acre as influenced by varying the ratio of fertilization, with and without lime, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Acre yield of cottonseed by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Pounds* |
| 1 | 0 | 15 | 0 | 152 | 194 | 225 | 152 | 175 | 201 | 183 |
| 2 | 0 | 12 | 3 | 517 | 552 | 459 | 550 | 601 | 459 | 523 |
| 3 | 3 | 12 | 0 | 388 | 375 | 335 | 310 | 149 | 162 | 286 |
| 4 | 0 | 9 | 6 | 560 | 553 | 529 | 608 | 618 | 712 | 597 |
| 5 | 3 | 9 | 3 | 679 | 741 | 571 | 553 | 395 | 307 | 541 |
| 6 | 6 | 9 | 0 | 529 | 573 | 207 | 219 | 155 | 152 | 306 |
| 7 | 0 | 6 | 9 | 497 | 576 | 341 | 489 | 563 | 861 | 554 |
| 8 | 3 | 6 | 6 | 615 | 656 | 389 | 556 | 686 | 996 | 650 |
| 9 | 6 | 6 | 3 | 527 | 456 | 429 | 611 | 922 | 1,132 | 680 |
| 10 | 9 | 6 | 0 | 285 | 391 | 270 | 415 | 777 | 651 | 465 |
| 11 | 0 | 3 | 12 | 362 | 415 | 326 | 447 | 1,038 | 1,103 | 615 |
| 12 | 3 | 3 | 9 | 391 | 417 | 779 | 830 | 595 | 669 | 613 |
| 13 | 6 | 3 | 6 | 275 | 385 | 462 | 699 | 618 | 734 | 529 |
| 14 | 9 | 3 | 3 | 191 | 265 | 447 | 703 | 378 | 573 | 426 |
| 15 | 12 | 3 | 0 | 249 | 304 | 192 | 413 | 233 | 372 | 294 |
| 16 | 0 | 0 | 15 | 62 | 72 | 112 | 317 | 268 | 350 | 197 |
| 17 | 3 | 0 | 12 | 172 | 378 | 118 | 438 | 146 | 495 | 291 |
| 18 | 6 | 0 | 9 | 291 | 456 | 49 | 484 | 178 | 696 | 359 |
| 19 | 9 | 0 | 6 | 252 | 515 | 33 | 486 | 94 | 741 | 353 |
| 20 | 12 | 0 | 3 | 252 | 530 | 15 | 304 | 317 | 952 | 395 |
| 21 | 15 | 0 | 0 | 204 | 453 | 9 | 346 | 307 | 453 | 295 |
| 22[3] | 0 | 0 | 0 | 131 | 193 | 97 | 196 | 221 | 314 | 192 |
| Mean | | | | 345 | 430 | 291 | 460 | 429 | 595 | 425 |

[1] Calculated from yields of seed cotton using an assumed 35-percent lint.

[2] A difference of 19.1 pounds of cotton between treatment means is significant, 5-percent level; a difference of 25 pounds of cotton between treatment means is highly significant, 1-percent level.

[3] Average of 3 check plots in each series each year.

TABLE 27.—*Fuzz [1] on cottonseed as affected by varying the ratio of fertilization in limed and unlimed series, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Percentage of fuzz on seed by series within years— | | | | | | Mean [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 10.87 | 11.82 | 11.32 | 11.43 | 8.78 | 8.41 | 10.44 |
| 2 | 0 | 12 | 3 | 10.90 | 11.79 | 11.59 | 11.50 | 9.97 | 9.65 | 10.90 |
| 3 | 3 | 12 | 0 | 11.83 | 11.03 | 10.65 | 11.44 | 9.00 | 9.25 | 10.53 |
| 4 | 0 | 9 | 6 | 12.10 | 11.17 | 11.57 | 11.60 | 10.85 | 9.77 | 11.18 |
| 5 | 3 | 9 | 3 | 11.56 | 10.85 | 11.87 | 11.61 | 10.49 | 9.23 | 10.94 |
| 6 | 6 | 9 | 0 | 12.35 | 13.61 | 14.59 | 10.40 | 10.44 | 8.70 | 11.68 |
| 7 | 0 | 6 | 9 | 11.05 | 10.54 | 15.08 | 15.23 | 11.08 | 10.39 | 12.23 |
| 8 | 3 | 6 | 6 | 10.77 | 10.19 | 12.19 | 12.59 | 10.83 | 9.85 | 11.07 |
| 9 | 6 | 6 | 3 | 10.64 | 9.77 | 11.42 | 11.80 | 9.31 | 9.59 | 10.42 |
| 10 | 9 | 6 | 0 | 11.41 | 10.67 | 11.18 | 10.49 | 10.13 | 9.14 | 10.50 |
| 11 | 0 | 3 | 12 | 11.31 | 10.67 | 12.94 | 12.97 | 10.31 | 8.42 | 11.10 |
| 12 | 3 | 3 | 9 | 12.30 | 12.14 | 12.30 | 11.48 | 10.93 | 9.24 | 11.40 |
| 13 | 6 | 3 | 6 | 13.24 | 11.87 | 13.06 | 11.59 | 10.97 | 10.31 | 11.84 |
| 14 | 9 | 3 | 3 | 11.96 | 11.71 | 13.13 | 12.03 | 11.14 | 6.90 | 11.15 |
| 15 | 12 | 3 | 0 | 12.03 | 10.71 | 13.34 | 13.01 | 9.98 | 8.78 | 11.31 |
| 16 | 0 | 0 | 15 | 11.82 | 13.17 | 14.73 | 13.23 | 11.39 | 9.77 | 12.35 |
| 17 | 3 | 0 | 12 | 12.45 | 11.52 | 14.57 | 12.40 | 12.41 | 10.64 | 12.33 |
| 18 | 6 | 0 | 9 | 12.75 | 11.58 | 14.60 | 15.76 | 11.57 | 10.91 | 12.86 |
| 19 | 9 | 0 | 6 | 11.34 | 11.39 | 16.05 | 18.09 | 11.03 | 8.70 | 12.77 |
| 20 | 12 | 0 | 3 | 11.77 | 12.07 | 14.56 | 12.79 | 9.35 | 8.00 | 11.42 |
| 21 | 15 | 0 | 0 | 11.35 | 11.00 | 13.01 | 12.45 | 10.04 | 8.02 | 10.97 |
| 22 [3] | 0 | 0 | 0 | 11.75 | 12.22 | 12.92 | 13.08 | 9.78 | 9.24 | 11.50 |
| Mean | | | | 11.71 | 11.43 | 13.03 | 12.59 | 10.44 | 9.22 | 11.40 |

[1] At 10-percent moisture content of the seed.

[2] A difference of 1.17 percent between treatment means is significant, 5-percent level; a difference of 1.55 percent between treatment means is highly significant, 1-percent level.

[3] Average of 3 plots in 1942 and 1943; of 2 plots in 1941.

TABLE 28.—*Percentage of kernels in cottonseed as influenced by varying the ratio of fertilization, with and without lime, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Percentage of kernels in seed by series within years— | | | | | | Mean[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 43.77 | 47.05 | 48.44 | 46.90 | 48.83 | 51.15 | 47.69 |
| 2 | 0 | 12 | 3 | 50.52 | 50.12 | 49.16 | 49.74 | 51.64 | 51.50 | 50.45 |
| 3 | 3 | 12 | 0 | 46.60 | 48.50 | 49.65 | 48.75 | 48.56 | 49.06 | 48.52 |
| 4 | 0 | 9 | 6 | 51.00 | 50.78 | 50.85 | 50.80 | 51.30 | 51.58 | 51.05 |
| 5 | 3 | 9 | 3 | 50.70 | 51.53 | 48.78 | 49.70 | 51.68 | 50.82 | 50.53 |
| 6 | 6 | 9 | 0 | 50.75 | 50.18 | 48.02 | 49.47 | 46.82 | 47.50 | 48.79 |
| 7 | 0 | 6 | 9 | 51.18 | 51.42 | 48.90 | 48.64 | 49.69 | 51.12 | 50.16 |
| 8 | 3 | 6 | 6 | 52.75 | 52.18 | 48.50 | 49.58 | 51.26 | 51.90 | 51.03 |
| 9 | 6 | 6 | 3 | 51.90 | 52.08 | 50.45 | 50.46 | 51.90 | 52.08 | 51.48 |
| 10 | 9 | 6 | 0 | 46.75 | 49.02 | 49.60 | 50.00 | 52.89 | 51.65 | 49.98 |
| 11 | 0 | 3 | 12 | 51.47 | 51.20 | 49.22 | 48.60 | 51.42 | 51.25 | 50.53 |
| 12 | 3 | 3 | 9 | 49.94 | 49.78 | 49.83 | 50.38 | 51.06 | 50.90 | 50.31 |
| 13 | 6 | 3 | 6 | 50.03 | 50.72 | 48.60 | 49.24 | 51.30 | 50.95 | 50.14 |
| 14 | 9 | 3 | 3 | 50.20 | 49.79 | 49.13 | 50.64 | 50.01 | 50.54 | 50.05 |
| 15 | 12 | 3 | 0 | 50.92 | 51.15 | 49.70 | 49.87 | 49.20 | 48.88 | 49.95 |
| 16 | 0 | 0 | 15 | 47.85 | 49.95 | 47.87 | 48.43 | 50.38 | 50.06 | 49.09 |
| 17 | 3 | 0 | 12 | 49.67 | 51.38 | 47.87 | 49.16 | 49.15 | 50.00 | 49.54 |
| 18 | 6 | 0 | 9 | 50.46 | 51.32 | 47.72 | 47.84 | 49.66 | 49.10 | 49.35 |
| 19 | 9 | 0 | 6 | 50.38 | 51.55 | 45.23 | 48.75 | 49.75 | 51.70 | 49.56 |
| 20 | 12 | 0 | 3 | 51.55 | 50.78 | 47.34 | 48.96 | 52.25 | 52.20 | 50.51 |
| 21 | 15 | 0 | 0 | 50.95 | 52.31 | 46.63 | 48.86 | 50.54 | 50.55 | 49.97 |
| 22[2] | 0 | 0 | 0 | 49.10 | 50.06 | 46.84 | 47.26 | 50.59 | 51.16 | 49.17 |
| Mean | | | | 49.93 | 50.58 | 48.56 | 49.18 | 50.45 | 50.71 | 49.90 |

[1] A difference of 1.78 percent between treatment means is significant, 5-percent level; a difference of 2.36 percent between treatment means is highly significant, 1-percent level.

[2] Average of 3 checks in 1942 and 1943; of 2 checks in 1941.

TABLE 29.—*Oil content [1] of kernels as affected by varying the ratio of fertilization, in limed and unlimed series, and by years, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Oil content of kernels by series within years— | | | | | | Mean [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 27.10 | 29.60 | 28.03 | 28.29 | 29.94 | 21.22 | 29.03 |
| 2 | 0 | 12 | 3 | 36.67 | 34.31 | 35.27 | 34.82 | 36.75 | 34.70 | 35.42 |
| 3 | 3 | 12 | 0 | 28.67 | 31.28 | 31.44 | 28.37 | 26.85 | 27.54 | 29.02 |
| 4 | 0 | 9 | 6 | 37.27 | 42.04 | 38.01 | 38.11 | 38.30 | 36.58 | 38.38 |
| 5 | 3 | 9 | 3 | 35.96 | 35.72 | 37.57 | 34.65 | 32.43 | 30.24 | 34.43 |
| 6 | 6 | 9 | 0 | 28.16 | 30.83 | 33.82 | 26.31 | 26.59 | 24.46 | 28.36 |
| 7 | 0 | 6 | 9 | 37.75 | 38.10 | 40.76 | 42.43 | 42.92 | 39.92 | 40.31 |
| 8 | 3 | 6 | 6 | 36.77 | 37.15 | 41.59 | 41.12 | 39.02 | 37.63 | 38.88 |
| 9 | 6 | 6 | 3 | 34.99 | 35.02 | 38.37 | 38.62 | 37.16 | 35.71 | 36.64 |
| 10 | 9 | 6 | 0 | 35.32 | 31.88 | 31.69 | 31.08 | 30.21 | 32.85 | 32.17 |
| 11 | 0 | 3 | 12 | 43.01 | 40.37 | 42.46 | 43.76 | 38.58 | 40.08 | 41.38 |
| 12 | 3 | 3 | 9 | 39.01 | 39.55 | 38.97 | 38.68 | 42.03 | 38.74 | 39.50 |
| 13 | 6 | 3 | 6 | 35.28 | 36.77 | 39.92 | 39.62 | 37.13 | 37.70 | 37.74 |
| 14 | 9 | 3 | 3 | 34.50 | 35.51 | 35.99 | 36.10 | 34.25 | 33.60 | 34.99 |
| 15 | 12 | 3 | 0 | 33.27 | 34.23 | 30.48 | 28.97 | 30.26 | 29.75 | 31.16 |
| 16 | 0 | 0 | 15 | 38.83 | 37.74 | 41.65 | 41.54 | 42.10 | 41.21 | 40.51 |
| 17 | 3 | 0 | 12 | 37.06 | 37.11 | 40.88 | 42.25 | 35.81 | 39.90 | 39.33 |
| 18 | 6 | 0 | 9 | 35.67 | 33.65 | 35.85 | 39.67 | 36.55 | 39.04 | 36.74 |
| 19 | 9 | 0 | 6 | 35.39 | 34.78 | 33.72 | 38.32 | 36.46 | 37.21 | 35.98 |
| 20 | 12 | 0 | 3 | 33.69 | 34.32 | 35.63 | 38.11 | 35.39 | 35.17 | 35.38 |
| 21 | 15 | 0 | 0 | 33.62 | 34.03 | 35.04 | 33.19 | 31.97 | 31.02 | 33.14 |
| 22 [3] | 0 | 0 | 0 | 33.34 | 35.22 | 30.67 | 29.28 | 34.17 | 35.22 | 32.98 |
| Mean | | | | 35.06 | 35.42 | 36.26 | 36.06 | 35.36 | 34.98 | 35.52 |

[1] Calculated on an assumed constant 0.5-percent oil content in hulls.

[2] A difference of 2.21 percent of oil between treatment means is significant, 5-percent level; a difference of 2.93 percent of oil between treatment means is highly significant, 1-percent level.

[3] Average of 3 check plots in 1942 and 1943; of 2 plots in 1941.

