**Competition Studies in Soybeans**

Kuell Hinson and W. D. Hanson

C**ompetition** stress is exerted on a plant by the spatial arrangement and phenotype of surrounding plants. The extent to which competition stress influences a plant character is an important consideration in selecting for that character in a breeding program. If a predetermined plant spacing can be identified at which competition stress has a negligible effect on genotypes, relative to their performance in drilled rows, effective selection may be practiced on an individual plant basis with considerable economy in time and field space. Plant spacings much wider than commercial planting rates would be desirable to facilitate plant measurements and identification and to provide adequate planting seed for progeny testing.

**Materials and Methods**

Four soybean varieties were grown in 38-inch rows at within-row spacings of 2, 4, 8, 16, and 32 inches to study the effect of competition on yield, chemical composition, and agronomic characters of soybeans and to determine if a within-row spacing could be identified at which the effects were negligible.

The varieties (Table 1) were selected to represent the range of their genetic potential for yield, are better indicators of their genetic potential for chemical composition, and are very reliable indicators of some agronomic characters. Differences in competition stress are undoubtedly one reason for the failure of spaced plants to indicate the relative performance of their less heritable characters at commercial planting rates. A differential response of genotypes to spacings was obtained for yield (10, 11) and number of branches (10) at within-row spacings likely to be encountered in commercial production. Border-row competition resulted in significant yield differences (5, 6) but had no appreciable effect on chemical composition of seed. Differences in response to photoperiod are likely to be very important since plant development is controlled to a considerable extent by the response of a plant to photoperiod (1, 2, 4). Limitations imposed by the necessity of small plot size for individual plants are obvious but have no satisfactory solution.

This paper presents the results of an experiment conducted at Gainesville, Florida, in 1955 and 1956 to study the effect of competition on yield, chemical composition of seed, and agronomic characters of soybeans and to determine if a within-row spacing could be identified at which the effects were negligible.

### Materials and Methods

Four soybean varieties were grown in 38-inch rows at within-row spacings of 2, 4, 8, 16, and 32 inches to study the effect of competition on yield, chemical composition of seed, and agronomic characters of soybeans and to determine if a within-row spacing could be identified at which the effects were negligible.

#### Materials and Methods

- **Four soybean varieties** were grown in 38-inch rows at within-row spacings of 2, 4, 8, 16, and 32 inches to study the effect of competition resulting from spatial arrangements of the same genotype. Three variety mixtures were grown at the same spacings to study the effect of competition resulting from varying the genotype of surrounding plants at each spacing. Differences in the performance of varieties in pure stands at the various spacings will be referred to as spacing effects, although they are one form of competition effects. The term “competition effect” will be restricted to comparisons of the performance of varieties in mixtures and the performance of the same varieties in pure stands at a given spacing or over all spacings.

- **The varieties (Table 1)** were selected to represent the range in height and maturity of parents that would ordinarily be used in a breeding program at Gainesville. Mixtures were made in combinations (1,2), (1,3), and (1,2,3,4). Each variety grown in pure stands and in each mixture was considered a separate treatment and is defined as a varietal treatment. Varieties in mixtures were identified by genetic traits.

- The field plan utilized spacings as whole plots and varietal treatments as subplots in a split-plot design. Three replications were planted on May 18 and 19 in 1955 and 4 on June 18, 19, and 20 in 1956. Seed were drilled at a rate to give approximately 3 times the desired plant population for the 2- and 4-inch spacings, and 3 seeds per hill were planted at the 8-, 16-, and 32-inch spacings. Mixtures were established by drilling equal numbers of thoroughly mixed seeds in each row of the 2- and 4-inch spacings and by planting an equal number of randomly occurring hills in each row of the 8-, 16-, and 32-inch spacings. Each plot contained several 19-foot rows to insure 12 bordered plants from each treatment for harvest from rows other than border rows. Plots were thinned to the correct plant population approximately two weeks after planting.

- **Data** were recorded on 12 bordered plants randomly selected from each plot at each treatment. Seed yield in grams, height at maturity in inches, number of branches with at least one node, and number of nodes excluding the terminal node were recorded both years, whereas height at flowering, days from planting to flowering (flowering date was recorded when at least 3 flowers had been produced), date of maturity (day in October), fruiting period (days from flowering to maturity) and change in height from flowering to maturity were recorded in 1956 only. Individual plant data were averaged to obtain treatment values. Seed from the 12 plants in each treatment were bulked to obtain average seed weights which were recorded as grams per 100 seeds. Seed quality scores were assigned from the bulked samples in 1956 only. A seed sample from each treatment was analyzed for protein and oil percentages by the chemical section of the U.S. Regional Soybean Laboratory at Urbana, Illinois. Seed yield, percent protein, and percent oil will be referred to as primary characters and the remaining characters will be referred to as secondary characters.

- **Data were analyzed by the analysis of variance. Analyses and interpretations were based on original measures for all attributes except seed yield per plant. Standard errors for an observation tended to be proportional to the mean for seed yield per plant; therefore, the seed yield per plant data were converted to logarithms before analysis. Thus, the seed yield analysis was directly amenable to the analysis described below.**

- If spacing has no effect on total seed yield per plot, the expected seed yield per inch of row would be constant, say Cg./inch for a spacing treatment. Spacing treatments were 2″ inches; hence, g/plant for the rth spacing treatment would be 2" Cg./plant. If Δ is taken as the increment change in the logarithm of the mean yield per plant between 2 consecutive spacings, then

\[
E[\log (\text{g/plant})] = \log 2 \approx 301.
\]

Similarly, if spacings have no effect on the yield per plant, E[log (g/plant)] = 0. Thus, with 5 spacing means, 4 Δs which characterize the response of plants to spacings are available. The variance for an estimated Δ is

\[
V(\Delta) = 2V(E)/t,
\]

where V(E) is the error variance based on logarithms. The standard error for testing a deviation from 301 or zero is

\[
V(\Delta)^{1/2},
\]

where t is selected for a one-tailed test. The error for the linear contrast of 4 Δs is 5V(Δ)/4 and for the quadratic contrast is 5V(Δ)/4.

**Results**

Mean squares from the analyses of the 7 characters measured both years are presented in Table 2. Highly significant year effects were obtained for all characters.

### Table 1

<table>
<thead>
<tr>
<th>Variety</th>
<th>Number</th>
<th>Height (inches)</th>
<th>Maturity date in October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Dickey</td>
<td>2</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Yeiunda</td>
<td>3</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Jackson</td>
<td>4</td>
<td>27</td>
<td>27</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Variety</th>
<th>Number</th>
<th>Height (inches)</th>
<th>Maturity date in October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Dickey</td>
<td>2</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Yeiunda</td>
<td>3</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Jackson</td>
<td>4</td>
<td>27</td>
<td>27</td>
</tr>
</tbody>
</table>