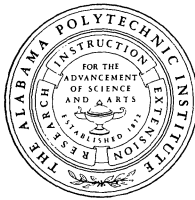


# EXPERIMENTS *with* OIL CROPS



**AGRICULTURAL EXPERIMENT STATION**  
*of the* **ALABAMA POLYTECHNIC INSTITUTE**

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Auburn, Alabama

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# EXPERIMENTS *with* OIL CROPS

D. G. STURKIE, Agronomist

THE UNITED STATES consumes large quantities of vegetable oils. In addition to the amount produced in this country during the 10-year period, 1930-1939, approximately 11 billion more pounds were imported for use. Difficulties encountered in importing oils during the war years emphasized the need for research on the possibility of increasing domestic production. In line with this need, the Alabama Agricultural Experiment Station expanded research with cotton, peanuts and soybeans, and additional work was started with oil crops not commonly grown by Alabama farmers. The new crops studied were: castorbeans, flax, hemp, benne, chia, perilla, safflower, and sunflower. This publication reports the results obtained with these new oil crops.

## CASTORBEANS

The castorbean, *Ricinus communis*, is often grown in Alabama as an ornamental and shade plant. It is referred to as castorbean, palma christi, or molebean. The plant is characterized by large colorful leaves and varies in size from a few feet in height to a height of 20 feet. Although there are numerous varieties of castorbeans, only a few low-growing varieties are suitable for commercial production. Castorbeans usually are produced for oil that is found in the seed. In general, large seeded varieties contain a lower percentage of oil but the variation is not great. Seed of most varieties contain approximately 50 per cent oil. The oil is used as a substitute for tung oil in the paint industry and in the manufacture of plastics. The refined oil is used for medicinal purposes. Since the seed and the meal remaining after the oil is extracted is poisonous to animals, the plant has no value as a feed. Attempts have been made to produce an insecticide from the leaves and stems, and to use the stalks for making paper.

## RESULTS OF VARIETY TESTS

VARIETIES. Variety tests were conducted at four locations in Alabama. In all tests the rows were 42 inches wide and the hills were spaced 3 feet apart with one stalk per hill. The fertilizer treatment consisted of an application of 600 pounds of 6-8-4 fertilizer per acre made before or at the time of planting. The spikes were harvested by hand as the seed ripened. Usually three pickings were made during the harvest period. The beans were hulled on a machine made for hulling small lots of castorbeans.

Tests were conducted at the Wiregrass Substation, Headland, on Norfolk sandy loam soil of above average fertility, Table 1. Tests at the Main Station, Auburn, were conducted on Norfolk sandy loam also of above average fertility, Table 2. Tests at the Tuskegee Experiment Field were on a Leaf soil low in fertility. Plants on this soil suffered from extremes of wet and drought. The yields obtained were the lowest of any of the tests in the State, Table 3. Tests at the Tennessee Valley Substation, Belle Mina, were conducted on a very fertile Decatur clay loam soil, Table 4.

Results of all of these tests show that Conner was probably the outstanding variety. Doughty 11 was also an excellent variety. Kentucky 38 produced good yields at Headland and at Auburn.

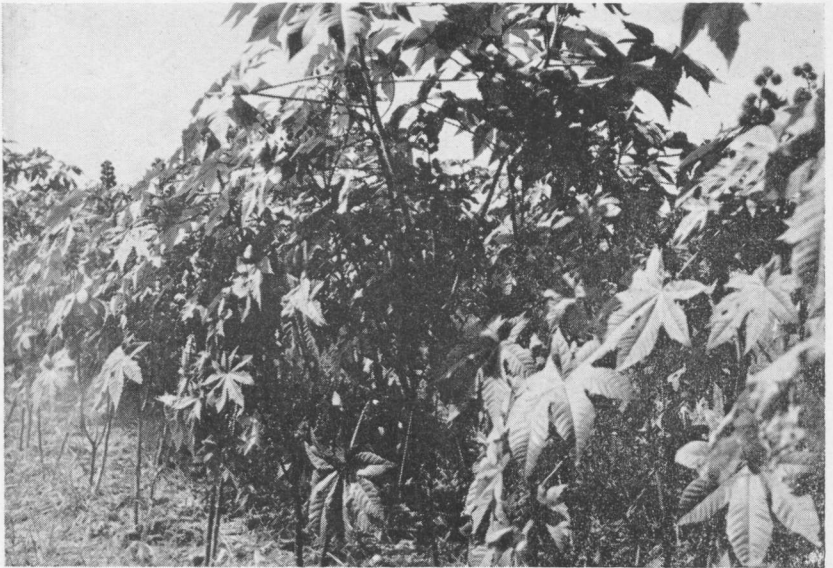


FIGURE 1. Conner variety of castorbean in variety tests at the Main Station, Auburn, Alabama

TABLE 1. RESULTS OBTAINED IN CASTORBEAN VARIETY TESTS, WIREGRASS SUBSTATION, HEADLAND, 1942-1943.

| Variety <sup>1</sup> | Yield per acre of shelled seed <sup>2</sup> |               | Shelling percentage |      | Average no. of spikes per plant |      | Average height per plant |               |
|----------------------|---|---------------|---------------------|------|---------------------------------|------|--------------------------|---------------|
|                      | 1942  | 1943          | 1942                | 1943 | 1942                            | 1943 | 1942                     | 1943          |
|                      | <i>Pounds</i>                               | <i>Pounds</i> |                     |      |                                 |      | <i>Inches</i>            | <i>Inches</i> |
| Conner .....         | 879   | 1,354         | 67                  | 69   | 2.4                             | 3.0  | 83                       | 84            |
| Doughty 11 .....     | 716   | 1,192         | 71                  | 72   | 0.9                             | 3.0  | 70                       | 79            |
| Kentucky 38 .....    | 900   | 898           | 75                  | 69   | 2.5                             | 7.0  | 66                       | 72            |
| Kansas Common .....  | 945   | —             | 74                  | —    | 3.5                             | —    | 66                       | —             |
| U. S. 4 .....        | 870   | —             | 74                  | —    | 3.6                             | —    | 62                       | —             |
| U. S. 7 .....        | 794   | —             | 71                  | —    | 4.2                             | —    | 62                       | —             |

<sup>1</sup>Planting dates: April 25, 1942; and April 23, 1943.

<sup>2</sup>Harvesting dates August 11, and November 15, 1942; and August 10, September 10, and November 6, 1943.

#### DESCRIPTION OF VARIETIES

**CONNER.** Conner is a medium height variety, averaging 5 to 7 feet, and develops a relatively small number of large spikes. The leaves are large and are dark reddish green. The seed are medium in size and are dark brown with white to gray mottling. The seed do not shatter easily.

Doughty 11, San Benito, and Kansas Common are varieties that are very similar to Conner and are probably closely related to it. The plants are medium to tall, averaging 6 to 7 feet. The leaves are large and the stems and leaves are reddish. The seed are medium in size. These varieties showed greater variation in plant characteristics than did Conner. This indicates that the seed used were not as pure as those of Conner, which may account for the lower yield of these varieties.

**KENTUCKY 38.** Plants are small, averaging 4 to 6 feet. The leaves, stems, and pods of this variety are characteristically marked with a beautiful pinkish red color. Plants of this variety, therefore, are very striking in appearance. The seed are red with brown mottling and are medium in size. The spikes are compact and are not as large as those of Conner. This variety does not appear to be able to withstand adverse conditions, particularly drought, as well as does Conner.

**U. S. 4 AND U. S. 7.** These two varieties appear to be very similar. They are small to medium in size, and the plants are much more branched than are those of Conner. The plants are blue green in color and produce relatively large numbers of spikes, which are very small and loose. The seed are relatively small and tend to shatter.