TABLE 30.—*Ammonia content of kernels*[1] *as influenced by varying the ratio of fertilization in limed and unlimed series, and by years, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Ammonia content of kernels by series within years— | | | | | | Mean [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 8.48 | 7.69 | 8.08 | 8.48 | 8.29 | 7.96 | 8.16 |
| 2 | 0 | 12 | 3 | 6.89 | 6.88 | 6.43 | 6.67 | 7.44 | 7.57 | 6.98 |
| 3 | 3 | 12 | 0 | 7.96 | 8.27 | 7.73 | 7.86 | 8.28 | 8.13 | 8.04 |
| 4 | 0 | 9 | 6 | 6.47 | 5.77 | 5.92 | 6.32 | 7.13 | 7.21 | 6.47 |
| 5 | 3 | 9 | 3 | 6.84 | 7.06 | 6.37 | 6.68 | 7.82 | 8.30 | 7.18 |
| 6 | 6 | 9 | 0 | 7.31 | 7.99 | 7.62 | 8.00 | 8.56 | 8.86 | 8.06 |
| 7 | 0 | 6 | 9 | 6.25 | 6.82 | 6.22 | 5.53 | 6.10 | 6.63 | 6.42 |
| 8 | 3 | 6 | 6 | 6.50 | 6.57 | 5.57 | 5.81 | 6.89 | 7.26 | 6.43 |
| 9 | 6 | 6 | 3 | 7.17 | 7.24 | 6.13 | 6.58 | 7.63 | 7.87 | 7.10 |
| 10 | 9 | 6 | 0 | 8.92 | 7.55 | 7.40 | 7.72 | 7.79 | 7.78 | 7.86 |
| 11 | 0 | 3 | 12 | 5.46 | 6.09 | 5.22 | 5.21 | 6.81 | 6.67 | 5.91 |
| 12 | 3 | 3 | 9 | 6.13 | 6.44 | 6.08 | 5.78 | 6.76 | 6.70 | 6.31 |
| 13 | 6 | 3 | 6 | 6.64 | 6.90 | 5.97 | 5.91 | 6.94 | 7.06 | 6.57 |
| 14 | 9 | 3 | 3 | 7.09 | 7.47 | 6.96 | 6.87 | 6.72 | 7.18 | 7.05 |
| 15 | 12 | 3 | 0 | 7.30 | 7.49 | 7.36 | 7.44 | 7.99 | 8.12 | 7.62 |
| 16 | 0 | 0 | 15 | 6.56 | 6.37 | 5.38 | 5.24 | 5.04 | 5.44 | 5.67 |
| 17 | 3 | 0 | 12 | 6.50 | 6.34 | 5.18 | 5.43 | 6.73 | 6.18 | 6.06 |
| 18 | 6 | 0 | 9 | 6.74 | 6.49 | 6.60 | 5.94 | 7.25 | 7.11 | 6.69 |
| 19 | 9 | 0 | 6 | 6.85 | 7.12 | 6.90 | 6.15 | 7.84 | 7.27 | 7.02 |
| 20 | 12 | 0 | 3 | 7.21 | 7.29 | 6.72 | 6.35 | 7.64 | 7.85 | 7.17 |
| 21 | 15 | 0 | 0 | 7.18 | 7.21 | 7.21 | 7.41 | 7.93 | 8.15 | 7.51 |
| 22 [3] | 0 | 0 | 0 | 7.21 | 7.17 | 7.39 | 6.91 | 7.47 | 7.33 | 7.25 |
| Mean | | | | 6.98 | 7.01 | 6.57 | 6.56 | 7.32 | 7.39 | 6.98 |

[1] Calculated on the basis of an assumed 0.5-percent $NH_3$ content of cottonseed hulls.

[2] A difference of 0.45 percent $NH_3$ between treatment means is significant, 5-percent level; a difference of 0.60 percent $NH_3$ between treatment means is highly significant, 1-percent level.

[3] Average of 3 plots in 1942 and 1943; of 2 plots in 1941.

**TABLE 31.**—*Oil content of cottonseed[1] as affected by varying the ratio of fertilization, limed and unlimed, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Oil content of seed by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 12.14 | 14.19 | 13.84 | 13.54 | 14.88 | 16.22 | 14.13 |
| 2 | 0 | 12 | 3 | 18.77 | 17.45 | 17.59 | 17.58 | 19.22 | 18.12 | 18.12 |
| 3 | 3 | 12 | 0 | 13.62 | 15.43 | 15.86 | 14.09 | 13.28 | 13.76 | 14.34 |
| 4 | 0 | 9 | 6 | 19.27 | 21.60 | 19.58 | 19.61 | 19.89 | 19.11 | 19.84 |
| 5 | 3 | 9 | 3 | 18.48 | 18.65 | 18.59 | 17.47 | 17.00 | 15.62 | 17.63 |
| 6 | 6 | 9 | 0 | 14.54 | 15.71 | 16.50 | 13.27 | 12.72 | 11.88 | 14.10 |
| 7 | 0 | 6 | 9 | 19.66 | 19.83 | 20.19 | 20.90 | 21.58 | 20.65 | 20.47 |
| 8 | 3 | 6 | 6 | 19.56 | 19.63 | 20.43 | 20.64 | 20.24 | 19.78 | 20.05 |
| 9 | 6 | 6 | 3 | 18.40 | 18.48 | 19.61 | 19.74 | 19.53 | 18.84 | 19.27 |
| 10 | 9 | 6 | 0 | 16.77 | 15.89 | 15.97 | 15.79 | 16.22 | 17.21 | 16.31 |
| 11 | 0 | 3 | 12 | 22.38 | 20.91 | 21.15 | 21.53 | 20.08 | 20.78 | 21.14 |
| 12 | 3 | 3 | 9 | 19.73 | 19.94 | 19.67 | 19.74 | 21.71 | 19.97 | 20.13 |
| 13 | 6 | 3 | 6 | 17.90 | 18.90 | 19.66 | 19.76 | 19.29 | 19.46 | 19.16 |
| 14 | 9 | 3 | 3 | 17.57 | 17.93 | 17.93 | 18.53 | 17.38 | 16.73 | 17.68 |
| 15 | 12 | 3 | 0 | 17.19 | 17.76 | 15.40 | 14.70 | 15.14 | 14.80 | 15.83 |
| 16 | 0 | 0 | 15 | 18.84 | 19.10 | 20.20 | 20.38 | 21.46 | 20.88 | 20.14 |
| 17 | 3 | 0 | 12 | 18.66 | 19.32 | 19.83 | 21.02 | 19.33 | 20.20 | 19.73 |
| 18 | 6 | 0 | 9 | 18.25 | 17.52 | 17.37 | 19.25 | 18.40 | 19.42 | 18.37 |
| 19 | 9 | 0 | 6 | 18.08 | 18.17 | 15.52 | 18.94 | 18.39 | 19.48 | 18.10 |
| 20 | 12 | 0 | 3 | 17.61 | 17.68 | 17.13 | 18.92 | 18.73 | 18.60 | 18.11 |
| 21 | 15 | 0 | 0 | 17.38 | 18.04 | 16.61 | 16.54 | 16.41 | 15.93 | 16.82 |
| 22[3] | 0 | 0 | 0 | 16.62 | 17.88 | 14.64 | 14.10 | 17.54 | 18.27 | 16.51 |
| Mean | | | | 17.79 | 18.18 | 17.88 | 18.00 | 18.11 | 17.99 | 17.99 |

[1] Fuzzy seed at 10-percent moisture content.

[2] A difference of 1.18 percent between treatment means is significant, 5-percent level; a difference of 1.56 percent between treatment means is highly significant, 1-percent level.

[3] Average of 3 checks in 1942 and 1943; of 2 check plots in 1941.

TABLE 32.—*Ammonia content of cottonseed*[1] *as affected by varying the ratio of fertilization, limed and unlimed, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Ammonia content of seed by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 3.99 | 3.86 | 4.17 | 4.25 | 4.31 | 4.31 | 4.15 |
| 2 | 0 | 12 | 3 | 3.73 | 3.70 | 3.41 | 3.57 | 4.09 | 4.15 | 3.77 |
| 3 | 3 | 12 | 0 | 3.96 | 4.25 | 4.09 | 4.09 | 4.28 | 4.24 | 4.15 |
| 4 | 0 | 9 | 6 | 3.55 | 3.18 | 3.26 | 3.46 | 3.91 | 3.96 | 3.55 |
| 5 | 3 | 9 | 3 | 3.72 | 3.88 | 3.37 | 3.57 | 4.28 | 4.47 | 3.88 |
| 6 | 6 | 9 | 0 | 3.96 | 4.26 | 3.92 | 4.11 | 4.28 | 4.47 | 4.17 |
| 7 | 0 | 6 | 9 | 3.44 | 3.75 | 2.87 | 2.95 | 3.28 | 3.64 | 3.32 |
| 8 | 3 | 6 | 6 | 3.67 | 3.67 | 2.95 | 3.13 | 3.77 | 4.01 | 3.53 |
| 9 | 6 | 6 | 3 | 3.96 | 4.01 | 3.34 | 3.57 | 4.20 | 4.34 | 3.90 |
| 10 | 9 | 6 | 0 | 4.43 | 3.96 | 3.92 | 4.11 | 4.36 | 4.26 | 4.17 |
| 11 | 0 | 3 | 12 | 3.05 | 3.37 | 2.82 | 2.79 | 3.74 | 3.66 | 3.24 |
| 12 | 3 | 3 | 9 | 3.31 | 3.46 | 3.28 | 3.16 | 3.69 | 3.66 | 3.42 |
| 13 | 6 | 3 | 6 | 3.57 | 3.75 | 3.16 | 3.16 | 3.80 | 3.85 | 3.55 |
| 14 | 9 | 3 | 3 | 3.81 | 3.97 | 3.67 | 3.73 | 3.61 | 3.88 | 3.78 |
| 15 | 12 | 3 | 0 | 3.96 | 4.07 | 3.91 | 3.96 | 4.18 | 4.23 | 4.05 |
| 16 | 0 | 0 | 15 | 3.40 | 3.43 | 2.82 | 2.79 | 2.79 | 2.97 | 3.03 |
| 17 | 3 | 0 | 12 | 3.48 | 3.51 | 2.74 | 2.92 | 3.56 | 3.34 | 3.26 |
| 18 | 6 | 0 | 9 | 3.65 | 3.75 | 3.41 | 3.10 | 3.85 | 3.74 | 3.58 |
| 19 | 9 | 0 | 6 | 3.70 | 3.91 | 3.39 | 3.26 | 4.15 | 4.01 | 3.74 |
| 20 | 12 | 0 | 3 | 3.96 | 3.95 | 3.44 | 3.37 | 4.23 | 4.34 | 3.88 |
| 21 | 15 | 0 | 0 | 3.91 | 4.01 | 3.63 | 3.88 | 4.26 | 4.37 | 4.01 |
| 22[3] | 0 | 0 | 0 | 3.79 | 3.84 | 3.73 | 3.53 | 4.03 | 3.99 | 3.82 |
| Mean | | | | 3.73 | 3.80 | 3.42 | 3.48 | 3.94 | 3.99 | 3.73 |

[1] Fuzzy seed at 10-percent moisture content.

[2] A difference of 0.25 percent between treatment means is significant, 5-percent level; a difference of 0.33 percent between treatment means is highly significant, 1-percent level.

[3] Average of 3 checks in 1942 and 1943; of 2 checks in 1941.

TABLE 33.—*Kernel capacity*[1] *for accumulation of oil and protein as influenced by the ratio of fertilization in limed and unlimed series, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Kernel capacity by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 70.60 | 69.05 | 69.48 | 71.49 | 72.47 | 72.05 | 70.91 |
| 2 | 0 | 12 | 3 | 72.01 | 69.60 | 68.26 | 69.03 | 74.91 | 73.53 | 71.22 |
| 3 | 3 | 12 | 0 | 69.50 | 73.71 | 71.09 | 68.69 | 69.33 | 69.24 | 70.26 |
| 4 | 0 | 9 | 6 | 70.46 | 71.64 | 68.38 | 70.53 | 74.88 | 73.57 | 71.58 |
| 5 | 3 | 9 | 3 | 71.05 | 71.93 | 70.23 | 68.91 | 72.55 | 72.81 | 71.25 |
| 6 | 6 | 9 | 0 | 65.66 | 71.81 | 72.91 | 67.35 | 70.50 | 69.91 | 69.69 |
| 7 | 0 | 6 | 9 | 69.81 | 73.08 | 72.67 | 71.80 | 74.21 | 73.93 | 72.58 |
| 8 | 3 | 6 | 6 | 70.11 | 70.85 | 70.16 | 70.92 | 74.36 | 74.87 | 71.88 |
| 9 | 6 | 6 | 3 | 71.77 | 72.16 | 69.81 | 72.37 | 76.30 | 76.08 | 75.08 |
| 10 | 9 | 6 | 0 | 81.07 | 70.61 | 69.65 | 70.68 | 70.47 | 72.81 | 72.50 |
| 11 | 0 | 3 | 12 | 71.01 | 71.61 | 69.24 | 70.49 | 73.51 | 74.29 | 71.69 |
| 12 | 3 | 3 | 9 | 70.46 | 72.58 | 70.16 | 68.33 | 76.70 | 73.11 | 71.89 |
| 13 | 6 | 3 | 6 | 69.34 | 72.17 | 70.54 | 69.94 | 72.73 | 73.92 | 71.44 |
| 14 | 9 | 3 | 3 | 70.87 | 73.83 | 71.69 | 71.34 | 68.72 | 70.43 | 71.15 |
| 15 | 12 | 3 | 0 | 70.72 | 72.65 | 68.23 | 67.13 | 71.25 | 71.40 | 70.23 |
| 16 | 0 | 0 | 15 | 72.50 | 70.42 | 69.24 | 68.42 | 67.95 | 69.11 | 69.61 |
| 17 | 3 | 0 | 12 | 70.40 | 69.63 | 67.45 | 70.10 | 73.33 | 71.60 | 70.42 |
| 18 | 6 | 0 | 9 | 70.24 | 66.94 | 69.71 | 70.14 | 73.74 | 75.50 | 71.04 |
| 19 | 9 | 0 | 6 | 70.53 | 71.30 | 69.12 | 69.87 | 76.67 | 74.50 | 72.00 |
| 20 | 12 | 0 | 3 | 70.68 | 71.71 | 70.10 | 70.68 | 74.58 | 75.44 | 72.20 |
| 21 | 15 | 0 | 0 | 70.45 | 71.02 | 72.03 | 71.20 | 72.65 | 72.83 | 71.70 |
| 22[3] | 0 | 0 | 0 | 70.33 | 72.00 | 68.58 | 64.73 | 72.49 | 72.82 | 70.16 |
| Mean | | | | 70.89 | 71.38 | 69.94 | 69.75 | 72.91 | 72.90 | 71.29 |

[1] Equal to the sum of percentage of oil and percentage of protein (5.13 × percent $NH_3$) in the kernels.

[2] A difference of 2.34 percent between treatment means is significant, 5-percent level; a difference of 3.10 percent between treatment means is highly significant, 1-percent level.

[3] Average of 3 plots in 1942 and 1943; of 2 plots in 1941.