**SANGUINEUS.** This variety is medium to tall, averaging 5 to 7 feet. The seed used were not pure. Some stalks were quite similar to those

TABLE 2. RESULTS OBTAINED IN CASTORBEAN VARIETY TEST, MAIN STATION, AUBURN, 1940-1944.

| Variety <sup>1</sup>   | Yield per acre of shelled seed <sup>2</sup> |            |            |            |            | Shelling percentage |      |      | Average no. of spikes per plant |      | Average height per plant |            |
|------------------------|---|------------|------------|------------|------------|---------------------|------|------|---------------------------------|------|--------------------------|------------|
|                        | 1940  | 1941       | 1942       | 1943       | 1944       | 1942                | 1943 | 1944 | 1942                            | 1943 | 1942                     | 1943       |
|                        | <i>Lb.</i>                                  | <i>Lb.</i> | <i>Lb.</i> | <i>Lb.</i> | <i>Lb.</i> |                     |      |      |                                 |      | <i>In.</i>               | <i>In.</i> |
| Kentucky 38 .....      | —   | 876        | 1,045      | 955        | 1,468      | 65                  | 72   | 69   | 6.4                             | 7.2  | 43                       | 54         |
| Doughty 11 .....       | —   | 778        | 819        | 1,521      | 1,443      | 63                  | 71   | 67   | 3.2                             | 7.2  | 49                       | 74         |
| Conner .....           | —   | 1,134      | 1,011      | 1,205      | 1,413      | 66                  | 69   | 66   | 3.1                             | 5.8  | 49                       | 64         |
| Sanguineus .....       | 697   | 973        | 405        | 1,042      | 1,416      | 63                  | 67   | 70   | 8.0                             | 13.9 | 70                       | 74         |
| Kansas Common .....    | —   | —          | 914        | 1,131      | 1,198      | 66                  | 66   | 69   | 6.6                             | 13.0 | 41                       | 76         |
| San Benito .....       | —   | —          | 377        | 1,201      | 1,142      | 53                  | 66   | 68   | 4.0                             | 8.5  | 57                       | 76         |
| Flowering .....        | —   | —          | 638        | 637        | —          | 63                  | 40   | —    | 4.0                             | 5.0  | 75                       | 76         |
| U. S. 7 .....          | 562   | 1,154      | 1,014      | 987        | —          | 68                  | 73   | —    | 8.4                             | —    | —                        | 45         |
| U. S. 4 .....          | —   | 1,261      | 1,000      | —          | —          | —                   | 72   | —    | —                               | 8.0  | —                        | 44         |
| Small Commercial ..... | 334   | 474        | 180        | —          | —          | 61                  | —    | —    | 6.0                             | —    | 60                       | —          |
| Zanzibarensis .....    | 202   | 186        | 155        | 189        | —          | 72                  | 33   | —    | 2.1                             | 1.7  | 64                       | 108        |
| Colbert .....          | —   | —          | 442        | 616        | 1,380      | 50                  | 53   | 51   | 2.2                             | 5.0  | 48                       | 72         |
| Cullars .....          | —   | —          | 150        | 528        | 974        | 26                  | 54   | 48   | 4.4                             | 4.7  | 40                       | 74         |
| Gibson .....           | —   | —          | 165        | 459        | —          | 26                  | 51   | —    | 1.2                             | 8.9  | 72                       | 80         |
| Thorsby .....          | 68  | 417        | 220        | —          | —          | 53                  | —    | —    | 5.6                             | —    | 65                       | —          |

<sup>1</sup>Planting dates were May 10, 1940; May 12, 1941; April 20, 1942; April 7, 1943; and April 29, 1944.

<sup>2</sup>Harvesting dates were September 20 and November 20, 1940; September 30 and December 2, 1941; September 3, October 28, and December 7, 1942; August 27, September 14, and November 9, 1943; and September 23, November 2 and December 21, 1944.



FIGURE 2. Left: Close-up of castorbean flower stalk showing male and female flowers and young spike with developing seed. Right: Castorbean spike at maturity, ready for harvest.

TABLE 3. RESULTS OBTAINED IN CASTORBEAN VARIETY TEST, TUSKEGEE EXPERIMENT FIELD, 1942-1943

| Variety <sup>1</sup>   | Yield per acre shelled seed <sup>2</sup> |               | Shelling percentage |      | Average no. of spikes per plant |      | Average height per plant |               |
|------------------------|--|---------------|---------------------|------|---------------------------------|------|--------------------------|---------------|
|                        | 1942                                     | 1943          | 1942                | 1943 | 1942                            | 1943 | 1942                     | 1943          |
|                        | <i>Pounds</i>                            | <i>Pounds</i> |                     |      |                                 |      | <i>Inches</i>            | <i>Inches</i> |
| Conner .....           | 596                                      | 329           | 66                  | 59   | 2.7                             | 2.3  | 56                       | 53            |
| Kansas Common .....    | 554                                      | 299           | 73                  | 63   | 4.5                             | 1.3  | 50                       | 44            |
| Doughty 11 .....       | 567                                      | 283           | 65                  | 59   | 2.5                             | 1.7  | 52                       | 47            |
| Sanguineus .....       | 395                                      | 223           | 69                  | 56   | 3.6                             | 3.3  | 58                       | 34            |
| Kentucky 38 .....      | 390                                      | 154           | 66                  | 47   | 4.9                             | 3.2  | 41                       | 38            |
| U. S. 4 .....          | 431                                      | —             | 74                  | —    | 5.1                             | —    | 53                       | —             |
| U. S. 7 .....          | 278                                      | —             | 75                  | —    | 3.2                             | —    | 39                       | —             |
| Zanzibarensis .....    | 343                                      | —             | 53                  | —    | 1.6                             | —    | 81                       | —             |
| Small Commercial ..... | 104                                      | —             | 59                  | —    | 4.0                             | —    | 49                       | —             |
| Thorsby .....          | 88                                       | —             | 61                  | —    | 2.9                             | —    | 54                       | —             |

<sup>1</sup>Dates planted were April 28, 1942; and June 7, 1943.

<sup>2</sup>Dates harvested were September 1 and 30 and October 30, 1942; and September 24, October 18, and November 9, 1943.

of Conner and had a red colored stem, while other stalks had a purple color. The seed did not shatter. The leaves are medium in size and are green in color. This variety did not appear to be any better suited to Alabama conditions than did Conner.

**ZANZIBARENSIS.** Plants of this variety are very tall. In some cases, they reach a height of 20 feet. The stems are large with few branches and are usually green but are sometimes purple in color. The leaves are green and the seeds are extremely large and easily shattered. This variety is not suited for commercial production.

**SMALL COMMERCIAL.** This is a small to medium variety with many branches. Its appearance is very similar to that of U. S. 4 or U. S. 7, but the seed shatter much more readily. Frequently the seed shatter

TABLE 4. RESULTS OBTAINED IN CASTORBEAN VARIETY TEST, TENNESSEE VALLEY SUBSTATION, BELLE MINA, 1942-1943.

| Variety <sup>1</sup> | Yield per acre<br>of shelled seed <sup>2</sup> |               | Shelling<br>percentage |      | Average no.<br>of spikes<br>per plant |      | Average<br>height<br>per plant |               |
|----------------------|--|---------------|------------------------|------|---------------------------------------|------|--------------------------------|---------------|
|                      | 1942   | 1943          | 1942                   | 1943 | 1942                                  | 1943 | 1942                           | 1943          |
|                      | <i>Pounds</i>                                  | <i>Pounds</i> |                        |      |                                       |      | <i>Inches</i>                  | <i>Inches</i> |
| Conner .....         | 1,128  | 1,087         | 64                     | 67   | 2.5                                   | 8.0  | 41                             | 79            |
| Kansas Common .....  | 1,114  | —             | 68                     | —    | 6.0                                   | —    | 39                             | —             |
| U. S. 4 .....        | 1,002  | —             | 66                     | —    | 12.0                                  | —    | 46                             | —             |
| U. S. 7 .....        | 1,082  | —             | 70                     | —    | 7.0                                   | —    | 35                             | —             |
| Doughty 11 .....     | 1,081  | 1,004         | 67                     | 68   | 2.1                                   | 6.0  | 41                             | 74            |
| Kentucky 38 .....    | 995  | 878           | 68                     | 69   | 4.7                                   | 12.0 | 36                             | 50            |

<sup>1</sup>Planting dates were April 22 and August 3, 1942; and April 25 and August 12, 1943.

<sup>2</sup>Harvesting dates were October 19 and November 11, 1942; and August 30, September 15, and October 23, 1943.

TABLE 5. NUMBER OF SEED PER POUND OF VARIOUS VARIETIES OF CASTORBEANS GROWN, MAIN STATION, AUBURN, 1942.

| Variety                | Number of seed per pound |
|------------------------|--------------------------|
| Cullars .....          | 4,668                    |
| Colbert .....          | 3,700                    |
| Gibson .....           | 3,502                    |
| Small Commercial ..... | 2,424                    |
| U. S. 7 .....          | 1,865                    |
| U. S. 4 .....          | 1,765                    |
| Kansas Common .....    | 1,558                    |
| Doughty 11 .....       | 1,542                    |
| Sanguineus .....       | 1,465                    |
| San Benito .....       | 1,308                    |
| Kentucky 38 .....      | 1,202                    |
| Conner .....           | 1,065                    |
| Flowering .....        | 859                      |
| Zanzibarensis .....    | 612                      |



as soon as they begin to ripen. Because of this characteristic, it is not suited to commercial production.

**LOCAL VARIETIES IN ALABAMA.** Colbert is a variety found growing locally in Colbert County, Alabama. The plants are tall, much-branched, and bear large spikes. The seed are very small and are retained tightly in the hulls, making the variety difficult to thresh. Cullars, a local variety found growing at Auburn, is tall growing. The plants are much-branched and have medium-sized spikes containing small seed. Gibson, from Cullman County, is a tall-growing variety. It has a large number of relatively small spikes with small seed. None of these varieties appeared to be suitable for commercial production in Alabama.