**TABLE 34.**—*Cottonseed capacity[1] for production of oil and protein as influenced by varying the ratio of fertilization, by treatment with and without lime, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Cottonseed capacity by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 15 | 0 | 32.61 | 33.98 | 35.23 | 35.34 | 36.99 | 38.33 | 35.41 |
| 2 | 0 | 12 | 3 | 37.90 | 36.43 | 35.08 | 35.89 | 40.20 | 39.41 | 37.48 |
| 3 | 3 | 12 | 0 | 33.93 | 37.23 | 36.84 | 35.07 | 35.23 | 35.51 | 35.63 |
| 4 | 0 | 9 | 6 | 37.48 | 37.91 | 36.30 | 37.36 | 39.94 | 39.42 | 38.07 |
| 5 | 3 | 9 | 3 | 37.56 | 38.55 | 35.88 | 35.78 | 38.95 | 38.55 | 37.54 |
| 6 | 6 | 9 | 0 | 34.85 | 37.56 | 36.61 | 34.35 | 34.66 | 34.81 | 35.49 |
| 7 | 0 | 6 | 9 | 37.31 | 39.06 | 34.91 | 36.03 | 38.41 | 39.32 | 37.51 |
| 8 | 3 | 6 | 6 | 38.38 | 38.46 | 35.56 | 36.70 | 39.58 | 40.35 | 38.17 |
| 9 | 6 | 6 | 3 | 38.71 | 39.05 | 36.74 | 38.05 | 41.08 | 41.10 | 39.12 |
| 10 | 9 | 6 | 0 | 39.50 | 36.20 | 36.08 | 36.87 | 38.59 | 39.06 | 37.72 |
| 11 | 0 | 3 | 12 | 38.03 | 38.20 | 35.62 | 35.84 | 39.27 | 39.56 | 37.75 |
| 12 | 3 | 3 | 9 | 36.71 | 37.69 | 36.50 | 35.95 | 40.64 | 38.74 | 37.70 |
| 13 | 6 | 3 | 6 | 36.21 | 38.14 | 35.87 | 35.97 | 38.78 | 39.21 | 37.36 |
| 14 | 9 | 3 | 3 | 37.11 | 38.30 | 36.76 | 37.66 | 35.90 | 36.63 | 37.06 |
| 15 | 12 | 3 | 0 | 37.50 | 38.64 | 35.46 | 35.01 | 36.58 | 36.50 | 36.61 |
| 16 | 0 | 0 | 15 | 36.28 | 36.69 | 34.67 | 34.69 | 35.77 | 36.12 | 35.70 |
| 17 | 3 | 0 | 12 | 36.51 | 37.33 | 33.88 | 36.00 | 37.59 | 37.33 | 36.44 |
| 18 | 6 | 0 | 9 | 36.97 | 36.76 | 34.84 | 35.15 | 38.15 | 38.61 | 36.75 |
| 19 | 9 | 0 | 6 | 37.06 | 38.23 | 32.91 | 35.66 | 39.68 | 40.05 | 37.26 |
| 20 | 12 | 0 | 3 | 37.92 | 37.94 | 34.78 | 36.21 | 40.43 | 40.86 | 38.02 |
| 21 | 15 | 0 | 0 | 37.44 | 38.61 | 35.23 | 36.44 | 38.26 | 38.35 | 37.39 |
| 22[3] | 0 | 0 | 0 | 36.06 | 37.58 | 33.77 | 32.21 | 38.21 | 38.74 | 36.09 |
| Mean | ---------- | ---------- | ---------- | 36.91 | 37.66 | 35.43 | 35.83 | 38.31 | 38.48 | 37.10 |

[1] Capacity is determined as the sum of the percentage of oil and the percentage of protein (5.73 × percent $NH_3$) in the fuzzy cottonseed at 10-percent moisture content.

[2] A difference of 0.91 between treatment means is significant, 5-percent level; a difference of 1.20 between treatment means is highly significant, 1-percent level.

[3] Average of 3 checks in 1942 and 1943; of 2 checks in 1941.

TABLE 35.—*Cottonseed grade[1] as influenced by varying the ratio of fertilization, with and without lime, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Cottonseed grade by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Points* | *Points* | *Points* | *Points* | *Points* | *Points* | *Points* |
| 1 | 0 | 15 | 0 | 72.6 | 82.1 | 82.2 | 81.2 | 88.3 | 95.0 | 83.5 |
| 2 | 0 | 12 | 3 | 102.5 | 97.0 | 95.8 | 96.7 | 106.4 | 102.4 | 100.1 |
| 3 | 3 | 12 | 0 | 79.9 | 90.6 | 91.8 | 83.0 | 80.1 | 82.5 | 84.6 |
| 4 | 0 | 9 | 6 | 103.4 | 110.5 | 102.9 | 104.2 | 108.2 | 105.2 | 105.7 |
| 5 | 3 | 9 | 3 | 101.2 | 102.9 | 99.6 | 96.3 | 98.7 | 92.9 | 98.6 |
| 6 | 6 | 9 | 0 | 84.5 | 92.1 | 94.0 | 79.0 | 77.3 | 74.2 | 81.8 |
| 7 | 0 | 6 | 9 | 104.3 | 106.8 | 103.0 | 106.3 | 111.0 | 109.4 | 106.8 |
| 8 | 3 | 6 | 6 | 105.9 | 105.5 | 104.4 | 106.3 | 108.6 | 108.2 | 106.5 |
| 9 | 6 | 6 | 3 | 102.4 | 103.0 | 103.5 | 105.4 | 108.3 | 106.4 | 104.8 |
| 10 | 9 | 6 | 0 | 89.4 | 91.2 | 91.4 | 91.6 | 95.3 | 99.4 | 93.1 |
| 11 | 0 | 3 | 12 | 112.8 | 108.9 | 106.5 | 107.9 | 107.8 | 110.1 | 109.0 |
| 12 | 3 | 3 | 9 | 103.8 | 105.5 | 103.4 | 102.9 | 114.0 | 106.8 | 106.1 |
| 13 | 6 | 3 | 6 | 98.0 | 103.0 | 102.6 | 103.0 | 105.0 | 105.9 | 102.9 |
| 14 | 9 | 3 | 3 | 98.1 | 100.5 | 98.7 | 101.5 | 96.2 | 94.9 | 98.3 |
| 15 | 12 | 3 | 0 | 97.5 | 100.5 | 88.5 | 85.3 | 88.8 | 87.4 | 91.3 |
| 16 | 0 | 0 | 15 | 100.7 | 101.9 | 102.7 | 103.3 | 107.6 | 106.3 | 103.7 |
| 17 | 3 | 0 | 12 | 100.5 | 103.3 | 100.8 | 106.6 | 103.7 | 105.8 | 103.4 |
| 18 | 6 | 0 | 9 | 99.9 | 97.8 | 94.9 | 100.6 | 101.7 | 105.1 | 100.0 |
| 19 | 9 | 0 | 6 | 99.5 | 101.1 | 85.9 | 100.3 | 103.5 | 107.0 | 99.4 |
| 20 | 12 | 0 | 3 | 98.8 | 99.4 | 94.2 | 100.9 | 105.3 | 105.4 | 100.7 |
| 21 | 15 | 0 | 0 | 98.0 | 101.2 | 92.8 | 94.0 | 95.6 | 93.9 | 95.9 |
| 22[3] | 0 | 0 | 0 | 93.8 | 99.6 | 83.6 | 79.7 | 99.3 | 102.0 | 93.0 |
| Mean | | | | 97.6 | 100.2 | 96.5 | 97.1 | 100.5 | 100.3 | 98.7 |

[1] Quantity index with prime quality assumed.

[2] A difference of 8.1 points between treatment means is significant, 5-percent level; a difference of 10.7 points between treatment means is highly significant, 1-percent level.

[3] Average of 3 checks in 1942 and 1943; of 2 checks in 1941.

TABLE 36.—*Seed index (weight of 100 fuzzy cottonseed in grams)*[1] *as affected by varying the ratio of fertilization, limed and unlimed, and by year, Experiment, Ga., 1941–43*

| Fertilizer treatment No. | Composition of fertilizer | | | Weight of 100 seed by series within years— | | | | | | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1941 | | 1942 | | 1943 | | |
| | N | $P_2O_5$ | $K_2O$ | Unlimed series | Limed series | Unlimed series | Limed series | Unlimed series | Limed series | |
| | *Percent* | *Percent* | *Percent* | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* |
| 1 | 0 | 15 | 0 | 8.66 | 10.10 | 10.20 | 8.53 | 10.06 | 11.02 | 9.76 |
| 2 | 0 | 12 | 3 | 11.23 | 9.31 | 10.90 | 10.53 | 12.54 | 12.21 | 11.12 |
| 3 | 3 | 12 | 0 | 8.87 | 11.74 | 9.77 | 8.91 | 9.32 | 9.51 | 9.69 |
| 4 | 0 | 9 | 6 | 11.78 | 11.78 | 10.80 | 11.12 | 12.68 | 12.76 | 11.82 |
| 5 | 3 | 9 | 3 | 11.98 | 11.02 | 10.67 | 10.13 | 11.28 | 11.01 | 11.01 |
| 6 | 6 | 9 | 0 | 11.04 | 10.87 | 8.66 | 9.33 | 9.17 | 8.49 | 9.59 |
| 7 | 0 | 6 | 9 | 11.19 | 11.20 | 11.04 | 9.98 | 12.20 | 12.81 | 11.40 |
| 8 | 3 | 6 | 6 | 11.30 | 11.87 | 10.75 | 11.26 | 12.55 | 12.71 | 11.74 |
| 9 | 6 | 6 | 3 | 11.37 | 10.97 | 10.75 | 10.81 | 13.32 | 12.42 | 11.57 |
| 10 | 9 | 6 | 0 | 9.05 | 9.31 | 9.98 | 10.46 | 11.88 | 12.02 | 10.45 |
| 11 | 0 | 3 | 12 | 11.24 | 10.86 | 10.52 | 10.62 | 12.40 | 12.93 | 11.42 |
| 12 | 3 | 3 | 9 | 11.41 | 11.12 | 11.03 | 11.09 | 12.15 | 12.27 | 11.51 |
| 13 | 6 | 3 | 6 | 11.77 | 11.68 | 10.67 | 11.01 | 12.12 | 12.41 | 11.61 |
| 14 | 9 | 3 | 3 | 12.76 | 12.29 | 10.40 | 11.66 | 11.41 | 11.82 | 11.72 |
| 15 | 12 | 3 | 0 | 11.59 | 11.30 | 10.76 | 9.99 | 10.75 | 10.69 | 10.85 |
| 16 | 0 | 0 | 15 | 11.22 | 11.42 | 10.60 | 11.08 | 12.98 | 12.10 | 11.56 |
| 17 | 3 | 0 | 12 | 11.60 | 11.81 | 10.70 | 11.46 | 11.62 | 12.03 | 11.54 |
| 18 | 6 | 0 | 9 | 12.32 | 12.06 | 11.04 | 11.11 | 12.91 | 12.09 | 11.92 |
| 19 | 9 | 0 | 6 | 11.84 | 11.53 | 10.26 | 11.63 | 13.60 | 12.41 | 11.88 |
| 20 | 12 | 0 | 3 | 12.85 | 12.16 | 11.88 | 11.51 | 12.83 | 12.38 | 12.27 |
| 21 | 15 | 0 | 0 | 11.97 | 11.92 | 9.99 | 11.37 | 11.09 | 10.95 | 11.21 |
| 22[3] | 0 | 0 | 0 | 10.56 | 10.75 | 9.66 | 9.98 | 12.13 | 12.23 | 10.88 |
| Mean | | | | 11.26 | 11.23 | 10.50 | 10.61 | 11.86 | 11.78 | 11.21 |

[1] Fuzzy cottonseed at 10-percent moisture content.

[2] A difference of 0.79 gram is significant, 5-percent level; a difference of 1.04 grams is highly significant, 1-percent level.

[3] Average of 2 plots in each series in 1941, for 3 plots per series in 1942 and 1943.

TABLE 37.—*Seed index as affected by fertilization, moisture supply, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Weight of 100 fuzzy seed, moisture-free | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| | *Pounds* | *Pounds* | *Pounds* | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* |
| 1943:[1] | | | | | | | | |
| 1 | 0 | 0 | 0 | 9.70 | 9.28 | 7.53 | 8.84 | 9.49 |
| 2 | 50 | 100 | 40 | 10.50 | 9.68 | 7.90 | 9.36 | 10.09 |
| 3 | 50 | 0 | 0 | 9.25 | 8.55 | 7.38 | 8.39 | 8.90 |
| 4 | 0 | 100 | 0 | 10.02 | 9.08 | 7.66 | 8.92 | 9.55 |
| 5 | 0 | 0 | 40 | 9.58 | 9.85 | 8.57 | 9.34 | 9.71 |
| 6 | 50 | 100 | 0 | 9.30 | 8.44 | 6.67 | 8.14 | 8.87 |
| 7 | ([2]) | 100 | 40 | 10.69 | 9.95 | 7.60 | 9.41 | 10.32 |
| SA (2W)[3] | 50 | 100 | 40 | 10.70 | 10.35 | 9.35 | 10.13 | ------ |
| SB (½W)[4] | 50 | 100 | 40 | 10.63 | 9.64 | 7.02 | 9.09 | ------ |
| Mean of treatments 1 to 7 | ------ | ------ | ------ | 9.86 | 9.26 | 7.62 | ------ | 9.56 |
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | ------ | ------ | ------ | .65 | .85 | 1.10 | 1.20 | ------ |
| 1-percent level | ------ | ------ | ------ | .89 | 1.14 | 1.50 | 1.63 | ------ |
| 1944:[5] | | | | | | | | |
| 1 | 0 | 0 | 0 | 8.78 | 9.99 | ------ | ------ | 9.39 |
| 2 | 50 | 100 | 40 | 8.34 | 7.52 | ------ | ------ | 7.93 |
| 3 | 50 | 0 | 0 | 8.78 | 9.42 | ------ | ------ | 9.09 |
| 4 | 0 | 100 | 0 | 8.79 | 8.29 | ------ | ------ | 8.55 |
| 5 | 0 | 0 | 40 | 9.82 | 10.12 | ------ | ------ | 9.97 |
| 6 | 50 | 100 | 0 | 8.81 | 8.35 | ------ | ------ | 8.58 |
| 7 | ([2]) | 100 | 40 | 8.77 | 6.96 | ------ | ------ | 7.86 |
| Mean | ------ | ------ | ------ | 8.87 | 8.66 | ------ | ------ | 8.77 |

See footnotes at end of table.

**TABLE 37.**—*Seed index as affected by fertilization, moisture supply, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*—Continued

| Year and treatment No. | Acre rate of fertilization with— | | | Weight of 100 fuzzy seed, moisture-free | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| | *Pounds* | *Pounds* | *Pounds* | *Grams* | *Grams* | *Grams* | *Grams* | *Grams* |
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | .71 | .63 | | | .62 |
| 1-percent level | | | | 1.07 | .95 | | | .94 |
| 2-year mean: | | | | | | | | |
| 1 | 0 | 0 | 0 | 9.24 | 9.64 | | | 9.44 |
| 2 | 50 | 100 | 40 | 9.42 | 8.60 | | | 9.01 |
| 3 | 50 | 0 | 0 | 9.02 | 8.98 | | | 9.00 |
| 4 | 0 | 100 | 0 | 9.40 | 8.69 | | | 9.04 |
| 5 | 0 | 0 | 40 | 9.70 | 9.98 | | | 9.84 |
| 6 | 50 | 100 | 0 | 9.05 | 8.40 | | | 8.73 |
| 7 | ([2]) | 100 | 40 | 9.73 | 8.45 | | | 9.09 |
| Mean | | | | 9.37 | 8.96 | | | 9.16 |
| Difference required for significance between pooled treatment mean: | | | | | | | | |
| 5-percent level | | | | | | | | .78 |
| 1-percent level | | | | | | | | 1.18 |

[1] Values in 1943 are means of 4 replicates.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

TABLE 38.—*Variation in fuzz content of cottonseed as affected by treatments within picking dates of Deltapine 6 selfed-line cotton, Baton Rouge, La., 1944*

| Treatment No. | Fertilization with— | | | Fuzz on moisture-free cotton [1] | | |
|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | First picking | Second picking | Mean |
| | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 12.36 [1] | 12.76 | 12.56 |
| 2 | 50 | 100 | 40 | 10.84 | 11.45 | 11.15 |
| 3 | 50 | 0 | 0 | 12.18 | 13.12 | 12.65 |
| 4 | 0 | 100 | 0 | 10.00 | 11.03 | 10.52 |
| 5 | 0 | 0 | 40 | 11.92 | 12.72 | 12.32 |
| 6 | 50 | 100 | 0 | 9.98 | 11.02 | 10.50 |
| 7 | ([2]) | 100 | 40 | 10.11 | 10.50 | 10.31 |
| Mean | | | | 11.06 | 11.80 | 11.43 |
| Difference required for significance between treatment means: | | | | | | |
| 5-percent level | | | | 1.02 | 1.55 | .78 |
| 1-percent level | | | | 1.54 | 2.35 | 1.18 |

[1] Mean of 2 replicates.
[2] 2 tons manure.