#### SIZE OF SEED

The number of seed per pound was determined for the varieties that were grown at Auburn in 1942. The results, Table 5, show that number of seed per pound varied from approximately 600 to 4,600. The three local varieties that were selected from different localities in Alabama produced the smallest seed. The largest seed were produced by Zanzibarensis. Of the varieties suited for commercial production, Conner had the largest seed and U. S. 7 had the smallest. The other varieties ranged between these two extremes.

#### PERCENTAGE OF OIL IN SEED

Seed from varieties grown in Auburn in 1941 were analyzed for oil. The results were as follows:

| <i>Variety</i>            | <i>Oil Percentage</i> |
|---------------------------|-----------------------|
| Conner .....              | 52                    |
| Doughty 11 .....          | 50                    |
| Kentucky 38 .....         | 49                    |
| U. S. 4 and U. S. 7 ..... | 48                    |
| Sanguineus .....          | 48                    |

It may be noted that the oil content varied from 52 per cent to 48 per cent. In this particular test, Conner had the largest percentage of oil and Sanguineus had the lowest percentage. The few varieties tested did not show the extreme variation in percentage of oil between varieties that has been shown in some other states.

#### SPACING TESTS

Using the Conner variety, spacing tests were conducted at Auburn in 1941 and 1942, and at Tuskegee in 1942. Fertilizer was applied at the rate of 600 pounds per acre of a 6-8-4 mixture before planting. Rows 42 inches in width were used. Spacing between hills and num-

ber of plants per hill varied, as shown in Table 6. The beans were planted at a rate of 5 to 6 beans per hill in the spacing shown and were thinned to the proper number of plants per hill at the first cultivation. Treatments were replicated four times in a completely randomized block design. Four-row plots 60 feet long were used, and the two inside rows were harvested by hand when beans were mature. The results are shown in Table 6.

The data indicate that the most satisfactory spacing is one to two stalks per hill spaced 2 to 3 feet apart in 42-inch rows.

TABLE 6. RESULTS OF SPACING TESTS OF CASTORBEANS, MAIN STATION, AUBURN, 1941-42, AND TUSKEGEE EXPERIMENT FIELD, 1942.

| Spacing<br>of hills | Number of plants<br>per hill <sup>1</sup> | Yield per acre of shelled seed <sup>2</sup> |               |               |               |
|---------------------|---|---|---------------|---------------|---------------|
|                     |   | Auburn                                      |               |               | Tuskegee      |
|                     |   | 1941  | 1942          | Average       | 1942          |
|                     |   | <i>Pounds</i>                               | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i> |
| 1 foot .....        | 1   | 1,279                                       | 705           | 992           | 572           |
| 2 feet .....        | 1   | 1,354                                       | 885           | 1,120         | 634           |
| 3 feet .....        | 1   | 1,194                                       | 832           | 1,013         | 478           |
| 3 feet .....        | 2   | —   | 1,040         | —             | 551           |
| 4 feet .....        | 1   | 857   | —             | —             | —             |

<sup>1</sup>Planting dates at Auburn were May 21, 1941 and April 20, 1942; and at Tuskegee, April 28, 1942.

<sup>2</sup>Harvesting dates at Auburn were September 30 and December 2, 1941; and September 3, October 28, and December 7, 1942. At Tuskegee, they were September 1, September 30, and October 30, 1942.

TABLE 7. RESULTS OF FERTILIZER TESTS WITH CASTORBEANS, MAIN STATION, AUBURN, 1941-1944.

| Fertilizer<br>grade <sup>1</sup> | Yield per acre of<br>shelled seed <sup>2</sup> |                   |                   |                   |
|----------------------------------|--|-------------------|-------------------|-------------------|
|                                  | 1941 <sup>3</sup>                              | 1942 <sup>3</sup> | 1943 <sup>3</sup> | 1944 <sup>3</sup> |
|                                  | <i>Pounds</i>                                  | <i>Pounds</i>     | <i>Pounds</i>     | <i>Pounds</i>     |
| None .....                       | 647  | 309               | 443               | 560               |
| 6-8-4 .....                      | 921  | 611               | 1,042             | 1,443             |
| 6-0-0 .....                      | 1,160  | 363               | 783               | —                 |
| 0-0-4 .....                      | —  | 482               | —                 | —                 |
| 0-8-4 .....                      | —  | 539               | 616               | —                 |
| 6-8-0 .....                      | —  | —                 | 780               | —                 |
| 6-0-4 .....                      | —  | —                 | 1,024             | —                 |
| 6-8-8 .....                      | —  | —                 | 1,071             | 1,648             |

<sup>1</sup>Rate of 600 pounds per acre used in 1941, 1942, and 1943 and 1,000 pounds per acre used in 1944.

<sup>2</sup>Planting dates were May 12, 1941; April 30, 1942; April 7, 1943; and April 29, 1944.

<sup>3</sup>Harvesting dates were September 30 and December 2, 1941; September 3, October 28, and December 7, 1942; August 27, September 14, and November 9, 1943; September 22, November 2, and December 21, 1944.

## FERTILIZER TESTS

Fertilizer tests were conducted on a Norfolk sandy loam soil at Auburn in 1941 to 1944 inclusive. A different area was used each year to avoid any cumulative effect of the fertilizer treatment. Beans were planted in 42-inch rows and spaced one plant per hill, 3 feet apart. The fertilizers were applied prior to planting. Single-row plots replicated either 3 or 4 times were used. The beans were harvested by hand as they ripened. Fertilizer treatments and yields are reported in Table 7. Results indicate that, while there was a dominant need for nitrogen, highest yields were obtained where a complete fertilizer was used. In 1942 it was noted that there was considerably less spotting of leaves on the plots receiving potash. Beginning in 1943 an additional plot was added. On this plot potash was doubled. It may be noted that this plot produced the highest yield in 1943 and 1944. In these 2 years, it was also evident that the application of potash reduced spotting of the leaves. Much of the spotting or rust appearance of the leaves may have been due to a deficiency in potash.

## DISEASES

Diseases have been suggested as being a limiting factor in producing castorbeans in portions of the South. Only one disease of any importance, other than potash deficiency referred to above, appeared in these tests. Leaf spot (*Cercospora ricinella* Sacc. and Berl.) was serious in the test at Tuskegee in 1942. No particular disease appeared in the other tests.

## CASTORBEANS FOR BOLL WEEVIL CONTROL

It has been claimed that insects are repelled or killed by the presence of castorbeans, and that scattered planting of castorbeans in a cotton field would control boll weevils. A test was conducted at Auburn in 1942, using one row of the Conner variety castorbean alternated with two rows of cotton.

| Item                                       | Cotton and<br>castorbeans | Cotton<br>alone |
|--|---------------------------|-----------------|
| Amount of cotton square<br>infestation on: |                           |                 |
| June 2, per cent .....                     | 65                        | 59              |
| July 2, per cent .....                     | 45                        | 41              |
| July 9, per cent .....                     | 46                        | 50              |
| July 20, per cent .....                    | 95                        | 83              |
| July 29, per cent .....                    | 89                        | 81              |
| Yield of seedcotton<br>per acre, pounds*   | 647                       | 1,086           |
| Yield of castorbeans<br>per acre, pounds*  | 370                       | —               |

\*Calculated on an acre basis.

Boll Weevil counts and yield records indicated that the presence of castorbeans did not reduce the percentage of infestation. Weevils were as prevalent in cotton containing beans as in that of cotton alone. The presence of castorbeans reduced the yield of cotton. This was probably due to shading by the beans, which in this case grew from 8 to 10 feet tall.

#### RECOMMENDATIONS FOR GROWING CASTORBEANS IN ALABAMA

If castorbeans were produced commercially in Alabama, the following practices appear to be best from the results obtained in the reported experiments:

1. The soil should be prepared as for cotton or corn. Early planting of the beans is preferable. Castorbeans will stand considerable frost, and, therefore, may be planted earlier than cotton. At Auburn, planting the last of March or first of April would be satisfactory. Planting may be delayed until May without danger of the beans being killed before the seed mature; however, the growth of plants would not be as large and the yield of beans would not be as great as that of early planting.

2. The beans should be dropped in hills from 2 to 3 feet apart with 2 or 3 beans per hill in rows 36 to 42 inches wide. With reasonably good germination, this should give from 1 to 3 plants every 2 or 3 feet. It will usually require from 5 to 8 pounds of seed per acre to plant at this rate. The seed should be covered  $\frac{1}{2}$  to 2 inches in depth.

3. The best variety is Conner. Varieties such as Doughty 11, with characteristics similar to Conner, might be used.

4. Six hundred or more pounds per acre of a fertilizer relatively high in nitrogen and potash, such as 6-8-8, should be used.

5. Castorbeans should be cultivated the same as corn. Frequent shallow cultivation should be practiced to control weeds until the plants are large enough to shade the ground. After plants are about 2 feet high, weeds will not be a serious problem and cultivation should cease.