TABLE 39.—*Percentage of kernels in cottonseed as affected by fertilization, moisture supply, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Kernels in moisture-free, fuzzy cottonseed | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| 1943:[1] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 55.77 | 55.51 | 53.92 | 55.07 | 55.64 |
| 2 | 50 | 100 | 40 | 57.87 | 56.56 | 54.48 | 56.39 | 57.22 |
| 3 | 50 | 0 | 0 | 54.83 | 53.70 | 51.57 | 53.37 | 54.27 |
| 4 | 0 | 100 | 0 | 57.59 | 55.53 | 53.22 | 55.45 | 56.56 |
| 5 | 0 | 0 | 40 | 55.99 | 56.65 | 55.16 | 55.94 | 56.32 |
| 6 | 50 | 100 | 0 | 55.96 | 53.70 | 50.21 | 53.29 | 54.83 |
| 7 | ([2]) | 100 | 40 | 57.47 | 58.17 | 53.77 | 56.48 | 57.82 |
| SA (2W)[3] | 50 | 100 | 40 | 58.48 | 57.49 | 57.71 | 57.89 | |
| SB (½W)[4] | 50 | 100 | 40 | 58.45 | 57.53 | 50.90 | 55.62 | |
| Mean of treatments 1 to 7 | | | | 56.50 | 55.69 | 53.19 | 55.13 | 56.09 |
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | 1.42 | 1.88 | 4.23 | 2.03 | |
| 1-percent level | | | | 1.93 | 2.55 | 5.74 | 2.76 | |
| 1944:[5] | | | | | | | | |
| 1 | 0 | 0 | 0 | 56.85 | 56.02 | | | 56.43 |
| 2 | 50 | 100 | 40 | 56.49 | 51.88 | | | 54.19 |
| 3 | 50 | 0 | 0 | 55.52 | 55.09 | | | 55.31 |
| 4 | 0 | 100 | 0 | 56.89 | 55.40 | | | 56.16 |
| 5 | 0 | 0 | 40 | 57.23 | 56.45 | | | 56.84 |
| 6 | 50 | 100 | 0 | 55.38 | 53.91 | | | 54.65 |
| 7 | ([2]) | 100 | 40 | 57.63 | 51.03 | | | 54.33 |
| Mean | | | | 56.57 | 54.25 | | | 55.41 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | 1.45 | 3.77 | | | 2.07 |
| 1-percent level | | | | 2.19 | 5.71 | | | 2.82 |
| 2-year mean: | | | | | | | | |
| 1 | 0 | 0 | 0 | 56.32 | 55.75 | | | 56.05 |
| 2 | 50 | 100 | 40 | 57.19 | 54.22 | | | 55.70 |
| 3 | 50 | 0 | 0 | 55.16 | 54.40 | | | 54.79 |
| 4 | 0 | 100 | 0 | 57.24 | 55.47 | | | 56.36 |
| 5 | 0 | 0 | 40 | 56.61 | 56.55 | | | 56.58 |
| 6 | 50 | 100 | 0 | 55.67 | 53.81 | | | 54.74 |
| 7 | ([2]) | 100 | 40 | 57.55 | 54.60 | | | 56.06 |
| Mean | | | | 56.54 | 54.97 | | | 55.75 |
| Difference required for significance between pooled treatment mean: | | | | | | | | |
| 5-percent level | | | | | | | | 1.77 |
| 1-percent level | | | | | | | | 2.40 |

[1] Values in 1943 are means of 4 replicates.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

TABLE 40.—*Percentage of oil content of kernels as affected by fertilization, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Oil content of cottonseed kernels, moisture-free | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| 1943:[1] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 33.18 | 32.32 | 29.88 | 31.79 | 32.75 |
| 2 | 50 | 100 | 40 | 33.99 | 33.03 | 31.76 | 32.93 | 33.51 |
| 3 | 50 | 0 | 0 | 31.56 | 31.03 | 29.80 | 30.79 | 31.30 |
| 4 | 0 | 100 | 0 | 35.05 | 33.00 | 29.89 | 32.64 | 34.03 |
| 5 | 0 | 0 | 40 | 33.44 | 33.34 | 33.00 | 33.26 | 33.39 |
| 6 | 50 | 100 | 0 | 31.92 | 30.61 | 29.05 | 30.53 | 31.27 |
| 7 | ([2]) | 100 | 40 | 34.30 | 34.93 | 29.59 | 32.94 | 34.61 |
| 8A (2W)[3] | 50 | 100 | 40 | 32.85 | 32.69 | 32.59 | 32.80 | |
| 8B (½W)[4] | 50 | 100 | 40 | 31.67 | 33.09 | 29.66 | 31.44 | |
| Mean of treatments 1 to 7 | | | | 33.35 | 32.61 | 30.04 | | 32.98 |
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | 1.07 | 1.76 | 2.19 | | 1.65 |
| 1-percent level | | | | 1.46 | 2.39 | 2.98 | | 2.20 |
| 1944:[5] | | | | | | | | |
| 1 | 0 | 0 | 0 | 34.60 | 35.16 | | | 34.88 |
| 2 | 50 | 100 | 40 | 37.22 | 33.39 | | | 35.31 |
| 3 | 50 | 0 | 0 | 34.97 | 34.15 | | | 34.56 |
| 4 | 0 | 100 | 0 | 36.98 | 34.52 | | | 35.75 |
| 5 | 0 | 0 | 40 | 36.31 | 34.42 | | | 35.37 |
| 6 | 50 | 100 | 0 | 34.96 | 33.38 | | | 34.17 |
| 7 | ([2]) | 100 | 40 | 36.28 | 32.20 | | | 34.24 |
| Mean | | | | 35.90 | 33.89 | | | 34.90 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Difference required for significance between treatment mean: | | | | | | | |
| 5-percent level | | | | 1.76 | 1.81 | | 1.57 |
| 1-percent level | | | | 2.66 | 2.74 | | 2.38 |
| 2-year mean: | | | | | | | |
| 1 | 0 | 0 | 0 | 33.89 | 33.74 | | 33.82 |
| 2 | 50 | 100 | 40 | 35.60 | 33.21 | | 34.41 |
| 3 | 50 | 0 | 0 | 33.26 | 32.59 | | 32.93 |
| 4 | 0 | 100 | 0 | 36.02 | 33.76 | | 34.89 |
| 5 | 0 | 0 | 40 | 34.88 | 33.88 | | 34.38 |
| 6 | 50 | 100 | 0 | 33.44 | 32.00 | | 32.72 |
| 7 | ([2]) | 100 | 40 | 35.29 | 33.56 | | 34.43 |
| Mean | | | | 34.63 | 33.25 | | 33.94 |
| Difference required for significance between pooled treatment mean: | | | | | | | |
| 5-percent level | | | | | | | 1.75 |
| 1-percent level | | | | | | | 2.65 |

[1] Values in 1943 are means of 4 replicates.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

TABLE 41.—*Percentage of protein[1] content of cottonseed kernels as affected by fertilization, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Protein content of moisture-free kernels | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| 1943:[2] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 40.8 | 40.8 | 42.6 | 41.4 | 40.8 |
| 2 | 50 | 100 | 40 | 39.7 | 39.9 | 41.2 | 40.3 | 39.8 |
| 3 | 50 | 0 | 0 | 43.2 | 42.8 | 43.1 | 43.0 | 43.0 |
| 4 | 0 | 100 | 0 | 37.9 | 39.8 | 41.9 | 39.9 | 38.9 |
| 5 | 0 | 0 | 40 | 40.5 | 40.0 | 40.3 | 40.3 | 40.3 |
| 6 | 50 | 100 | 0 | 42.0 | 42.9 | 43.0 | 42.6 | 42.4 |
| 7 | ([3]) | 100 | 40 | 37.1 | 36.7 | 42.0 | 38.6 | 36.9 |
| 8A (2W)[4] | 50 | 100 | 40 | 39.7 | 38.3 | 41.2 | 39.7 | |
| 8B (½W)[5] | 50 | 100 | 40 | 41.6 | 40.5 | 42.4 | 41.5 | |
| Mean of treatments 1 to 7 | | | | 40.1 | 40.4 | 42.0 | | 40.3 |
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | 1.4 | 1.1 | 1.9 | 1.4 | |
| 1-percent level | | | | 1.8 | 1.5 | 2.7 | 1.9 | |
| 1944:[6] | | | | | | | | |
| 1 | 0 | 0 | 0 | 39.9 | 42.1 | | | 41.0 |
| 2 | 50 | 100 | 40 | 37.1 | 41.3 | | | 39.2 |
| 3 | 50 | 0 | 0 | 39.8 | 42.0 | | | 40.9 |
| 4 | 0 | 100 | 0 | 36.8 | 40.1 | | | 38.5 |
| 5 | 0 | 0 | 40 | 39.1 | 41.3 | | | 40.2 |
| 6 | 50 | 100 | 0 | 39.5 | 40.5 | | | 40.0 |
| 7 | ([3]) | 100 | 40 | 37.6 | 41.2 | | | 39.4 |
| Mean | | | | 38.5 | 41.2 | | | 39.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Difference required for significance between treatment mean: | | | | | | | | |
| 5-percent level | | | | .7 | 1.0 | | | .9 |
| 1-percent level | | | | 1.0 | 1.6 | | | 1.4 |
| 2-year mean: | | | | | | | | |
| 1 | 0 | 0 | 0 | 40.3 | 41.5 | | | 40.9 |
| 2 | 50 | 100 | 40 | 38.4 | 40.6 | | | 39.5 |
| 3 | 50 | 0 | 0 | 41.5 | 42.4 | | | 42.0 |
| 4 | 0 | 100 | 0 | 37.3 | 40.0 | | | 38.6 |
| 5 | 0 | 0 | 40 | 39.8 | 40.6 | | | 40.2 |
| 6 | 50 | 100 | 0 | 40.7 | 41.7 | | | 41.2 |
| 7 | ([3]) | 100 | 40 | 37.3 | 38.9 | | | 38.1 |
| Mean | | | | 39.3 | 40.8 | | | 40.1 |
| Difference required for significance between pooled treatment mean: | | | | | | | | |
| 5-percent level | | | | | | | | 1.2 |
| 1-percent level | | | | | | | | 1.8 |

[1] Measured and analyzed statistically as ammonia, then converted to protein ($NH_3 \times 5.13$ = protein).

[2] Values in 1943 are means of 4 replicates.

[3] 20 tons of manure.

[4] Given twice the water falling on treatments 1 to 7.

[5] Given one-half the water falling on treatments 1 to 7.

[6] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

TABLE 42.—*Percentage of reserve capacity of kernels as influenced by fertilization, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Reserve capacity of cottonseed kernels | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| 1943:[1] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 74.0 | 73.1 | 72.5 | 73.2 | 73.6 |
| 2 | 50 | 100 | 40 | 73.7 | 72.9 | 73.0 | 73.2 | 73.3 |
| 3 | 50 | 0 | 0 | 74.8 | 73.8 | 72.9 | 73.8 | 74.3 |
| 4 | 0 | 100 | 0 | 73.0 | 72.8 | 71.8 | 72.5 | 72.9 |
| 5 | 0 | 0 | 40 | 73.9 | 73.3 | 73.3 | 73.6 | 73.7 |
| 6 | 50 | 100 | 0 | 73.9 | 73.5 | 72.0 | 73.1 | 73.7 |
| 7 | (2) | 100 | 40 | 71.4 | 71.6 | 71.6 | 71.5 | 71.5 |
| 8A (2W)[3] | 50 | 100 | 40 | 72.6 | 71.0 | 73.8 | 72.5 | |
| 8B (½W)[4] | 50 | 100 | 40 | 73.3 | 73.6 | 72.1 | 72.9 | |
| Mean of treatments 1 to 7 | | | | 73.5 | 73.0 | 72.0 | | 73.3 |
| 1944:[5] | | | | | | | | |
| 1 | 0 | 0 | 0 | 74.5 | 77.3 | | | 75.9 |
| 2 | 50 | 100 | 40 | 74.3 | 74.7 | | | 74.5 |
| 3 | 50 | 0 | 0 | 74.8 | 76.2 | | | 75.5 |
| 4 | 0 | 100 | 0 | 73.8 | 74.6 | | | 74.2 |
| 5 | 0 | 0 | 40 | 75.4 | 75.7 | | | 75.6 |
| 6 | 50 | 100 | 0 | 74.5 | 73.9 | | | 74.2 |
| 7 | (2) | 100 | 40 | 73.9 | 73.4 | | | 73.6 |
| Mean | | | | 74.4 | 75.1 | | | 74.8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2-year mean: | | | | | | | |
| 1 | 0 | 0 | 0 | 74.2 | 75.2 | | 74.7 |
| 2 | 50 | 100 | 40 | 74.0 | 73.8 | | 73.9 |
| 3 | 50 | 0 | 0 | 74.8 | 75.0 | | 74.9 |
| 4 | 0 | 100 | 0 | 73.3 | 73.8 | | 73.5 |
| 5 | 0 | 0 | 40 | 74.7 | 74.5 | | 74.6 |
| 6 | 50 | 100 | 0 | 74.1 | 73.7 | | 73.9 |
| 7 | (2) | 100 | 40 | 72.6 | 72.5 | | 72.5 |
| Mean | | | | 73.9 | 74.0 | | 74.0 |

[1] Values in 1943 are means of 4 replicates.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

TABLE 43.—*Ratio of percentage of oil to percentage of protein in kernels as influenced by fertilization, date of tagging and picking, and year, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Ratio of oil to protein in cottonseed kernels | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Picking | | | Mean of all pickings | Mean of first and second pickings |
| | N | $P_2O_5$ | $K_2O$ | First | Second | Third | | |
| 1943:[1] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| 1 | 0 | 0 | 0 | 0.81 | 0.79 | 0.70 | 0.77 | 0.80 |
| 2 | 50 | 100 | 40 | .86 | .83 | .77 | .82 | .84 |
| 3 | 50 | 0 | 0 | .73 | .72 | .69 | .72 | .73 |
| 4 | 0 | 100 | 0 | .92 | .83 | .71 | .82 | .87 |
| 5 | 0 | 0 | 40 | .82 | .83 | .82 | .82 | .83 |
| 6 | 50 | 100 | 0 | .76 | .71 | .68 | .72 | .74 |
| 7 | (2) | 100 | 40 | .92 | .95 | .70 | .85 | .94 |
| 8A (2W)[3] | 50 | 100 | 40 | .83 | .85 | .79 | .83 | |
| 8B (½W)[4] | 50 | 100 | 40 | .76 | .82 | .70 | .76 | |
| Mean of treatments 1 to 7 | | | | .83 | .81 | .72 | | .82 |
| 1944:[5] | | | | | | | | |
| 1 | 0 | 0 | 0 | .87 | .84 | | | .85 |
| 2 | 50 | 100 | 40 | 1.00 | .81 | | | .90 |
| 3 | 50 | 0 | 0 | .88 | .81 | | | .84 |
| 4 | 0 | 100 | 0 | 1.00 | .86 | | | .93 |
| 5 | 0 | 0 | 40 | .93 | .83 | | | .88 |
| 6 | 50 | 100 | 0 | .88 | .82 | | | .85 |
| 7 | (2) | 100 | 40 | .96 | .78 | | | .87 |
| Mean | | | | .93 | .82 | | | .87 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2-year mean: | | | | | | | | |
| 1 | 0 | 0 | 0 | .84 | .81 | | | .83 |
| 2 | 50 | 100 | 40 | .93 | .82 | | | .87 |
| 3 | 50 | 0 | 0 | .80 | .77 | | | .78 |
| 4 | 0 | 100 | 0 | .96 | .84 | | | .90 |
| 5 | 0 | 0 | 40 | .88 | .83 | | | .86 |
| 6 | 50 | 100 | 0 | .82 | .77 | | | .79 |
| 7 | ([2]) | 100 | 40 | .95 | .86 | | | .90 |
| Mean | | | | .88 | .81 | | | .85 |

[1] Values in 1943 are means of 4 replicates.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Values for treatments 1, 4, and 7 are means of 4 replicates; others are means of duplicate laboratory samples from a blend of 3 or fewer replicates.

**TABLE 44.**—*Mean effects of treatment on the cottonseed measurements utilized in forming a basis for sale of seed, of Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943–44*

| Year and treatment No. | Acre rate of fertilization with— | | | Seed per acre [1] | Oil content of fuzzy seed [2] | Ammonia content of fuzzy seed [2] | Cottonseed grade [3] | Acre value of seed [4] |
|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | | | | | |
| 1943: | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Points* | *Dollars* |
| 1 | 0 | 0 | 0 | 619 | 16.26 | 3.99 | 93.2 | 16.15 |
| 2 | 50 | 100 | 40 | 1,001 | 17.26 | 3.99 | 98.0 | 27.47 |
| 3 | 50 | 0 | 0 | 672 | 15.29 | 4.10 | 89.1 | 16.77 |
| 4 | 0 | 100 | 0 | 771 | 17.35 | 3.85 | 97.5 | 21.05 |
| 5 | 0 | 0 | 40 | 724 | 16.91 | 3.97 | 96.4 | 19.54 |
| 6 | 50 | 100 | 0 | 752 | 15.73 | 4.13 | 91.4 | 19.24 |
| 7 | (5) | 100 | 40 | 1,023 | 18.01 | 3.75 | 99.5 | 28.50 |
| 8A (2W) [6] | 50 | 100 | 40 | 1,067 | 17.19 | 4.01 | 97.8 | 29.23 |
| 8B (½W) [7] | 50 | 100 | 40 | 568 | 16.95 | 4.19 | 97.9 | 15.57 |
| Mean of treatments 1 to 7 | | | | 795 | 16.61 | 3.99 | 95.0 | 21.25 |
| 1944: | | | | | | | | |
| 1 | 0 | 0 | 0 | 214 | 17.91 | 4.23 | 102.0 | 6.11 |
| 2 | 50 | 100 | 40 | 955 | 17.44 | 3.95 | 98.5 | 26.35 |
| 3 | 50 | 0 | 0 | 132 | 17.31 | 4.22 | 99.6 | 3.68 |
| 4 | 0 | 100 | 0 | 741 | 18.27 | 3.96 | 101.8 | 21.11 |
| 5 | 0 | 0 | 40 | 190 | 18.34 | 4.20 | 103.6 | 5.51 |
| 6 | 50 | 100 | 0 | 774 | 17.11 | 4.09 | 98.0 | 21.24 |
| 7 | (5) | 100 | 40 | 1,059 | 17.01 | 4.02 | 97.2 | 28.81 |
| Mean | | | | 581 | 17.63 | 4.10 | 100.1 | 16.12 |
| Average, both years: | | | | | | | | |
| 1 | 0 | 0 | 0 | 417 | 17.08 | 4.11 | 97.6 | 11.13 |
| 2 | 50 | 100 | 40 | 978 | 17.35 | 3.97 | 98.3 | 26.91 |
| 3 | 50 | 0 | 0 | 402 | 16.30 | 4.16 | 94.4 | 10.23 |
| 4 | 0 | 100 | 0 | 756 | 17.81 | 3.91 | 99.7 | 21.08 |
| 5 | 0 | 0 | 40 | 457 | 17.66 | 4.09 | 100.0 | 12.53 |
| 6 | 50 | 100 | 0 | 764 | 16.15 | 4.11 | 94.7 | 20.24 |
| 7 | (5) | 100 | 40 | 1,041 | 17.51 | 3.89 | 98.4 | 28.66 |
| Mean | | | | 688 | 17.12 | 4.04 | 97.6 | 18.68 |

[1] Calculations based on yield of seed cotton × percentage of seed in 1943. Mean percentage of seed from 1943 used to calculate 1944 yields of seed from yields of seed cotton.

[2] Percentage in fuzzy seed calculated to 10-percent moisture. Means of first two pickings.

[3] Calculated according to rules *(26)* of the National Cottonseed Products Assn.

[4] Calculated at $56 per ton for basis grade (100 points) cottonseed.

[5] 20 tons of manure.

[6] Received twice the water falling on treatments 1 to 7.

[7] Received one-half the water falling on treatments 1 to 7.

TABLE 45.—*Refractive index and free fatty acid content of oils from Deltapine 6 selfed-line cotton grown at Baton Rouge, La., 1943*

AS AFFECTED BY FERTILIZER TREATMENT AND TIME OF PICKING

| Treatment or plot No. | Acre rate of fertilization with— | | | Refractive index (ND at 25° C.)[1] of oils for— | | | | Free fatty acid content[1] of oils for— | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | First picking | Second picking | Third picking | Mean | First picking | Second picking | Third picking | Mean |
| | *Pounds* | *Pounds* | *Pounds* | *1.4000+* | *1.4000+* | *1.4000+* | *1.4000+* | *Percent* | *Percent* | *Percent* | |
| 1 | 0 | 0 | 0 | 0.0688 | 0.0688 | 0.0690 | 0.0689 | 0.35 | 0.70 | 0.56 | 0.54 |
| 2 | 50 | 100 | 40 | .0692 | .0690 | .0691 | .0691 | .26 | .30 | .61 | .39 |
| 3 | 50 | 0 | 0 | .0691 | .0691 | .0689 | .0690 | .33 | .28 | .44 | .35 |
| 4 | 0 | 100 | 0 | .0694 | .0692 | .0690 | .0692 | .23 | .29 | .45 | .22 |
| 5 | 0 | 0 | 40 | .0695 | .0690 | .0688 | .0691 | .25 | .23 | .99 | .48 |
| 6 | 50 | 100 | 0 | .0693 | .0692 | .0686 | .0690 | .37 | .32 | 7.27 | 2.65 |
| 7 | ([2]) | 100 | 40 | .0694 | .0696 | .0690 | .0693 | .46 | .37 | 1.60 | .81 |
| 8A (2W)[3] | 50 | 100 | 40 | .0692 | .0693 | .0689 | .0691 | .24 | .31 | .27 | .27 |
| 8B (½W)[4] | 50 | 100 | 40 | .0689 | .0690 | .0689 | .0689 | .19 | .31 | .45 | .31 |
| Mean | | | | .0692 | .0691 | .0688 | .0691 | .30 | .35 | 1.40 | .67 |
| **VARIATION IN SINGLE-BOLL SAMPLES[5] WITHIN TREATMENT No. 7** | | | | | | | | | | | |
| By replication: | | | | | | | | | | | |
| Plot No.: | | | | | | | | | | | |
| 5 | | | | 0.0698 | 0.0697 | 0.0692 | 0.0696 | 0.48 | 0.30 | 0.58 | 0.45 |
| 10 | | | | .0696 | .0697 | .0687 | .0693 | .65 | .45 | 4.44 | 1.85 |
| 23 | | | | .0691 | .0695 | .0690 | .0692 | .37 | .35 | .74 | .49 |
| 28 | | | | .0692 | .0696 | .0690 | .0693 | .36 | .38 | .64 | .46 |
| Mean | | | | | | | | .46 | .37 | 1.60 | .81 |

[1] Mean of 4 replicate multiple boll-samples.
[2] 20 tons of manure.
[3] Given twice the water falling on treatments 1 to 7.
[4] Given one-half the water falling on treatments 1 to 7.
[5] Mean of 4 bolls, each containing a different number of seed (see table 5).

**TABLE 46.**—*Fertilizer ratio and rotation results with Coker 4 in 1-4 cotton at Florence, S. C.*

[Experiment 4] [1]

| Treatment No. | Fertilizer at the rate of 1,000 pounds per acre | | | Oil in seed [2] | Ammonia in seed [2] | Grade [3] | Acre yield of seed [4] | Acre value of seed [5] |
|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | | | | | |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| 1 | 0 | 8 | 4 | 19.57 | 3.34 | 103.3 | 751 | 21.72 |
| 2 | 2 | 8 | 4 | 19.42 | 3.56 | 104.0 | 807 | 23.50 |
| 3 | 4 | 8 | 4 | 19.21 | 3.77 | 104.5 | 811 | 23.73 |
| 4 | 8 | 8 | 4 | 17.88 | 3.96 | 100.3 | 790 | 22.19 |
| 5 | 4 | 0 | 4 | 18.94 | 3.85 | 103.0 | 439 | 12.77 |
| 6 | 4 | 2 | 4 | 19.30 | 3.74 | 104.6 | 589 | 17.25 |
| 7 | 4 | 6 | 4 | 19.27 | 3.80 | 104.9 | 805 | 23.64 |
| 8 | 4 | 10 | 4 | 19.32 | 3.77 | 104.9 | 848 | 24.91 |
| 9 | 4 | 16 | 4 | 18.97 | 3.82 | 103.8 | 853 | 24.79 |
| 10 | 4 | 8 | 0 | 18.32 | 4.07 | 102.7 | 697 | 20.04 |
| 11 | 4 | 8 | 3 | 19.13 | 3.80 | 104.3 | 878 | 25.64 |
| 12 | 4 | 8 | 6 | 19.08 | 3.83 | 104.3 | 863 | 25.20 |
| 13 | 4 | 8 | 8 | 19.61 | 3.72 | 105.8 | 842 | 24.94 |
| 14 | 0 | 0 | 0 | 18.22 | 3.64 | 99.7 | 439 | 12.26 |

[1] Inaugurated in 1912, with cotton grown in rotation with corn, oats, and soybeans in 3 tiers on Ruston sandy loam soil at the Pee Dee Experiment Station. Prior publications (*2, 9, 18*).

[2] Fuzzy seed at 10-percent moisture content; analyses of 100-boll samples of 1943 crop year; values for analysis of a single (nonreplicated) sample.

[3] Quantity index; prime quality assumed.

[4] Calculated as 65 percent of the 7-year average yields of seed cotton.

[5] Calculated at $56 per ton for basis grade seed.

TABLE 47.—*Effect of rate of nitrogen on Mexican Big Boll cotton, grown at Rocky Mount, N. C., 1943–44*

[Experiment 5] [1]

| Year and date of picking | Acre rate of nitrogen [2] | Oil in seed [3] | Ammonia in seed [3] | Grade [4] | Acre yield of seed [5] | Acre value of seed [6] |
|---|---|---|---|---|---|---|
| 1943: | *Pounds* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| Sept. 14 | 0 | 21.04 | 2.75 | 105.7 | | |
| | 18 | 20.66 | 2.87 | 104.9 | | |
| | 36 | 20.78 | 3.04 | 106.4 | | |
| Oct. 7 | 0 | 21.83 | 3.06 | 110.7 | | |
| | 18 | 22.88 | 3.01 | 112.2 | | |
| | 36 | 21.54 | 3.19 | 110.3 | | |
| 1944: | 0 | 20.97 | 3.13 | 107.7 | 683 | 20.59 |
| | 18 | 20.58 | 3.34 | 107.4 | 900 | 29.77 |
| | 36 | 20.22 | 3.93 | 109.4 | 1,207 | 36.97 |
| | [7] 36 | 19.74 | 4.01 | 108.0 | 1,197 | 36.20 |

[1] Inaugurated in 1941 on Norfolk fine sandy loam, at the Upper Coastal Plain Branch Station. Results are replicate 100-boll samples from early pickings in 1943 and 1944 and samples composited from 50-bolls for second picking in 1943.

[2] Uniform applications of 48 pounds of phosphate and 72 pounds of potash made to all plots.

[3] Fuzzy seed at 10-percent moisture content. Averages for 3 replicate plots.

[4] Quantity index at prime quality.

[5] Calculated from plot yields, 1944 crop.

[6] Based on $56 per ton for basis grade seed, 1944 crop.

[7] Vetch also added.

**TABLE 48.**—*Effect of rotations*[1] *with different levels of potash on cotton (1943) and earlier applications of limestone and gypsum on peanuts in 1941*

[Experiments 6 (Rocky Mount), 7 (Weldon), 8 (Edenton), and 9 (Windsor, North Carolina)][2]

| Place and date of picking | Treatment | | Oil in seed[3] | Ammonia in seed[3] | Grade[4] | Acre yield of seed[5] | Acre value of seed[6] |
|---|---|---|---|---|---|---|---|
| | Supplement | Rate of $K_2O$ | | | | | |
| | | *Pounds* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| Rocky Mount, N. C.: Sept. 14, 1943 | None | 36 | 16.77 | 4.36 | 98.0 | 828 | 22.72 |
| | | 72 | 17.66 | 4.21 | 100.9 | 876 | 24.75 |
| | Lime | 36 | 17.19 | 4.33 | 99.7 | 806 | 22.50 |
| | | 72 | 18.03 | 4.08 | 101.6 | 879 | 25.00 |
| | Gypsum | 36 | 16.91 | 4.18 | 97.6 | [7] 830 | 22.68 |
| | | 72 | 17.95 | 4.06 | 101.2 | 832 | 23.57 |
| Oct. 7, 1944 | None | 36 | 18.46 | 4.10 | 103.4 | | |
| | | 72 | 19.47 | 4.20 | 108.1 | | |
| Weldon, N. C. | do | 24 | 17.44 | 4.22 | 100.1 | 225 | 6.31 |
| | | 48 | 17.00 | 4.06 | 97.4 | 410 | 11.18 |
| | Lime | 24 | 17.35 | 4.11 | 99.1 | 350 | 9.71 |
| | | 48 | 17.09 | 4.14 | 98.2 | 384 | 10.56 |
| | Gypsum | 24 | 16.85 | 4.01 | 96.3 | 598 | 16.13 |
| | | 48 | 16.94 | 4.02 | 96.8 | 322 | 8.73 |
| Edenton, N. C.: Sept. 3, 1943 | None | 24 | 15.73 | 3.73 | 89.0 | [7] 920 | [8] 22.93 |
| | | 48 | 15.88 | 3.78 | 90.1 | 1,007 | 25.40 |
| Oct. 12, 1943 | do | 24 | 16.38 | 3.88 | 93.2 | | |
| | | 48 | 17.00 | 3.93 | 96.6 | | |
| Windsor, N. C. | do | 24 | 13.12 | 3.39 | 73.9 | 504 | 10.42 |
| | | 48 | 13.77 | 3.57 | 79.5 | 534 | 11.89 |

[1] Cotton, peanuts, and legumes.

[2] Inaugurated in 1938; triplicate plots. Results are analyses of 100-boll samples taken from selected treatments. Fertilizer differentials had been applied twice. Experiment 6: Plots on Norfolk very fine sandy loam received 36 pounds of nitrogen and 48 pounds of phosphate per acre; cotton variety—Mexican Big Boll. Experiment 7: Cotton (Coker 100) grown on Lenior fine sandy loam. Experiment 8: Plots on Craven fine sandy loam received 12 pounds of nitrogen and 48 pounds of phosphate per acre; cotton variety—Coker 200. Experiment 9: Plots on Ruston loamy sand received 36 pounds of nitrogen and 48 pounds of phosphate; cotton variety—Coker 100. Earlier publications (*38, 39*).

[3] Fuzzy seed at 10-percent moisture content. Averages for 3 replicate plots.

[4] Quantity index at prime quality.

[5] Calculated from plot yields.

[6] Based on $56 per ton for basis grade seed.

[7] Both picking dates.

[8] Average grade for both picking dates used in the calculation.