6. Castorbeans should be harvested by hand as the spikes mature. It would be desirable to make about three harvests during the fall. The first harvest will be about September 1. One person can harvest from 600 to 1,000 pounds of beans in the hull per day. The beans should be stored in a well aerated house to prevent molding. As soon as they are dry they may be threshed. In commercial production, it probably would be preferable for a farmer to sell beans in the hull and for the processor to provide a threshing machine in the plant. Beans may be left until frost and harvested with a combine. If this is done there will be a considerable loss in yield due to shattering

of seed; at least this would be true of the varieties now available. A combine will not thresh the seed clean. It will remove them from the spikes, but many hulls will be left on the beans.

## FLAX

Flax, *Linum usitatissimum*, is grown for oil and fiber. Varieties grown for oil usually are not suitable for fiber; conversely, varieties grown for fiber usually do not produce as large a yield of seed as do the varieties grown for oil.

Tests reported in this publication deal with varieties suitable for oil production. The straw from these varieties, however, is suitable for use in making paper, upholstery, and other purposes where a high grade flax fiber is not necessary. In some instances the yield of straw was determined, in which cases the results are reported.

Oil from flax is known as linseed oil and is principally used for oil in the paint industry. The meal known as linseed meal is edible and makes an excellent stock feed.

The plant is an annual that grows best in cool moist climates. In Alabama, therefore, it is suitable for growing in winter and early spring months. Flax normally reaches a height of 18 to 30 inches. When planted thickly it produces few branches, but when planted thinly it produces a considerable number of branches. The flowers vary in color from blue to white or pale pink, depending on the

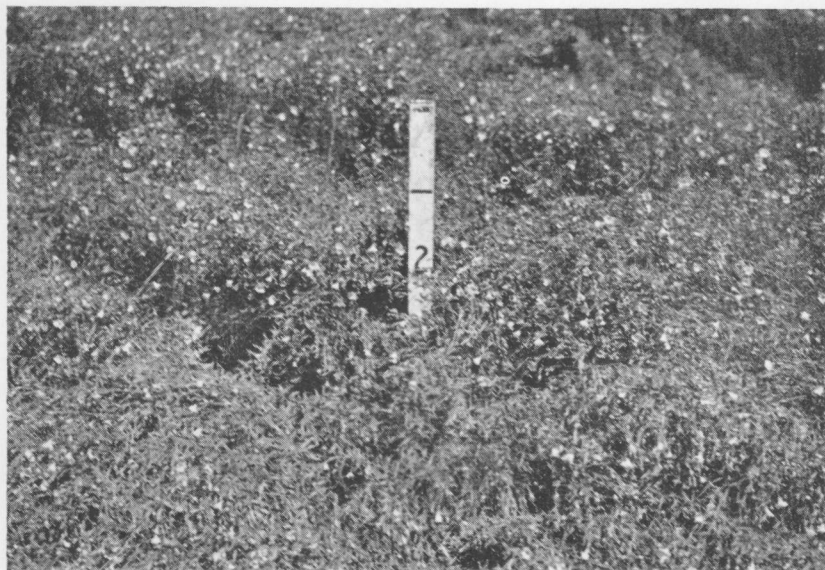


FIGURE 3. Flax in seed production experiments at Main Station, Auburn, Alabama.

variety. Usually they open before sunrise and the petals shed before noon. The seed are borne in a 5-cell boll. Each boll contains 5 to 10 seed. There are never more than 10 seed in a boll, and under unfavorable conditions there may be only 2 or 3. The seed contain from 32 to 38 per cent oil. The oil content is greatly reduced by high temperatures and dry weather during the ripening period.

Flax requires a fertile loamy type of soil. Soils low in organic matter or low in fertility are not suitable for flax production.

The plant usually is able to withstand a temperature as low as 15° F., but it may be killed at a temperature of 18 to 24° if this low temperature occurs either in the seedling stage or when the plants are growing rapidly in the spring. Although the crop is seldom grown in Alabama, it can be produced in central and southern portions of the State.

#### VARIETY TESTS

Variety tests were conducted at Atmore and at Auburn. In these tests the flax was planted in rows 12 inches apart. Usually three-row plots were used and the middle row was harvested for yield records. Varieties were randomized and usually were replicated from 2 to 4 times. Seed usually were planted at a rate of 60 pounds per acre. Fertilizer was applied prior to planting at the rate of 300 pounds of superphosphate and 50 pounds of muriate of potash per acre. Nitrogen was supplied from nitrate of soda applied as a side-dressing about March 1 at the rate of 225 pounds per acre. The varieties were harvested when mature, threshed, and the seed yields determined. In a few cases where straw yields were determined, the plants were weighed before threshing and the seed weight subtracted from that of the entire plant; the resulting difference was reported as weight of straw.

**RESULTS AT ATMORE.** The variety tests at Atmore were conducted on Orangeburg fine sandy loam of high fertility. The results, Table 8, show that the leading varieties were Rio, Bison x C.I. 479, Biwing, and Royal. Straw yields were determined in 1943 and are given in the table. These yields were the highest ever reported in the State. The results show that in general the varieties produced a good yield of seed and straw.

Yields in 1944 were greatly reduced by unusually heavy rainfall that occurred several days during the blooming period.

**RESULTS AT AUBURN.** The variety tests at Auburn were conducted on a Norfolk sandy loam of average fertility. This soil, low in organic matter, was not well suited for growth of flax. In 1941 two variety tests were conducted. In one test varieties that had been grown at

TABLE 8. THE YIELDS OF VARIETIES OF FLAX, STATE FARM, ATMORE, 1943-1944.

| Variety <sup>1</sup>      | C. I.<br>No. | Yield of seed per acre <sup>2</sup> |               |               | Straw yield<br>per acre |
|---------------------------|--------------|-------------------------------------|---------------|---------------|-------------------------|
|                           |              | 1943                                | 1944          | 2-yr. av.     | 1943                    |
|                           |              | <i>Pounds</i>                       | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i>           |
| Rio .....                 | 280          | 1,578                               | 139           | 859           | 2,926                   |
| Bison X C. I. 479 .....   | 920          | 1,457                               | 244           | 851           | 2,457                   |
| Biwing .....              | 917          | 1,463                               | 165           | 814           | 2,192                   |
| Royal .....               | 828          | 1,538                               | 84            | 811           | 3,097                   |
| Bolley Golden .....       | 644          | 1,409                               | 142           | 776           | 1,919                   |
| Redwing .....             | 320          | 1,293                               | 226           | 760           | 2,042                   |
| 5012-B 37 .....           | 874          | 1,252                               | 147           | 700           | 2,505                   |
| Bison X Redwing .....     | 914          | 1,170                               | 212           | 691           | 2,035                   |
| Bison X Redwing .....     | 918          | 1,123                               | 256           | 690           | 2,015                   |
| Koto (Coteau) .....       | 842          | 1,103                               | 272           | 688           | 1,729                   |
| Indian 12-12 .....        | 1,011        | 1,225                               | 140           | 683           | 2,559                   |
| Linota .....              | 244          | 1,178                               | 128           | 653           | 3,062                   |
| 355 X Bison .....         | 1,038        | 1,171                               | 80            | 625           | 2,028                   |
| Argentine Pale-Blue ..... | 4,729        | 1,116                               | 106           | 611           | 1,749                   |
| Abyssinian Yellow .....   | 36           | 939                                 | 263           | 601           | 1,225                   |
| Bison .....               | 389          | 1,082                               | 122           | 602           | 2,050                   |
| Renew .....               | 839          | 994                                 | 73            | 534           | 1,919                   |
| Punjab .....              | 20           | 953                                 | 104           | 529           | 912                     |
| Bison X C. I. 479 .....   | 975          | 749                                 | 220           | 485           | 1,633                   |
| 355 X Bison .....         | 1,042        | 803                                 | 139           | 471           | 1,266                   |

<sup>1</sup>Planting dates were November 16, 1943, and November 18, 1944.

<sup>2</sup>Harvesting dates were May 19, 1943, and May 23, 1944.

TABLE 9. YIELDS OF VARIETIES OF FLAX, MAIN STATION, AUBURN, 1938-1941.

| Variety <sup>1</sup>    | C. I.<br>No. | Yield of seed per acre |               |               |               |               | Straw yield<br>per acre |
|-------------------------|--------------|------------------------|---------------|---------------|---------------|---------------|-------------------------|
|                         |              | 1938                   | 1939          | 1940          | 1941          | 4-yr. av.     | 1940                    |
|                         |              | <i>Pounds</i>          | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i>           |
| Punjab .....            | 20           | 485                    | 537           | 425           | 640           | 522           | 808                     |
| Bison .....             | 389          | 344                    | 588           | 381           | 531           | 461           | 1,100                   |
| Linota .....            | 244          | 429                    | 567           | 393           | 339           | 432           | 1,105                   |
| Redwing .....           | 320          | 223                    | 601           | 400           | 467           | 423           | 1,324                   |
| Rio .....               | 280          | 120                    | 656           | 359           | 455           | 398           | 1,015                   |
| Abyssinian Yellow ..... | 36           | 315                    | 476           | 299           | 408           | 374           | 593                     |
| Bolley Golden .....     | 644          | 66                     | 349           | 367           | 487           | 317           | 714                     |

<sup>1</sup>Planting dates were March 5, 1938; February 17, 1939; February 28, 1940; and December 20, 1941.