TABLE 49.—*Results of different rates of potash application on Mexican Big Boll cotton at Rocky Mount, N. C., 1944*

[Experiment 10][1]

| Acre rate of fertilization with $K_2O$ (pounds) | Oil in seed[2] | Ammonia in seed[2] | Grade[3] | Acre yield of seed[4] | Acre value of seed[5] |
|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| 36 | 18.22 | 4.29 | 103.6 | 1,101 | 31.94 |
| 54 | 18.59 | 4.25 | 104.8 | 1,169 | 34.30 |
| 72 | 18.99 | 4.20 | 106.2 | 1,105 | 32.86 |
| 108 | 19.20 | 4.17 | 106.8 | 1,158 | 34.63 |
| 144 | 19.67 | 4.05 | 108.0 | 1,200 | 36.29 |

[1] At Upper Coastal Plain Branch Station, on Norfolk very fine sandy loam. Triplicate plots uniformly fertilized with 36 pounds of nitrogen and 48 pounds of phosphate per acre. Cottonseed samples harvested from first picking. Values shown are averages for 3 replicate plots.

[2] Fuzzy seed at 10-percent moisture content.

[3] Quantity index at prime quality.

[4] Calculated from triplicate plot yields of seed cotton and percentages of lint.

[5] Based on $56 per ton for basis grade seed.

TABLE 50.—*Effect of potash and lime on Coker 100 Wilt cotton at Raeford, N. C., 1944*

[Experiment 11][1]

| Treatment No. | Acre rate of fertilization with— | | Oil in seed [2] | Ammonia in seed [2] | Grade [3] | Acre yield of seed [4] | Acre value of seed [5] |
|---|---|---|---|---|---|---|---|
| | $K_2O$ | Calcitic lime | | | | | |
| | *Pounds* | *Pounds* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| 1 | 20 | 0 | 18.28 | 4.41 | 104.4 | 714 | 20.86 |
| 2 | 60 | 0 | 19.04 | 4.10 | 105.8 | 684 | 20.26 |
| 3 | 20 | 1,000 | 17.78 | 4.37 | 102.3 | 838 | 24.00 |
| 4 | 60 | 1,000 | 17.83 | 4.23 | 101.7 | 885 | 25.20 |
| 5 | 20 | 2,000 | 17.25 | 4.48 | 100.9 | 871 | 24.61 |
| 6 | 60 | 2,000 | 17.99 | 4.44 | 103.6 | 824 | 23.91 |
| 7 | 20 | 4,000 | 17.10 | 4.57 | 100.8 | 769 | 21.70 |
| 8 | 60 | 4,000 | 17.77 | 4.53 | 103.3 | 789 | 22.82 |
| Averages for increase in $K_2O$ supply: | | | | | | | |
| 20 pounds | | | 17.60 | 4.46 | 102.1 | 798 | 22.81 |
| 60 pounds | | | 18.16 | 4.33 | 103.6 | 795 | 23.06 |
| Averages for increase in lime supply: | | | | | | | |
| 0 pounds | | | 18.66 | 4.25 | 105.1 | 699 | 20.57 |
| 1,000 pounds | | | 17.80 | 4.30 | 102.0 | 861 | 24.59 |
| 2,000 pounds | | | 17.62 | 4.46 | 102.2 | 847 | 24.24 |
| 4,000 pounds | | | 17.43 | 4.55 | 102.0 | 779 | 22.25 |

[1] On Norfolk loamy sand. Quadruplicate plots uniformly fertilized with 36 pounds of nitrogen and 48 pounds of phosphate per acre. First picking of cotton used for seed analysis. Values shown are averages for triplicate plots.

[2] Fuzzy seed at 10-percent moisture content.

[3] Quantity index at prime quality.

[4] Calculated from triplicate plot yields of seed cotton and percentages of lint.

[5] Based on $56 per ton for basis grade seed.

TABLE 51.—*Rate and source of magnesium supply for Coker 100 Wilt cotton at Raeford, N. C., 1944*

[Experiment 12][1]

| Fertilizer | | Oil in seed[2] | Ammonia in seed[2] | Grade[3] |
|---|---|---|---|---|
| Compound | Acre rate | | | |
| | *Pounds* | *Percent* | *Percent* | *Points* |
| Neutral calcite | 3,000 | 19.06 | 4.01 | 105.3 |
| Neutral dolomite | 3,000 | 18.80 | 4.09 | 104.7 |
| Magnesium sulfate | 150 | 18.65 | 3.96 | 103.4 |
| Do | 450 | 19.09 | 4.26 | 106.9 |
| Dolomite | 1,000 | 19.03 | 4.07 | 105.5 |
| Do | 2,000 | 18.50 | 4.17 | 104.2 |

[1] On Norfolk loamy sand. Quadruplicate plots received 36 pounds of nitrogen and 48 pounds of phosphate per acre. Cotton samples taken at first picking for cottonseed analysis. Values shown are averages for quadruplicate plots.
[2] Fuzzy seed at 10-percent moisture content.
[3] Quantity index at prime quality.

TABLE 52.—*Effect of various fertilizer treatments on Coker 100 Wilt, strain 3, at Rocky Mount and Wake Forest, N. C., 1944*

[Experiment 13][1]

EXPERIMENTAL DATA[2]

| Place and treatment No. and change in N, P, K levels | Acre rate of fertilization with— | | | Fuzz in seed | Kernels in seed | Oil in seed | Ammonia in seed | Oil in kernels | Ammonia in kernels | Seed capacity | Kernel capacity | Acre yield of seed | Cottonseed grade | Acre value of seed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | | | | | | | | | | | |
| Rocky Mount:[3] | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Sum* | *Sum* | *Pounds* | *Points* | *Dollars* |
| 1 | 10 | 50 | 0 | 12.09 | 51.30 | 15.92 | 3.71 | 30.56 | 6.76 | 34.95 | 65.24 | 431 | 89.9 | 10.85 |
| 2 | 10 | 50 | 30 | 12.40 | 52.52 | 17.66 | 3.30 | 33.17 | 5.83 | 34.59 | 63.08 | 501 | 95.4 | 13.38 |
| 3 | 10 | 50 | 60 | 12.05 | 52.75 | 18.96 | 3.07 | 35.49 | 5.36 | 34.71 | 62.99 | 551 | 99.3 | 15.32 |
| 4 | 35 | 50 | 0 | 11.70 | 52.88 | 15.70 | 4.03 | 29.24 | 7.17 | 36.38 | 66.02 | 652 | 90.7 | 16.56 |
| 5 | 35 | 50 | 30 | 11.63 | 53.35 | 18.16 | 3.71 | 33.61 | 6.52 | 37.19 | 67.08 | 808 | 99.9 | 22.60 |
| 6 | 35 | 50 | 60 | 11.67 | 53.73 | 18.97 | 3.38 | 34.88 | 5.86 | 36.31 | 64.94 | 870 | 101.2 | 24.65 |
| 7 | 35 | 50 | 90 | 11.83 | 53.95 | 19.40 | 3.37 | 35.53 | 5.82 | 36.69 | 65.39 | 866 | 102.8 | 24.93 |
| 8 | 60 | 50 | 0 | 12.30 | 53.07 | 15.62 | 4.17 | 28.98 | 7.42 | 37.01 | 67.04 | 837 | 91.1 | 21.35 |
| 9 | 60 | 50 | 30 | 11.62 | 54.43 | 17.38 | 4.10 | 31.53 | 7.13 | 38.41 | 68.11 | 900 | 99.1 | 24.97 |
| 10 | 60 | 50 | 60 | 10.77 | 54.79 | 18.20 | 3.83 | 32.82 | 6.59 | 37.85 | 66.63 | 1,048 | 100.8 | 29.60 |
| 11 | 35 | 0 | 60 | 11.69 | 53.22 | 18.36 | 3.52 | 34.07 | 6.18 | 36.42 | 65.77 | 820 | 99.6 | 22.87 |
| 12 | 35 | 100 | 60 | 11.52 | 52.87 | 17.82 | 3.46 | 33.25 | 6.09 | 35.57 | 64.49 | 846 | 97.0 | 22.98 |
| 13 | 60 | 50 | 90 | 11.73 | 54.12 | 18.95 | 3.66 | 34.59 | 6.36 | 37.73 | 67.22 | 1,070 | 102.8 | 30.80 |
| Wake Forest:[4] | | | | | | | | | | | | | | |
| 1 | 10 | 50 | 0 | 12.85 | 53.14 | 18.81 | 3.33 | 34.96 | 5.83 | 35.89 | 64.87 | 611 | 100.2 | 17.14 |
| 2 | 10 | 50 | 30 | 12.71 | 54.28 | 19.26 | 3.50 | 35.05 | 6.04 | 37.21 | 66.03 | 728 | 103.0 | 20.99 |
| 3 | 10 | 50 | 60 | 12.67 | 53.58 | 19.45 | 3.33 | 35.87 | 5.81 | 36.53 | 65.67 | 799 | 102.8 | 23.00 |
| 4 | 35 | 50 | 0 | 12.44 | 53.58 | 18.11 | 3.72 | 33.37 | 6.51 | 37.19 | 66.77 | 901 | 99.8 | 25.18 |
| 5 | 35 | 50 | 30 | 13.25 | 53.42 | 18.55 | 3.62 | 34.29 | 6.35 | 37.12 | 66.86 | 956 | 100.9 | 27.01 |
| 6 | 35 | 50 | 60 | 13.56 | 52.91 | 18.35 | 3.78 | 34.25 | 6.69 | 37.74 | 68.57 | 1,037 | 101.1 | 29.35 |
| 7 | 35 | 50 | 90 | 13.29 | 54.16 | 18.88 | 3.70 | 34.45 | 6.42 | 37.86 | 67.37 | 1,074 | 102.7 | 30.88 |
| 8 | 60 | 50 | 0 | 13.28 | 54.79 | 17.85 | 4.05 | 32.18 | 6.99 | 38.63 | 68.04 | 939 | 100.7 | 26.48 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 60 | 50 | 30 | 13.34 | 53.74 | 17.75 | 4.03 | 32.60 | 7.07 | 38.42 | 68.87 | 986 | 100.2 | 27.74 |
| 10 | 60 | 50 | 60 | 12.42 | 54.37 | 18.07 | 3.99 | 32.81 | 6.93 | 38.54 | 68.36 | 1,079 | 101.2 | 30.57 |
| 11 | 35 | 0 | 60 | 13.08 | 53.11 | 18.46 | 3.69 | 34.32 | 6.51 | 37.40 | 67.72 | 857 | 101.0 | 24.24 |
| 12 | 35 | 100 | 60 | 12.37 | 53.69 | 18.53 | 3.76 | 34.08 | 6.57 | 37.82 | 67.78 | 1,215 | 101.7 | 34.60 |
| 13 | 60 | 50 | 90 | 12.32 | 54.35 | 17.89 | 4.02 | 32.51 | 6.99 | 38.51 | 68.37 | 1,081 | 100.7 | 30.48 |
| **Means Associated with Changes in Level of N, P, and K; Averages for Both Locations** | | | | | | | | | | | | | | |
| Nitrogen levels | 10 | 50 | [5] | 12.46 | 52.93 | 18.19 | 3.37 | 34.18 | 5.94 | 35.65 | 64.65 | 603 | 98.4 | 16.61 |
| | 35 | 50 | [5] | 12.39 | 53.31 | 17.97 | 3.71 | 33.27 | 6.52 | 36.99 | 66.71 | 871 | 98.9 | 24.11 |
| | 60 | 50 | [5] | 12.23 | 54.20 | 17.48 | 4.03 | 31.82 | 7.02 | 38.14 | 67.84 | 965 | 98.8 | 26.70 |
| Potash levels A | [6] | 50 | 0 | 12.44 | 53.13 | 17.00 | 3.83 | 31.52 | 6.78 | 36.67 | 66.33 | 728 | 95.4 | 19.45 |
| | [6] | 50 | 30 | 12.49 | 53.62 | 18.12 | 3.71 | 33.37 | 6.49 | 37.16 | 66.69 | 813 | 99.7 | 22.70 |
| | [6] | 50 | 60 | 12.19 | 53.69 | 18.67 | 3.56 | 34.35 | 6.21 | 36.95 | 66.19 | 897 | 101.1 | 25.39 |
| Potash levels B | [7] | 50 | 0 | 12.43 | 53.58 | 16.82 | 3.99 | 30.94 | 7.02 | 37.30 | 66.97 | 832 | 96.1 | 22.39 |
| | [7] | 50 | 30 | 12.46 | 53.74 | 17.96 | 3.86 | 33.01 | 6.77 | 37.79 | 67.73 | 912 | 100.0 | 25.54 |
| | [7] | 50 | 60 | 12.10 | 53.95 | 18.40 | 3.60 | 33.69 | 6.52 | 37.61 | 66.82 | 1,008 | 101.1 | 28.54 |
| | [7] | 50 | 90 | 12.29 | 54.15 | 18.78 | 3.69 | 34.27 | 6.40 | 37.70 | 67.09 | 1,023 | 102.2 | 29.27 |
| Phosphate levels [8] | 35 | 0 | 60 | 12.38 | 53.16 | 18.41 | 3.60 | 34.19 | 6.34 | 36.91 | 66.74 | 838 | 100.3 | 23.53 |
| | 35 | 50 | 60 | 12.61 | 53.32 | 18.66 | 3.58 | 34.56 | 6.27 | 37.02 | 66.75 | 954 | 101.1 | 27.00 |
| | 35 | 100 | 60 | 11.94 | 53.28 | 18.18 | 3.61 | 33.66 | 6.33 | 36.64 | 66.14 | 1,030 | 101.7 | 29.33 |

[1] Inaugurated 1944. Treatments were applied to quadruplicate plots; samples taken at first picking for cottonseed analysis.

[2] Average from 4 replicate plots shown on a basis of fuzzy seed at 10-per cent moisture content grade is represented by quantity index at prime quality. Acre value of seed calculated at $56 per ton for basis grade seed. Seed and kernel capacity measured as percentages of oil plus protein (5.13 × percent $NH_3$).

[3] Experiment conducted on Norfolk fine sandy loam.

[4] Experiment conducted on Cecil gravelly loam.

[5] Average effect for 0, 30, and 60 pounds of potash in complete series: Treatments 1–6, 8–10, inclusive.

[6] Average effect for 10, 35, and 60 pounds of nitrogen in complete series: Treatments 1–6, 8–10, inclusive.

[7] Average for 35 and 60 pounds of nitrogen: Treatments 4–10, inclusive, and 13.

[8] Treatments 6, 11, 12.