Auburn since 1938 were used. The other test consisted of new varieties obtained from the United States Department of Agriculture in 1941. The results of all experiments at Auburn are reported in Tables 9 and 10. Yields of straw were determined in 1940 and are shown in Table 9. Straw yields were again determined in 1943 and are shown in Table 10. The leading varieties were Indian 12-12, Punjab, Bison, Linota, Redwing and Rio.

TABLE 10. THE YIELDS OF VARIETIES OF FLAX, MAIN STATION, AUBURN, 1941-1944.

| Variety <sup>1</sup>              | C. I.<br>No. | Yield of seed per acre |      |                |      |           | 3-yr. av.              | Straw             |
|-----------------------------------|--------------|------------------------|------|----------------|------|-----------|------------------------|-------------------|
|                                   |              | 1941                   | 1942 | 1943           | 1944 | 4-yr. av. | 1941,<br>1942,<br>1944 | yield<br>per acre |
|                                   |              | Lb.                    | Lb.  | Lb.            | Lb.  | Lb.       | Lb.                    | Lb.               |
| Indian 12-12 .....                | 1,011        | 540                    | 568  | 826            | 490  | 606       | 533                    | 1,134             |
| Redwing .....                     | 320          | 577                    | 477  | 545            | 366  | 491       | 473                    | 831               |
| Bison .....                       | 389          | 399                    | 554  | 640            | 290  | 471       | 414                    | 1,035             |
| Rio .....                         | 280          | 340                    | 546  | 436            | 525  | 462       | 470                    | 653               |
| 5012 - B 37 .....                 | 874          | 246                    | 418  | 681            | 462  | 452       | 375                    | 871               |
| Renew (Newland<br>x 19/112) ..... | 839          | 552                    | 411  | 395            | 402  | 440       | 455                    | 681               |
| Koto (Coteau) .....               | 842          | 442                    | 520  | 354            | 404  | 430       | 455                    | 572               |
| Argentine Pale Blue. 472-9        | 198          | 491                    | 681  | 346            | 429  | 345       | 789                    |                   |
| Royal .....                       | 828          | 408                    | 545  | 490            | 258  | 425       | 404                    | 695               |
| Linota .....                      | 244          | 314                    | 545  | 418            | 398  | 419       | 419                    | 690               |
| Bison X C.I. 479 ..               | 975          | 467                    | 411  | 0 <sup>2</sup> | 744  | 406       | 541                    | —                 |
| 355 X Bison .....                 | 1,038        | 289                    | 431  | 408            | 364  | 373       | 361                    | 612               |
| Bison X C.I. 479 ..               | 920          | 577                    | 431  | 0 <sup>2</sup> | 469  | 369       | 492                    | —                 |
| Bison X Redwing ..                | 914          | 535                    | 518  | 0 <sup>2</sup> | 421  | 369       | 491                    | —                 |
| Bison X Redwing ..                | 918          | 594                    | 456  | 0 <sup>2</sup> | 410  | 365       | 487                    | —                 |
| 355 X Bison .....                 | 1,042        | 195                    | 390  | 408            | 466  | 365       | 351                    | 640               |
| Bolley Golden .....               | 644          | 297                    | 664  | 0 <sup>2</sup> | 432  | 348       | 466                    | —                 |
| Biwing (Bison X<br>Redwing) ..... | 917          | 416                    | 420  | 245            | 270  | 338       | 369                    | 381               |
| Abyssinian Yellow..               | 36           | 408                    | 479  | 0 <sup>2</sup> | 440  | 332       | 442                    | —                 |
| Punjab .....                      | 20           | 450                    | 452  | 0 <sup>2</sup> | 269  | 293       | 390                    | —                 |

<sup>1</sup>Planting dates were December 20, 1941; January 23, 1942; November 5, 1943; and January 25, 1944.

<sup>2</sup>Killed by cold.

#### FERTILIZER TESTS

In 1940 and 1941 grade and rate of fertilizer tests were conducted at Auburn. The soil used was a Norfolk sandy loam of average fertility. The superphosphate and/or muriate of potash was applied in the furrow and mixed with the soil before planting the seed. Nitrogen from nitrate of soda was applied as a side-dressing about March 1. Four-row plots 16 feet long were used and the rows were spaced 12 inches apart. Treatments were replicated from 2 to 4 times. The two inside rows were harvested for yield determination. The results are given in Tables 11 and 12.

When a 6-8-4 fertilizer was used, the flax yields were increased as the rate was increased. In this test the yields were increased at the highest rate used, possibly indicating that the test did not include a rate sufficiently high for maximum production. The principal response was to nitrogen, but both phosphate and potash were beneficial. This indicates that flax should receive a complete fertilizer high in nitrogen. The rate of fertilization should be 600 or more pounds per acre when flax is grown on a soil similar to the one at Auburn. Tests were not conducted on other soils.



TABLE 11. YIELDS OF FLAX RECEIVING FERTILIZERS OF DIFFERENT GRADES, MAIN STATION, AUBURN, 1940-1941<sup>1</sup>

| Grade <sup>2</sup> | Yield of seed per acre |               |                |
|--------------------|------------------------|---------------|----------------|
|                    | 1940                   | 1941          | 2-year average |
|                    | <i>Pounds</i>          | <i>Pounds</i> | <i>Pounds</i>  |
| 0-0-0              | 160                    | 91            | 126            |
| 0-8-4              | 190                    | 146           | 168            |
| 6-8-0              | 532                    | 383           | 458            |
| 6-8-4              | 532                    | 469           | 500            |
| 6-0-4              | 425                    | 379           | 402            |

<sup>1</sup>Punjab Variety.<sup>2</sup>600 pounds per acre was used.TABLE 12. YIELDS OF FLAX RECEIVING DIFFERENT RATES OF FERTILIZATION, MAIN STATION, AUBURN, 1940-1941<sup>1</sup>.

| Fertilization per acre <sup>2</sup> |       | Yield of seed per acre |               |               | Straw yield per acre |
|-------------------------------------|-------|------------------------|---------------|---------------|----------------------|
| Rate                                | Grade | 1940                   | 1941          | 2-yr. average | 1940                 |
| <i>Pounds</i>                       |       | <i>Pounds</i>          | <i>Pounds</i> | <i>Pounds</i> | <i>Pounds</i>        |
| 0                                   | 0-0-0 | 160                    | 91            | 126           | 653                  |
| 300                                 | 6-8-4 | 381                    | 310           | 346           | 1,100                |
| 600                                 | 6-8-4 | 532                    | 469           | 500           | 1,408                |

<sup>1</sup>Punjab variety.<sup>2</sup>Fertilizer from superphosphate (18%), muriate of potash (60%), and nitrate of soda (16%).

### TIME OF PLANTING TESTS

Time-of-planting tests were conducted with most of the varieties at Auburn in 1941 to 1944 inclusive. These tests were on Norfolk sandy loam of average fertility. There were 2 to 4 replications of single-row plots 16 feet long. The seed were drilled at the rate of 60 pounds per acre on two dates. One planting was usually in late fall or early winter and the other was late winter or early spring. The fertilizer used was 600 pounds of 6-8-4 per acre. Phosphate and potash were applied ahead of planting, while nitrogen as nitrate of soda was applied as top dressing about March 1. The results are reported in Table 13. In 2 of the 4 years, there was serious winter-killing in one or the other dates of planting. Serious winter-killing occurred in 1943 with some varieties in both dates of planting. Indian 12-12 was the only variety that withstood cold during all of the years on each of the dates of planting. This variety was more cold resistant at any stage of growth than the others tested. Most varieties are able to withstand considerable cold after they are well established and are not in a succulent growing condition.

TABLE 13. YIELD OF VARIETIES OF FLAX WHEN PLANTED ON DIFFERENT DATES, MAIN STATION, AUBURN, 1941-1944.

| Variety            | C. I. No. | Seed yield per acre from different planting dates <sup>1</sup> |               |               |               |                |                |                |               |  |
|--------------------|-----------|--|---------------|---------------|---------------|----------------|----------------|----------------|---------------|--|
|                    |           | Dec. 20, 1940  | Feb. 12, 1941 | Nov. 29, 1941 | Jan. 23, 1942 | Nov. 5, 1942   | Feb. 28, 1943  | Nov. 16, 1943  | Jan. 25, 1944 |  |
|                    |           | Lb.  | Lb.           | Lb.           | Lb.           | Lb.            | Lb.            | Lb.            | Lb.           |  |
| Punjab .....       | 20        | 640  | 450           | 295           | 452           | 0 <sup>1</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 269           |  |
| Abyssinian         |           |  |               |               |               |                |                |                |               |  |
| Yellow .....       | 36        | 403  | 408           | 263           | 479           | 0 <sup>1</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 440           |  |
| Linota .....       | 244       | 339  | 314           | 265           | 545           | 418            | 0 <sup>2</sup> | 0 <sup>2</sup> | 398           |  |
| Rio .....          | 280       | 455  | 340           | 210           | 546           | 436            | 0 <sup>2</sup> | 0 <sup>2</sup> | 525           |  |
| Redwing .....      | 320       | 467  | 577           | 390           | 477           | 545            | 0 <sup>2</sup> | 0 <sup>2</sup> | 366           |  |
| Bison .....        | 389       | 531  | 399           | 297           | 554           | 640            | 0 <sup>2</sup> | 0 <sup>2</sup> | 290           |  |
| Argentine          |           |  |               |               |               |                |                |                |               |  |
| Pale Blue .....    | 472-9     | 736  | 198           | 198           | 491           | 681            | 0 <sup>2</sup> | 0 <sup>2</sup> | 346           |  |
| Bolley Golden ..   | 644       | 487  | 297           | 308           | 664           | 0 <sup>2</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 432           |  |
| Royal .....        | 828       | —  | 408           | 263           | 545           | 490            | 0 <sup>2</sup> | 0 <sup>2</sup> | 258           |  |
| Renew (Newland     |           |  |               |               |               |                |                |                |               |  |
| X 19/112 .....     | 839       | —  | 552           | 454           | 411           | 395            | 0 <sup>2</sup> | 0 <sup>2</sup> | 402           |  |
| Koto (Coteau) ..   | 842       | —  | 442           | 379           | 520           | 354            | 0 <sup>2</sup> | 0 <sup>2</sup> | 404           |  |
| 5012 - B 37 .....  | 874       | —  | 246           | 140           | 418           | 681            | 0 <sup>2</sup> | 0 <sup>2</sup> | 462           |  |
| Bison X Redwing    | 914       | —  | 535           | 317           | 518           | 0 <sup>2</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 421           |  |
| Biwing (Bison      |           |  |               |               |               |                |                |                |               |  |
| X Redwing) ..      | 917       | —  | 416           | 311           | 420           | 245            | 0 <sup>2</sup> | 0 <sup>2</sup> | 270           |  |
| Bison X Redwing    | 918       | —  | 594           | 295           | 456           | 0 <sup>2</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 410           |  |
| Bison X            |           |  |               |               |               |                |                |                |               |  |
| C. I. 479 .....    | 920       | —  | 577           | 324           | 431           | 0 <sup>2</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 469           |  |
| Bison X            |           |  |               |               |               |                |                |                |               |  |
| C. I. 479 .....    | 975       | —  | 467           | 176           | 411           | 0 <sup>2</sup> | 0 <sup>2</sup> | 0 <sup>2</sup> | 744           |  |
| Indian 12-12 ..... | 1,011     | 621  | 540           | 459           | 568           | 826            | 1,030          | 298            | 490           |  |
| 355 x Bison .....  | 1,038     | —  | 289           | 317           | 431           | 408            | 0 <sup>2</sup> | 0 <sup>2</sup> | 364           |  |
| 355 x Bison .....  | 1,042     | —  | 195           | 208           | 390           | 408            | 0 <sup>2</sup> | 0 <sup>2</sup> | 466           |  |

<sup>1</sup>Harvesting dates were May 28 and June 5, 1941; June 6 and June 12, 1942; June 8 and June 14, 1943; and June 13, 1944.

<sup>2</sup>Killed by cold.

The yield shows that in years in which winter-killing occurred, fall planting produced a higher yield than did spring planting. Usually there is a greater danger of cold damage in the spring than in the fall; hence, on the average, fall planting should be preferable.

#### IODINE NUMBER AND OIL CONTENT

Seed of several varieties of flax grown in Auburn in 1944 were analyzed for oil content and iodine number of the oil. The results are shown in Table 14. It may be noted that there was very little variation between the seeds of different varieties.

TABLE 14. PERCENTAGE OF OIL AND IODINE NUMBER OF THE OIL OF FLAX VARIETIES GROWN AT MAIN STATION, AUBURN, 1944.

| Variety                 | C. I.<br>No. | Oil content <sup>1</sup> | Iodine No. <sup>2</sup> |
|-------------------------|--------------|--------------------------|-------------------------|
|                         |              | <i>Per cent</i>          |                         |
| Punjab .....            | 20           | 37.8                     | 175                     |
| Abyssinian Yellow ..... | 36           | 35.8                     | 179                     |
| Linota .....            | 244          | 35.0                     | 184                     |
| Rio .....               | 280          | 37.4                     | 176                     |
| Redwing .....           | 320          | 36.0                     | 183                     |
| Bison .....             | 389          | 37.2                     | 176                     |
| Argentine Sel .....     | 472-9        | 36.1                     | 171                     |
| Bolley Golden .....     | 644          | 36.9                     | 179                     |
| Royal .....             | 828          | 37.9                     | 175                     |
| Renew .....             | 839          | 36.5                     | 181                     |
| Koto (Coteau) .....     | 842          | 35.8                     | 183                     |
| Bolley's No. 5012 ..... | 874          | 37.0                     | 180                     |
| Biwing .....            | 917          | 36.3                     | 182                     |
| Bison x Redwing .....   | 914          | 37.9                     | 182                     |
| Bison x Redwing .....   | 918          | 34.1                     | 182                     |
| Avon .....              | 920          | 35.7                     | 182                     |
| Bison x 479 .....       | 975          | 36.2                     | 182                     |
| Indian Sel .....        | 1,011        | 38.5                     | 175                     |
| 355 x Bison .....       | 1,038        | 36.8                     | 176                     |
| 355 x Bison .....       | 1,042        | 36.8                     | 178                     |
| Fiber Flax .....        | 15A          | 33.8                     | 182                     |
| Fiber Flax .....        | 29A          | 29.8                     | 181                     |
| Fiber Flax .....        | 40A          | 35.0                     | 178                     |

<sup>1</sup>Oil content, based on 8 per cent moisture in flaxseed determined by extraction method.

<sup>2</sup>Iodine number determined by refraction method.

The determinations were made by J. A. Schrickler at the University of Minnesota.

### RECOMMENDATIONS

Flax can be grown in central and southern Alabama if fertile loamy soils are used. Seed should be planted after the weather is cool in the fall, but before severe cold weather begins. Usually this will be between the middle of October and the last of November.

The best variety to use is Indian 12-12, which is more winter hardy than the others. It will make nearly as large a yield in favorable winters as the other varieties, and in cold winters it will make a higher yield. If flax is planted along the Gulf Coast where winter-killing is not common, some of the other better yielding varieties may be used, such as Rio, Bison x C. I. 479, Biwing, and Royal.

The tests reported herein did not include a rate of fertilization high enough for maximum yields. From these tests and from observations, it is believed that flax should receive a liberal application of a complete fertilizer, 500 or 600 pounds of 6-8-4 at planting time. It should be top-dressed with nitrogen about March 1 with 300 pounds of nitrate of soda or its equivalent.

The soil should be thoroughly prepared and the flax planted at a rate of 60 to 80 pounds of seed per acre. Seed should be broadcast and covered very lightly with a cultipacker. If a drill is used, care should be taken to cover the seed not over  $\frac{1}{2}$  inch in depth. Flax seed should never be planted as deep as oats.

Harvesting may be done with a combine when the seed are ripe.

## H E M P

Hemp, *Cannabis sativa*, is grown both as a fiber crop and as a grain crop. The seed are used for oil production and as a feed for birds. The flowers and leaves of the plant contain a narcotic known as marihuana. Because of its narcotic principal, a Federal permit has to be obtained in order to grow it. It is principally grown in the United States as a fiber crop, but it can be grown for oil purposes.

The plant is an annual and grows from a few feet to 15 feet in height, depending on the fertility of soil and earliness of planting. It is dioecious (with male and female flowers on separate plants). The male plants die soon after the pollen is shed, while the female plants live until frost or until the seed become mature. Hemp requires a fertile loamy soil. The plant is capable of standing the high temperatures of Alabama summers.

Results of several tests conducted at Auburn show that hemp might

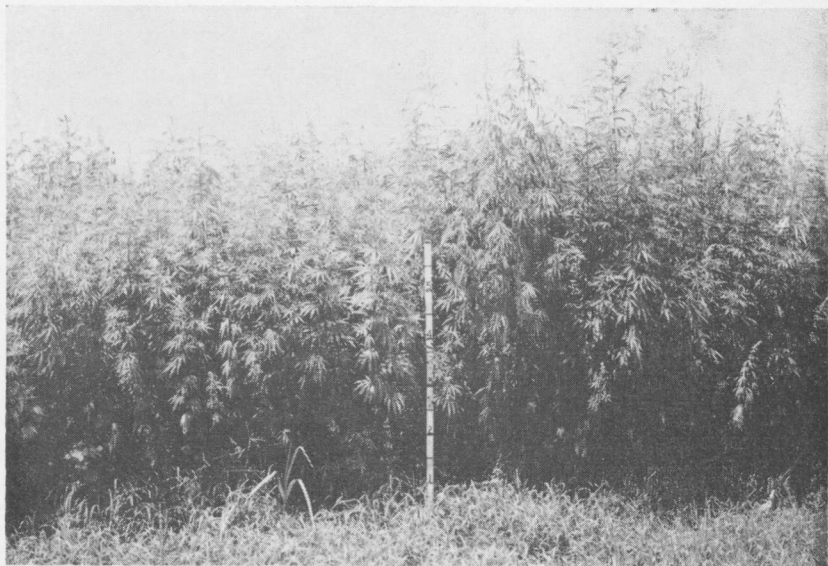


FIGURE 4. Hemp in seed production experiments at Main Station, Auburn, Alabama.

be produced in Alabama for oil purposes. The soil used was a Norfolk sandy loam of above the average in fertility.