TABLE 53.—*Effect of various fertilizer treatments on sea-island cotton at Leesburg and Gainesville, Fla., 1943*

[Experiments 14 and 15][1]

EXPERIMENTAL DATA[2]

| Treatment No. and main effect | Fertilization | | | | Leesburg, Fla. | | | | | Gainesville, Fla. | | | | | Both locations | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Acre rate | Oil in seed | Ammonia in seed | Grade | Acre yield of seed | Acre value of seed | Oil in in seed | Ammonia in seed | Grade | Acre yield of seed | Acre value of seed | Grade | Acre value of seed |
| | *Pct.* | *Pct.* | *Pct.* | *Pounds* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* | *Points* | *Dollars* |
| 1 | 3 | 5 | 4 | 300 | 20.80 | 3.29 | 107.9 | 235 | 7.10 | 21.25 | 3.09 | 108.5 | 385 | 11.70 | 108.2 | 9.40 |
| | | | | 600 | 21.67 | 3.23 | 111.1 | 206 | 6.41 | 21.41 | 3.11 | 109.3 | 518 | 15.85 | 110.8 | 11.13 |
| 2 | 3 | 5 | 8 | 300 | 21.30 | 3.31 | 110.1 | 204 | 6.29 | 21.88 | 3.14 | 111.4 | 408 | 12.73 | 110.8 | 9.51 |
| | | | | 600 | 21.46 | 3.26 | 110.4 | 236 | 7.29 | 21.79 | 3.10 | 110.8 | 541 | 16.79 | 110.6 | 12.04 |
| 3 | 3 | 10 | 4 | 300 | 20.98 | 3.30 | 108.7 | 216 | 6.57 | 21.75 | 2.97 | 109.8 | 394 | 12.11 | 109.3 | 9.34 |
| | | | | 600 | 21.03 | 3.25 | 108.6 | 268 | 8.15 | 21.02 | 3.06 | 107.4 | 502 | 15.10 | 108.0 | 11.63 |
| 4 | 3 | 10 | 8 | 300 | 20.14 | 3.20 | 104.8 | 211 | 6.19 | 21.54 | 2.97 | 109.0 | 453 | 13.83 | 106.9 | 10.01 |
| | | | | 600 | 21.44 | 3.24 | 110.2 | 258 | 7.96 | 21.36 | 3.07 | 108.9 | 523 | 15.95 | 109.6 | 11.96 |
| 5 | 6 | 5 | 4 | 300 | 20.79 | 3.19 | 107.3 | 233 | 7.00 | 21.44 | 3.02 | 108.9 | 458 | 13.97 | 108.1 | 10.49 |
| | | | | 600 | 20.85 | 3.04 | 106.6 | 307 | 9.16 | 21.39 | 3.20 | 109.8 | 480 | 14.76 | 108.2 | 11.96 |
| 6 | 6 | 5 | 8 | 300 | 21.04 | 3.29 | 108.7 | 253 | 7.70 | 21.79 | 2.94 | 109.8 | 497 | 15.28 | 109.3 | 11.49 |
| | | | | 600 | 21.00 | 3.21 | 108.3 | 349 | 10.58 | 21.34 | 3.28 | 110.0 | 560 | 17.25 | 109.2 | 13.92 |
| 7 | 6 | 10 | 4 | 300 | 20.13 | 3.21 | 104.8 | 260 | 7.63 | 21.60 | 3.01 | 109.5 | 500 | 15.34 | 107.2 | 11.49 |
| | | | | 600 | 21.26 | 3.29 | 109.8 | 282 | 8.67 | 21.24 | 3.00 | 108.0 | 510 | 15.43 | 108.9 | 12.05 |
| 8 | 6 | 10 | 8 | 300 | 21.05 | 3.28 | 108.9 | 227 | 6.92 | 21.44 | 2.97 | 108.6 | 511 | 15.54 | 108.8 | 11.23 |
| | | | | 600 | 21.62 | 3.14 | 110.3 | 341 | 10.53 | 21.05 | 3.26 | 108.8 | 534 | 16.27 | 109.6 | 13.40 |

AVERAGE MAIN EFFECTS

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen: | | | | | | | | | | | | | | | | |
| 3 percent | | | | | 21.10 | 3.26 | 109.0 | 230 | 7.02 | 21.50 | 3.06 | 109.4 | 466 | 14.28 | 109.3 | 10.65 |
| 6 percent | | | | | 20.98 | 3.21 | 108.2 | 281 | 8.51 | 21.41 | 3.09 | 109.2 | 506 | 15.48 | 108.7 | 12.00 |
| Phosphorus: | | | | | | | | | | | | | | | | |
| 5 percent | | | | | 21.12 | 3.23 | 108.9 | 253 | 7.71 | 21.54 | 3.11 | 109.8 | 481 | 14.79 | 109.4 | 11.25 |
| 10 percent | | | | | 20.96 | 3.24 | 108.3 | 258 | 7.82 | 21.37 | 3.04 | 108.8 | 491 | 14.97 | 108.6 | 11.40 |
| Potassium: | | | | | | | | | | | | | | | | |
| 4 percent | | | | | 20.94 | 3.23 | 108.2 | 251 | 7.60 | 21.39 | 3.06 | 108.9 | 468 | 14.27 | 108.6 | 10.95 |
| 8 percent | | | | | 21.14 | 3.24 | 109.0 | 260 | 7.93 | 21.53 | 3.09 | 109.7 | 504 | 15.49 | 109.4 | 11.69 |
| Acre rate: | | | | | | | | | | | | | | | | |
| 300 pounds | | | | | 20.79 | 3.26 | 107.7 | 230 | 6.93 | 21.58 | 3.01 | 109.4 | 451 | 13.82 | 108.6 | 10.37 |
| 600 pounds | | | | | 21.29 | 3.21 | 109.5 | 281 | 8.61 | 21.33 | 3.14 | 109.2 | 521 | 15.93 | 109.4 | 12.28 |
| Location means | | | | | 21.04 | 3.23 | 108.6 | 256 | 7.78 | 21.46 | 3.08 | 109.3 | 486 | 14.87 | 109.0 | 11.33 |

[1] Inaugurated in 1942 on Arredonda loamy fine sand, at Gainesville, and on Blanton fine sand at Leesburg. Locations, each containing four randomized blocks, are confounded in the factorial design with varieties: Seabrook strain Z-10 planted at Leesburg (experiment 14) and Seabrook strain Z at Gainesville (experiment 15). Data are results from analyses of cottonseed sampled once, 100 bolls per sample.

[2] Data given are averages from 4 replicates. Percentage composition based on 10-percent moisture in the fuzzy seed. Grade is quantity index at prime quality. Acre yields calculated from replicate yields. Acre values calculated at $56 per ton for basis grade seed.

TABLE 54.—*Effect of potassium and sodium fertilizers on sea-island cotton, at Leesburg and Gainesville, Fla., 1943*

[Experiments 16 and 17][1]

EXPERIMENTAL DATA[2]

| Treatment No. and main effect | Acre rate of fertilization with— | | | | Leesburg, Fla. | | | | | Gainesville, Fla. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_2$ | $K_2O$ | $Na_2O$ | Oil in seed | Ammonia in seed | Grade | Acre yield of seed | Acre value of seed | Oil in seed | Ammonia in seed | Grade | Acre yield of seed | Acre value of seed |
| | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* | *Percent* | *Percent* | *Points* | *Pounds* | *Dollars* |
| 1 | 20 | 32 | 20 | 0 | 21.20 | 3.28 | 109.5 | 276 | 8.46 | 20.92 | 3.15 | 107.6 | 365 | 11.00 |
| 2 | 20 | 32 | 35 | 0 | 21.57 | 3.25 | 110.8 | 294 | 9.12 | 20.77 | 3.20 | 105.3 | 364 | 10.73 |
| 3 | 28 | 32 | 35 | 0 | 20.93 | 3.32 | 108.6 | 352 | 10.71 | 21.60 | 3.46 | 112.2 | 396 | 12.44 |
| 4 | 20 | 32 | 50 | 0 | 21.29 | 3.34 | 110.2 | 285 | 8.79 | 21.26 | 3.09 | 108.6 | 332 | 10.09 |
| 5 | 20 | 32 | 20 | 17 | 20.94 | 3.33 | 108.7 | 264 | 8.04 | 21.64 | 3.15 | 110.5 | 334 | 10.33 |
| 6 | 28 | 32 | 20 | 17 | 20.85 | 3.38 | 108.7 | 304 | 9.25 | 20.53 | 3.26 | 106.7 | 358 | 10.70 |
| 7 | 20 | 32 | 0 | 17 | 22.08 | 3.42 | 113.8 | 293 | 9.34 | 20.51 | 3.37 | 107.3 | 325 | 9.76 |
| 8 | 28 | 32 | 0 | 17 | 22.29 | 3.55 | 115.5 | 267 | 8.63 | 19.94 | 3.65 | 106.7 | 352 | 10.52 |
| 9 | 20 | 32 | 0 | 34 | 21.47 | 3.34 | 110.9 | 297 | 9.23 | 20.97 | 3.44 | 109.5 | 211 | 6.47 |
| 10 | 20 | 32 | 17½ | 11 | 21.78 | 3.35 | 112.2 | 278 | 8.73 | 20.47 | 3.19 | 106.0 | 309 | 9.17 |
| MAIN EFFECTS | | | | | | | | | | | | | | |
| Increase in potash | 20 | 32 | 20 | 0 | 21.20 | 3.28 | 109.5 | 276 | 8.46 | 20.92 | 3.15 | 107.6 | 365 | 11.00 |
| | 20 | 32 | 35 | 0 | 21.57 | 3.25 | 110.8 | 294 | 10.71 | 20.77 | 3.20 | 105.3 | 364 | 10.73 |
| | 20 | 32 | 50 | 0 | 21.29 | 3.34 | 110.2 | 285 | 8.79 | 21.26 | 3.09 | 108.6 | 332 | 10.09 |
| Increase in soda | 20 | 32 | 0 | 17 | 22.08 | 3.42 | 113.8 | 293 | 9.34 | 20.51 | 3.37 | 107.3 | 325 | 9.76 |
| | 20 | 32 | 0 | 34 | 21.47 | 3.34 | 110.9 | 297 | 9.23 | 20.97 | 3.44 | 109.5 | 211 | 6.47 |
| Increase in both potash and soda | 20 | 32 | 17½ | 11 | 21.78 | 3.35 | 112.2 | 278 | 8.73 | 20.47 | 3.19 | 106.0 | 309 | 9.17 |
| | 20 | 32 | 20 | 17 | 20.94 | 3.33 | 108.7 | 264 | 8.04 | 21.64 | 3.15 | 110.5 | 334 | 10.33 |

[1] See footnote 1, table 53, for varieties and types of soil; same type of analyses used. Experiment 16 conducted at Leesburg; 17, at Gainesville.

[2] Calculated to a basis of 10 percent moisture in fuzzy cottonseed with quantity index representing grade and $56 per ton utilized in calculations for acre value of cottonseed.

TABLE 55.—*Results [1] of different rates of potash application on sea-island cotton, at Tifton, Ga., 1944*

[Experiment 18] [2]

| Rate of $K_2O$ (pounds) | Sea-island strain [3] | Seed content: Oil | Seed content: Ammonia | Seed content: Grade |
|---|---|---|---|---|
| | | *Percent* | *Percent* | *Points* |
| 0 | TZ | 20.14 | 3.75 | 108.1 |
| 50 | do | 20.53 | 3.58 | 108.6 |
| 100 | do | 19.45 | 3.59 | 104.3 |
| 3-8-0 [4] | do | 15.26 | 3.58 | 85.8 |
| 0 | TZ-114 | 19.30 | 3.78 | 104.9 |
| 50 | do | 20.73 | 3.91 | 111.4 |
| 100 | do | 20.75 | 3.70 | 110.2 |
| 3-8-0 [4] | do | 17.58 | 3.80 | 98.1 |
| 0 | TZRV | 20.39 | 3.70 | 108.8 |
| 50 | do | 20.97 | 3.56 | 110.2 |
| 100 | do | 21.26 | 3.62 | 111.8 |
| 3-8-0 [4] | do | 16.85 | 3.92 | 95.8 |
| 0 | Z | 20.72 | 3.75 | 110.4 |
| 50 | do | 21.00 | 3.73 | 111.4 |
| 100 | do | 22.25 | 3.82 | 116.9 |
| 3-8-0 [4] | do | 19.14 | 3.75 | 104.1 |
| 0 | Z-8 | 22.44 | 3.74 | 117.2 |
| 50 | do | 20.94 | 3.57 | 110.2 |
| 100 | do | 20.66 | 3.70 | 109.8 |
| 3-8-0 [4] | do | 18.22 | 3.74 | 100.3 |
| 0 | Z-10 | 20.49 | 3.64 | 108.8 |
| 50 | do | 21.21 | 3.97 | 113.7 |
| 100 | do | 19.44 | 3.63 | 104.5 |
| 3-8-0 [4] | do | 19.26 | 3.82 | 105.0 |
| 0 | Gaddis | 21.78 | 3.57 | 113.5 |
| 50 | do | 21.12 | 3.62 | 111.2 |
| 100 | do | 21.06 | 3.74 | 111.7 |
| 3-8-0 [4] | do | 17.98 | 3.70 | 99.1 |
| Averages: | | | | |
| 0 | All strains | 20.75 | 3.70 | 110.2 |
| 50 | do | 20.93 | 3.71 | 111.0 |
| 100 | do | 20.70 | 3.69 | 109.9 |
| 3-8-0 [4] | do | 17.76 | 3.76 | 98.3 |

[1] Nonreplicated data. Percentages based on fuzzy seed at 10-percent moisture content. Grade is calculated as quantity index at prime quality.

[2] Conducted on Tifton sandy loam. Analytical samples represent seed from 50 bolls taken from each of 4 replicate plots.

[3] Code for sea-island strains: T = Westbury; Z = Seabrook 12 B 2; R = Puerto Rico; V = Bleak Hall.

[4] 500 pounds of fertilizer used. These rows planted without potash to observe fruiting development of plants and effect on fiber properties and seed analysis.

**TABLE 56.**—*Results* [1] *of different rates of nitrogen and potash applications on sea-island cotton, at Leesburg and McIntosh, Fla., 1944*

[Experiment 19] [2]

| Fertilizer [3] treatment | Strain [4] | McIntosh, Fla. | | | Leesburg, Fla. | | |
|---|---|---|---|---|---|---|---|
| | | Oil in seed | Ammonia in seed | Grade | Oil in seed | Ammonia in seed | Grade |
| | | *Percent* | *Percent* | *Points* | *Percent* | *Percent* | *Points* |
| None | TZ | 21.49 | 4.38 | 117.2 | 18.32 | 4.37 | 104.5 |
| N | do | 20.63 | 3.69 | 109.7 | 19.04 | 4.78 | 109.8 |
| K | do | 22.06 | 3.77 | 115.9 | 19.44 | 4.26 | 108.3 |
| NK | do | 21.43 | 4.13 | 115.5 | 19.20 | 4.53 | 109.0 |
| None | TZ 144 | 20.67 | 4.07 | 112.1 | 18.75 | 4.64 | 107.8 |
| N | do | 21.38 | 4.03 | 114.7 | 18.67 | 4.96 | 109.4 |
| K | do | 20.30 | 3.97 | 110.4 | 19.32 | 4.37 | 108.5 |
| NK | do | 21.55 | 4.10 | 115.8 | 18.74 | 4.65 | 107.9 |
| None | TZRV | 18.99 | 3.88 | 104.2 | 19.29 | 4.73 | 110.5 |
| N | do | 18.81 | 4.24 | 105.7 | 20.20 | 5.02 | 115.9 |
| K | do | 19.50 | 3.87 | 106.2 | 18.99 | 4.82 | 109.9 |
| NK | do | 20.74 | 4.21 | 113.2 | 19.58 | 4.90 | 112.7 |
| None | Z | 17.85 | 3.89 | 99.7 | 19.03 | 4.30 | 106.9 |
| N | do | 20.16 | 3.79 | 108.4 | 20.02 | 4.80 | 113.9 |
| K | do | 22.81 | 3.80 | 119.0 | 19.54 | 4.38 | 109.4 |
| NK | do | 20.12 | 4.10 | 100.1 | 19.89 | 4.43 | 111.1 |
| None | Z 8 | 20.91 | 3.87 | 111.9 | 21.06 | 4.03 | 113.4 |
| N | do | 20.84 | 4.32 | 114.3 | 19.87 | 4.66 | 112.4 |
| K | do | 21.46 | 3.85 | 113.9 | 20.78 | 4.51 | 115.2 |
| NK | do | 21.64 | 3.85 | 114.7 | 21.00 | 4.70 | 117.2 |
| None | Z 10 | 20.84 | 4.00 | 112.4 | 19.79 | 4.32 | 110.1 |
| N | do | 20.02 | 3.91 | 108.5 | 18.32 | 4.62 | 106.0 |
| K | do | 20.24 | 3.92 | 109.5 | 19.30 | 4.32 | 108.1 |
| NK | do | 21.56 | 4.00 | 115.2 | 19.37 | 4.63 | 109.3 |
| Averages for treatments: | | | | | | | |
| None | All strains | 20.13 | 4.02 | 109.6 | 19.37 | 4.40 | 108.9 |
| N | do | 20.31 | 3.92 | 109.8 | 19.35 | 4.81 | 111.3 |
| K | do | 21.08 | 3.86 | 112.5 | 19.58 | 4.44 | 110.0 |
| NK | do | 21.17 | 4.07 | 114.1 | 19.63 | 4.64 | 111.4 |

[1] Nonreplicated data. Percentages based on fuzzy seed at 10-percent moisture content. Grade is calculated as quantity index at prime quality.