TEST No. 1. The area was broken, and fertilizer was broadcast and disked into the soil. Fertilization consisted of a mixture of 500 pounds of nitrate of soda, 500 pounds of superphosphate, and 160 pounds of muriate of potash per acre. Hemp was planted March 29, 1943, in 42-inch rows. Hills were 4 feet apart with 3 to 5 stalks per hill. Flat shallow cultivation to control weeds was given until the plants were 3 to 4 feet high. The plants were harvested August 23. A yield of 250 pounds of threshed seed per acre was obtained.

It was noted that the hemp did not begin to set seed until the last of July when the days were shorter. Very few, if any, seed were set from blooms occurring in June and early July.

TEST No. 2. The object of this test was to determine if hemp seed might be produced from broadcast seedings made at a time of year so that blooming would occur in a short-day period. Preparation consisted of breaking and disking. One thousand pounds of 6-8-4 fertilizer per acre was broadcast and disked into the soil. Seed were sown broadcast at the rate of 50 pounds per acre and were covered with a cultipacker. The results are as follows:

| <i>Planting</i> | <i>Date of</i> | <i>Harvesting</i>       | <i>Yield of threshed seed</i><br><i>per acre</i> |
|-----------------|----------------|-------------------------|--|
|                 |                |                         | <i>Pounds</i>                                    |
| June 28         |                | October 19              | 272  |
| July 30         |                | October 19              | 255  |
| August 30       |                | Too small to<br>harvest | 0  |

The plants began blooming and setting seed rapidly. Although August 30 plantings bloomed and set seed, the seed did not mature by frost. The yields were not large but were sufficient, except for the late August seeding, to justify planting hemp for seed by this method, since the seed could be harvested with a combine and no cultivation would be involved.

TEST No. 3. Since the results in 1943 indicated that length of day was very important in seed formation of hemp and that high yields might be obtained if the proper planting date was used, a time-of-planting test was conducted in 1944. Preparation consisted of turning the land and broadcasting and disking the fertilizer into the soil. Fertilizer was applied at the rate of 850 pounds per acre of 0-14-10 before planting, and 350 pounds of nitrate of soda was applied as a side-dressing when the plants were 5 to 6 inches high. The hemp was planted in 4-foot rows, with hills 2 feet apart and 4 to 5 plants per hill.

| Planting | Date of<br>Harvesting | Yield of threshed<br>seed per acre | Average heights<br>of stalks |
|----------|-----------------------|------------------------------------|------------------------------|
|          |                       | Pounds                             | Feet                         |
| March 15 | October 4             | 510                                | 10                           |
| April 14 | October 4             | 938                                | 8                            |
| May 15   | October 4             | 1,747                              | 6                            |
| June 15  | —*                    | —                                  | —                            |

\* Died from dry weather in June.

An excellent yield was obtained from the May 15 planting. If planted too early, the stalks become too large to be harvested with a combine and too many of the stalks are killed by disease.

The most important disease noted on hemp was Southern blight, *Sclerotium Rolfsii* (Sacc.). This disease killed 20 to 25 per cent of the stalks during hot weather. It usually was not very serious in spring and early summer on hemp planted for fiber.

#### RECOMMENDATIONS

Hemp can be grown in all sections of Alabama if planted on fertile loamy soil. For seed purposes hemp should be planted from May 15 to June 15 if seed are to be harvested with a combine. Seeding earlier than this will result in plants that are too large to harvest easily with a combine. If seed are to be harvested by cutting and threshing, planting may be done in late March or early April.

No fertilizer tests were conducted with hemp, but, from observation of plantings made by farmers near Atmore, Alabama, it is believed that hemp should receive a liberal application of a complete fertilizer such as a 6-8-4 before planting. As soon as the plants are up, it should be top-dressed with 200 to 300 pounds of nitrate of soda or its equivalent.

The soil should be thoroughly prepared; if broadcast the seed should be sown at a rate of 30 to 40 pounds per acre. They should be covered lightly with a cultipacker or corrugated roller. Hemp may be planted with a grain drill, in which case the rows should be spaced as close as possible and the seed should be covered not over  $\frac{1}{2}$  inch in depth. No cultivation is necessary in broadcast plantings. If hemp is planted in rows, the rows should be 36 to 42 inches apart and the plants spaced 12 to 15 inches in the drill; this will require 5 to 8 pounds of seed per acre.

When planted in rows the crop should be cultivated to control weeds. Frequent and shallow cultivation should be continued until the plants are 24 to 32 inches in height, after which they will shade the ground and weeds will not be a problem.

Seed may be harvested with a combine if plants are not too large; otherwise hand harvesting followed by threshing will be necessary.

## SAFFLOWER

Safflower, *Carthamus tinctorius*, is an annual, the seed of which contain a valuable oil. It has been grown principally in the western part of the United States. Tests were conducted at Atmore and Auburn to see if this plant offered any possibility for production in Alabama. The tests at Atmore were conducted on very fertile Orangeburg fine sandy loam. The Auburn tests were on Norfolk sandy loam of average fertility. In the tests at Auburn and at Atmore, 300 pounds of superphosphate and 50 pounds of muriate of potash were applied prior to planting. Nitrate of soda was applied as a top-dressing about March 1 at the rate of 225 pounds per acre. The seed were planted in rows 1 foot apart at the rate of 60 pounds per acre. Single-row plots 16 feet long were used. The varieties were replicated from 2 to 4 times. The varieties used and the yields obtained are given in Table 15.

It will be noted that the yields were very low. In most instances the plants were very susceptible to several fungus diseases, which were not identified. The results indicate that safflower is not suited for growing under Alabama conditions.

TABLE 15. YIELDS OF SAFFLOWER AT MAIN STATION, AUBURN, 1943-44, AND AT ATMORE, 1944.

| Item                   | Yield of threshed seed<br>per acre |                |                |                |
|------------------------|------------------------------------|----------------|----------------|----------------|
|                        | Auburn                             |                |                | Atmore         |
|                        | 1943                               | 1944           | 1944           | 1944           |
|                        | Pounds                             | Pounds         | Pounds         | Pounds         |
| Selection No. 1 .....  | 108                                | 0 <sup>1</sup> | 0 <sup>1</sup> | 0 <sup>1</sup> |
| Selection No. 4 .....  | 95                                 | 0              | 0              | 0              |
| Russian .....          | 78                                 | 0              | 0              | 0              |
| Selection No. 2 .....  | 68                                 | 0              | 0              | 0              |
| Common .....           | 64                                 | 0              | 0              | 0              |
| Mandan .....           | 41                                 | 0              | 0              | 0              |
| Selection No. 3 .....  | 15                                 | 0              | 0              | 0              |
| Kardir 1082 .....      | <sup>2</sup>                       | 0              | 0              | 0              |
| Shalafer No. 1 .....   | <sup>2</sup>                       | 0              | 0              | 0              |
| Simla 66/1508 .....    | <sup>2</sup>                       | 0              | 0              | 0              |
| Karar 1885 .....       | <sup>2</sup>                       | 0              | 0              | 0              |
| Ahmadagar No. 1 .....  | <sup>2</sup>                       | 0              | 0              | 0              |
| Pusa No. 1 .....       | <sup>2</sup>                       | 0              | 0              | 0              |
| Pusa No. 25 .....      | <sup>2</sup>                       | 0              | 0              | 0              |
| Date of Planting ..... | Feb.<br>24                         | Nov.<br>16     | Jan.<br>25     | Nov.<br>18     |
| Date of Harvest .....  | June<br>2                          |                |                |                |

<sup>1</sup>Killed by cold or by disease.

<sup>2</sup>Not planted.

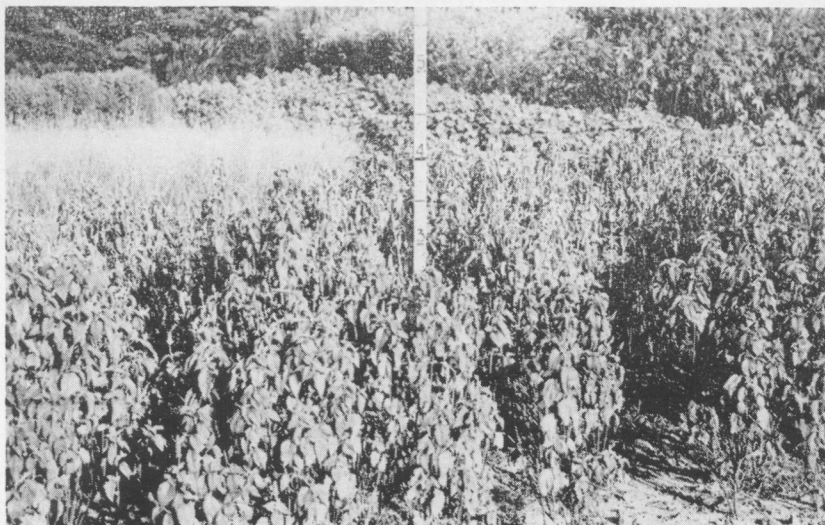


FIGURE 5. Chia in seed production experiments at Main Station, Auburn, Alabama.

## CHIA

Chia, *Salvia hispanica*, is a summer-growing annual having seed that contain oil. Tests were conducted at Auburn on a Norfolk sandy loam of average fertility to determine if the plant could be grown profitably in Alabama. Fertilizer was applied at the rate of 600 pounds per acre, using a 6-8-4 before planting. Broadcast and drill plantings were made. The method of planting, dates of planting, dates of harvesting, and yields are given below.

| Item                       | Yields of threshed seed per acre |                |                |
|----------------------------|----------------------------------|----------------|----------------|
|                            | 1942<br>Pounds                   | 1943<br>Pounds | 1944<br>Pounds |
| Broadcast .....            | 340                              | 204            | 330            |
| Drilled, 3 foot rows ..... | —                                | —              | 301            |
| Date of planting .....     | May 10                           | April 29       | May 4          |
| Date of harvest .....      | Oct. 31                          | Nov. 19        | Nov. 18        |

The plants grew well and were not attacked by disease; however, seed yields were low, which indicate that the plant cannot be grown profitably in Alabama.

## PERILLA

Two species of perilla, *Perilla frutescens* and *Perilla crispa*, were grown to determine if they had any value for oil production in Alabama. The tests were conducted at Auburn on a Norfolk sandy loam of average fertility. Six hundred pounds of a 6-8-4 fertilizer was ap-



TABLE 16. SEED YIELDS OF TWO SPECIES OF PERILLA FROM DIFFERENT DATES OF PLANTING, AUBURN, ALABAMA, 1942-44.

| Years grown | Perilla frutescens |                 |               | Perilla crispa |                 |               |
|-------------|--------------------|-----------------|---------------|----------------|-----------------|---------------|
|             | Planting date      | Harvesting date | Yield         | Planting date  | Harvesting date | Yield         |
|             |                    |                 | <i>Pounds</i> |                |                 | <i>Pounds</i> |
| 1942        | May 10             | October 10      | 146           | May 10         | October 10      | 124           |
| 1943        | April 29           | October 18      | 120           | April 29       | October 18      | 95            |
| 1944        | May 4              | October 13      | 357           | May 4          | October 13      | 306           |

plied prior to planting. Broadcast and drill plantings were tested. The crop was not able to compete with weeds in the broadcast plantings. Rows 2 to 3 feet wide were used and the plants drilled thickly in the rows. Sufficient cultivation to keep out weeds was practiced. The plants grew satisfactorily and were not attacked by disease, but the yields of seed were low, Table 16. The yields do not seem to justify growing this plant as an oil crop in Alabama.

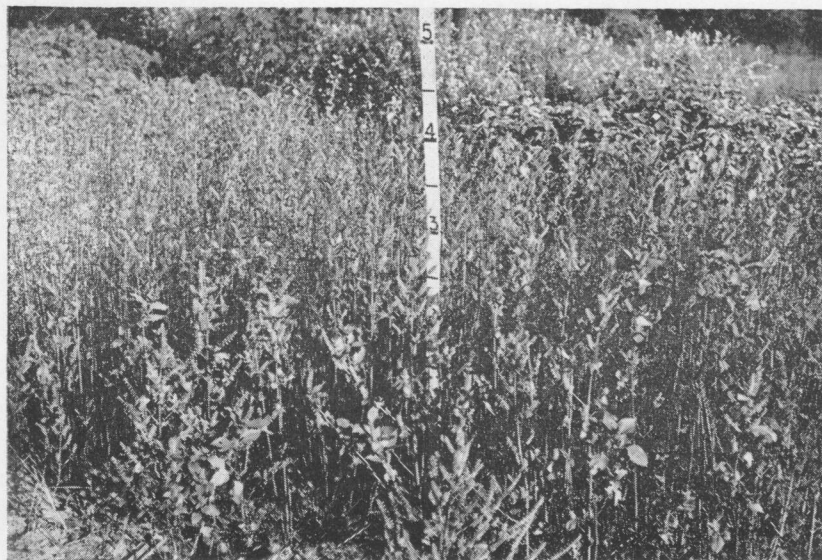


FIGURE 6. Perilla in seed production experiments at Main Station, Auburn, Alabama



FIGURE 7. Sesame (benne) in seed production experiments at Main Station, Auburn, Alabama. Left: Sesame at blooming stage. Right: Sesame at harvest stage.

### SESAME OR BENNE

Sesame or Benne, *Sesamum indicum*, is an annual summer-growing plant grown for the seed, which usually are imported under the name of sesame. The seed may be used for oil and are sometimes used on foods. The seed are very palatable and are especially liked by birds. The plant is frequently grown in the South for bird feed under the name of benne.

Experiments were conducted at Auburn on a Norfolk sandy loam of average fertility. An application of 600 pounds of 6-8-4 fertilizer was made prior to planting.

Two varieties, as shown, were tested in 1944.

| <i>Kind</i>            | <i>Yield of threshed seed per acre</i> |
|------------------------|--|
|                        | <i>Pounds</i>                          |
| Sesame, Common .....   | 396                                    |
| Sesame, Imported ..... | 66                                     |

METHODS OF SEEDING. In this test the common variety of sesame was used. The results were as follows:

| Item                       | Yield of threshed seed per acre |         |
|----------------------------|---------------------------------|---------|
|                            | 1943                            | 1944    |
|                            | Pounds                          | Pounds  |
| Broadcast .....            | 374                             | 396     |
| Drilled, 3-foot rows ..... | 750                             | 276     |
| Date planted .....         | April 29                        | May 4   |
| Date harvested .....       | Nov. 19                         | Oct. 13 |

The data show an advantage for drill plantings in 1943 and a slight advantage for broadcast plantings in 1944. No definite conclusions, however, can be drawn from these results. Weeds are usually prevalent, and under such a condition drill plantings are probably preferable.

DISCUSSION. In the experiments sesame was not attacked severely by diseases. The seed shatter easily. In the tests at Auburn, the plants were harvested as early as practical to prevent loss of seed. Sesame does not appear to be especially well suited for commercial production as an oil crop in Alabama because the seed shatter so readily. If a non-shattering variety were available, it might be produced. However, yields in these tests do not appear to be large enough to compete with the higher-yielding oil crops.

## SUNFLOWER

The sunflower, *Helianthus annuus*, is an annual plant frequently grown for shade and as a flower. The seed are fairly high in oil content, approximately 25 per cent. The seed are edible and are used commonly in chicken feed. The oil is used as a substitute for olive or other edible oils. In Russia the seed are frequently eaten by humans in the manner very similar to peanuts.

Experiments with sunflowers were conducted at Auburn on a Norfolk sandy loam of average fertility. The mammoth Russian variety was planted in 42-inch rows. The plants were spaced from 15 to 18 inches apart in the row. Fertilizer was applied prior to planting at a rate of 600 pounds per acre of a 6-8-4. The plants were cultivated sufficiently to keep out weeds. The results were as follows:

| Year       | Planting | Date of  |          | Yield of threshed seed per acre |
|------------|----------|----------|----------|---------------------------------|
|            |          | Planting | Harvest  |                                 |
|            |          |          |          | Pounds                          |
| 1941 ..... | June 17  |          | Sept. 18 | 1,200                           |
| 1942 ..... | June 19  |          | Oct. 3   | 1,992                           |
| 1943 ..... | June 15  |          | Sept. 25 | 1,812                           |

It may be noted that the yields of seed were quite high. This plant appears to be especially well suited to Alabama conditions and might be grown extensively for oil purposes if the price should justify.

#### RECOMMENDATIONS

Sunflowers should be planted on fertile, well fertilized soil. They should be planted in rows 36 to 42 inches wide and the plants spaced 12 to 18 inches in the row. To control weeds the crop is cultivated like corn. Weeds will not be a problem after the plants reach a height of 2 to 3 feet. The heads should be harvested when the seed are ripe, cured by storing in a dry place, and then threshed. It might be possible to harvest the seed with a combine, but no attempts were made to use a combine in these tests.