[2] At Leesburg, experiment was conducted on Norfolk fine sandy loam; at McIntosh, on Arredonda and Gainesville fine sandy loams. Samples represent seed from 100 bolls taken from each of 12 replicate plots.

[3] At Leesburg, 500 pounds, and at McIntosh, 260 pounds, of 4-7-5 in drill 4 days before planting. N=16 pounds per acre $NaNO_3$; K=30 pounds $K_2O$ as muriate; and NK combination of N and K.

[4] See table 55 for code.

TABLE 57.—*Results of two studies on regional wilt varieties and influence of potash fertilizers, at Hamlet and Orangeburg, S. C., 1939*

AT HAMLET[1]

| Condition and variety | Composition of fertilizer: N | Composition of fertilizer: $P_2O_5$ | Composition of fertilizer: $K_2O$ | Composition[2] of seed as affected by treatment, variety, and disease — Seed: Index | Seed: Oil | Seed: Ammonia | Seed: Proportion | Kernels: Oil | Kernels: Ammonia | Kernels: Capacity[3] | Kernels: Ratio[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Grams* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | |
| Healthy: | | | | | | | | | | | |
| Clevewilt 7 | 6 | 8 | 0 | 8.95 | 21.96 | 4.96 | 60.43 | 36.35 | 8.22 | 78.95 | 0.862 |
| | 6 | 8 | 4 | 10.04 | 22.61 | 4.69 | 61.89 | 36.56 | 7.58 | 75.44 | .940 |
| | 6 | 8 | 8 | 10.05 | 24.09 | 4.77 | 62.91 | 38.31 | 7.58 | 77.19 | .985 |
| Cook 307 | 6 | 8 | 0 | 9.12 | 22.99 | 5.07 | 65.24 | 35.22 | 7.77 | 75.08 | .883 |
| | 6 | 8 | 4 | 9.39 | 25.49 | 4.97 | 66.26 | 38.49 | 7.49 | 76.91 | 1.001 |
| | 6 | 8 | 8 | 10.37 | 25.67 | 4.84 | 67.16 | 38.22 | 7.54 | 76.90 | .988 |
| Diseased: | | | | | | | | | | | |
| Coker 100 | 6 | 8 | 0 | 6.55 | 13.77 | 5.12 | 51.02 | 26.29 | 10.16 | 78.41 | .504 |
| | 6 | 8 | 4 | 8.10 | 19.71 | 5.29 | 61.13 | 32.31 | 8.65 | 76.58 | .726 |
| | 6 | 8 | 8 | 8.29 | 19.10 | 5.41 | 59.82 | 31.89 | 9.08 | 78.47 | .685 |
| Rowden 2088 | 6 | 8 | 0 | 7.37 | 16.12 | 5.35 | 57.97 | 27.78 | 9.23 | 75.13 | .587 |
| | 6 | 8 | 4 | 9.54 | 21.20 | 5.32 | 64.36 | 32.94 | 8.27 | 75.36 | .776 |
| | 6 | 8 | 8 | 9.15 | 20.37 | 5.38 | 63.05 | 32.29 | 8.54 | 76.10 | .737 |
| Average of two healthy varieties | 6 | 8 | 0 | 9.04 | 22.48 | 5.02 | 62.84 | 35.79 | 8.00 | 76.83 | .872 |
| | 6 | 8 | 4 | 9.74 | 24.05 | 4.83 | 64.08 | 37.53 | 7.53 | 76.16 | .972 |
| | 6 | 8 | 8 | 10.21 | 24.88 | 4.81 | 65.04 | 38.27 | 7.56 | 77.05 | .987 |
| Average of two diseased varieties | 6 | 8 | 0 | 6.96 | 14.95 | 5.24 | 54.50 | 27.04 | 9.70 | 76.80 | .543 |
| | 6 | 8 | 4 | 8.82 | 20.46 | 5.31 | 62.75 | 32.58 | 8.46 | 75.88 | .750 |
| | 6 | 8 | 8 | 8.72 | 19.74 | 5.40 | 61.44 | 32.09 | 8.81 | 77.28 | .710 |
| Average of all varieties | 6 | 8 | 0 | 8.00 | 18.72 | 5.13 | 58.67 | 31.42 | 8.85 | 76.89 | .708 |
| | 6 | 8 | 4 | 9.28 | 22.25 | 5.07 | 63.41 | 35.06 | 8.00 | 76.07 | .861 |
| | 8 | 8 | 8 | 9.47 | 22.31 | 5.11 | 63.24 | 35.18 | 8.18 | 77.17 | .849 |

TABLE 57.—*Results of two studies on regional wilt varieties and influence of potash fertilizers, at Hamlet and Orangeburg, S. C., 1939*—Continued

AT ORANGEBURG[5]

| Condition and variety | Composition of fertilizer | | | Composition[2] of seed as affected by treatment, variety, and disease | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Seed | | | | Kernels | | | |
| | N | $P_2O_5$ | $K_2O$ | Index | Oil | Ammonia | Proportion | Oil | Ammonia | Capacity[3] | Ratio[4] |
| Healthy: | *Percent* | *Percent* | *Percent* | *Grams* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | |
| Cook 307 | 6 | 8 | 0 | 9.35 | 24.17 | 5.40 | 67.37 | 35.53 | 7.67 | 74.88 | 0.903 |
| | 6 | 8 | 4 | 9.84 | 23.88 | 5.18 | 66.01 | 35.81 | 7.49 | 74.23 | .932 |
| | 6 | 8 | 8 | 9.50 | 24.44 | 5.47 | 67.25 | 35.52 | 7.29 | 72.92 | .950 |
| Rowden 2088 | 6 | 8 | 0 | 10.84 | 23.70 | 5.53 | 67.66 | 34.92 | 7.84 | 75.14 | .868 |
| | 6 | 8 | 4 | 10.38 | 24.12 | 5.40 | 68.38 | 35.17 | 7.58 | 74.05 | .905 |
| | 6 | 8 | 8 | 10.79 | 23.12 | 5.12 | 67.37 | 34.18 | 7.40 | 72.14 | .900 |
| Diseased: | | | | | | | | | | | |
| Cook 507 | 6 | 8 | 0 | 7.84 | 21.17 | 5.32 | 63.38 | 33.01 | 7.98 | 73.95 | .896 |
| | 6 | 8 | 4 | 8.08 | 23.79 | 5.33 | 65.14 | 35.97 | 7.80 | 75.98 | .899 |
| | 6 | 8 | 8 | 8.33 | 24.26 | 4.84 | 66.14 | 36.38 | 7.62 | 75.47 | .931 |
| Rowden 2088 | 6 | 8 | 0 | 10.16 | 22.78 | 5.51 | 66.81 | 33.99 | 7.95 | 74.77 | .833 |
| | 6 | 8 | 4 | 9.79 | 24.27 | 5.26 | 67.68 | 35.73 | 7.44 | 73.90 | .936 |
| | 6 | 8 | 8 | 9.38 | 23.68 | 5.00 | 66.21 | 35.74 | 7.19 | 72.62 | .969 |
| Average of all varieties for potash | 6 | 8 | 0 | 9.55 | 22.96 | 5.44 | 66.30 | 34.37 | 7.87 | 74.74 | .851 |
| | 6 | 8 | 4 | 9.53 | 24.02 | 5.30 | 66.80 | 35.67 | 7.58 | 74.55 | .917 |
| | 6 | 8 | 8 | 9.51 | 23.88 | 5.13 | 66.75 | 35.46 | 7.39 | 73.37 | .935 |

[1] Experiment 20. Seed not available for a complete variety by plant condition series. This experiment is presented as an example of treatment that significantly altered cottonseed composition. See experiment 21 (second part of table) for contrast. Earlier publications: (*19*, *27*).

[2] Averages for 3 replicate plots. Determinations all based on acid-delinted, moisture-free seed.

[3] Capacity equals percentage of oil in kernels plus percentage of protein ($NH_3$ × 5.13) in kernels.

[4] Ratio equals percentage of oil/percentage of protein in kernels.

[5] Experiment 21. The variety, Cook 307, considered highly resistant to wilt; the variety, Rowden 2088, tolerant or intermediate. In this location, treatment with potash had negligible effect on cottonseed composition. Earlier publication (*1*).

TABLE 58.—*Results of treatments with and without manure and irrigation and influence of disease on analysis of cottonseed, 1944*

[Experiment 22][1]

| Treatment and picking dates | Oil in seed | | | Ammonia in seed | | | Grade[2] | | | Capacity[3] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Points* | *Points* | *Points* | *Percent* | *Percent* | *Percent* |
| **Irrigated, plus manure:** | | | | | | | | | | | | |
| Sept. 10 | 17.92 | 13.10 | 14.64 | 4.09 | 3.92 | 3.97 | 101.2 | 74.1 | 82.8 | 38.90 | 33.21 | 35.03 |
| Oct. 5 | 17.87 | 14.73 | 15.61 | 3.97 | 3.86 | 3.89 | 100.3 | 83.5 | 88.7 | 38.24 | 34.53 | 35.57 |
| Weighted mean | 17.90 | 13.81 | 15.05 | 4.05 | 3.89 | 3.94 | 100.8 | 78.2 | 85.1 | 38.64 | 33.79 | 35.26 |
| **Irrigated:**[4] | | | | | | | | | | | | |
| Sept. 10 | 20.14 | 14.36 | 16.90 | 3.94 | 3.80 | 3.86 | 109.2 | 81.0 | 93.4 | 40.35 | 33.85 | 36.71 |
| Oct. 5 | 18.21 | 18.70 | 18.46 | 3.90 | 3.81 | 3.86 | 101.2 | 102.7 | 102.0 | 38.22 | 38.24 | 38.23 |
| Weighted mean | 19.09 | 16.46 | 17.70 | 3.91 | 3.80 | 3.86 | 104.8 | 91.5 | 98.1 | 39.16 | 35.97 | 37.49 |
| **Dry, plus manure:** | | | | | | | | | | | | |
| Sept. 10 | 17.00 | 13.98 | 16.94 | 3.82 | 3.82 | 3.82 | 95.9 | 78.8 | 95.6 | 36.60 | 33.58 | 36.54 |
| Oct. 5 | 18.55 | 18.34 | 18.51 | 3.99 | 4.02 | 4.00 | 103.1 | 102.5 | 103.0 | 39.02 | 38.96 | 39.01 |
| Weighted mean | 17.46 | 17.67 | 17.47 | 3.81 | 3.99 | 3.84 | 98.0 | 98.9 | 98.3 | 37.35 | 38.14 | 37.38 |
| **Dry:** | | | | | | | | | | | | |
| Sept. 10 | 16.52 | 15.16 | 16.45 | 3.83 | 3.98 | 3.84 | 93.6 | 86.8 | 93.3 | 36.17 | 35.58 | 36.14 |
| Oct. 5 | 18.71 | 17.63 | 18.34 | 4.11 | 4.15 | 4.12 | 104.5 | 100.4 | 103.1 | 39.79 | 38.92 | 39.49 |
| Weighted mean | 17.17 | 17.15 | 17.17 | 3.91 | 4.12 | 3.94 | 96.8 | 97.7 | 97.0 | 37.24 | 38.27 | 37.41 |

**TABLE 58.**—*Results of treatments with and without manure and irrigation and influence of disease on analysis of cottonseed, 1944*—Continued

[Experiment 22] [1]

| Treatment and picking dates | Oil in seed | | | Ammonia in seed | | | Grade [2] | | | Capacity [3] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean | Live plants | Dead plants | Field-run, or weighted mean |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| All treatments: | | | | | | | | | | | | |
| Sept. 10 | 17.90 | 14.15 | 16.23 | 3.92 | 3.88 | 3.87 | 100.0 | 80.2 | 91.3 | 38.00 | 34.06 | 36.11 |
| Oct. 5 | 18.34 | 17.35 | 17.73 | 3.99 | 3.92 | 3.97 | 102.3 | 97.2 | 99.1 | 38.82 | 37.66 | 38.08 |
| Mean of weighted mean | 17.90 | 16.27 | 16.84 | 3.92 | 3.96 | 3.89 | 100.1 | 91.6 | 94.6 | 38.10 | 36.54 | 36.88 |

[1] Stoneville 2B cotton planted on Houston clay, at Temple, Tex. Death of plants caused by phymatotrichum root rot. Prior publication: (*11*).

[2] Calculated as quantity index with prime quality assumed (*26*).

[3] Sum of the percentage of oil in seed plus the percentage of protein ($NH_3 \times 5.13$) in seed.

[4] Seven weekly 1-inch irrigations applied.

TABLE 59.—*Analysis of cottonseed from irrigation studies in Arizona*

[Experiment 23][1]

| Variety, time of harvest, and treatment | Oil in seed | Ammonia in seed | Grade |
|---|---|---|---|
| S × P (planted): | | | |
| Picked early: | *Percent* | *Percent* | *Points* |
| Light irrigation | 21.42 | 4.76 | 119.2 |
| Heavy irrigation | 20.50 | 4.34 | 113.0 |
| Picked late: | | | |
| Light irrigation | 21.41 | 4.61 | 118.3 |
| Heavy irrigation | 21.61 | 4.18 | 116.5 |
| S × P (ratooned): | | | |
| Picked early: | | | |
| Light irrigation | 21.68 | 3.80 | 114.5 |
| Heavy irrigation | 21.56 | 4.08 | 115.7 |
| Picked late: | | | |
| Light irrigation | 22.04 | 4.25 | 118.7 |
| Heavy irrigation | 21.98 | 4.08 | 117.4 |
| Acala Shafter (planted): | | | |
| Picked late, 1937: | | | |
| Light irrigation | 17.25 | 4.29 | 99.7 |
| *Optimum irrigation* | 16.47 | 4.33 | 96.1 |
| Heavy irrigation | 16.10 | 4.27 | 94.1 |
| Picked early, 1938: | | | |
| Light irrigation | 16.29 | 4.27 | 95.0 |
| Optimum irrigation | 16.64 | 4.33 | 97.2 |
| Heavy irrigation | 16.24 | 4.56 | 96.6 |
| Picked late, 1938: | | | |
| Light irrigation | 17.33 | 4.18 | 99.4 |
| Optimum irrigation | 16.94 | 4.39 | 99.0 |
| Heavy irrigation | 16.35 | 4.32 | 95.7 |
| Averages: | | | |
| With S × P: | | | |
| Light irrigation | 21.64 | 4.36 | 117.7 |
| Heavy irrigation | 21.41 | 4.17 | 115.7 |
| With Acala Shafter: | | | |
| Light irrigation | 16.96 | 4.27 | 98.4 |
| Optimum irrigation | 16.68 | 4.35 | 97.5 |
| Heavy irrigation | 16.23 | 4.38 | 95.4 |

[1] Analyses of cottonseed from this experiment are from several tests and from different years.

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