Breeding for Seed Size and Composition of Vegetable Soybean

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Introduction and Methods

Breeding for seed size

Specialty soybean [*Glycine max* (L.) Merr.] cultivars with large seed size are used in the production of edamame. At Iowa State University, a cultivar is considered large seeded if it has a seed size of 250 mg seed^{-1} or greater. The objective when breeding large-seeded cultivars is to maintain the desired seed size, while increasing seed yield and other desirable agronomic traits. Three population types were evaluated for the frequency of acceptable segregates obtained from each.

One population type is a two-parent cross between two large-seeded parents. The advantage of this population type is that the majority of the segregates should have the desired seed size. The disadvantage is that large-seeded cultivars used as parents yield approximately 20% less than conventional soybean cultivars grown in the northern United States (Voss et al., 2000). The second population type involves the use of a conventional soybean cultivar to introduce genes with greater yield potential. A two-parent cross between a large-seeded parent and a normal-size conventional parent may produce progeny with greater yield potential; however, it may be difficult to obtain segregates with the desired seed size. The third population type is a three-parent cross involving two large-seeded parents and a normal-size parent. The normal-size parent may introduce yield genes, while the two large-seeded parents may increase the frequency of segregates with desirable seed size. To form a three-parent population, a cross is made between a large-seeded parent and a normal-size parent. The resulting F_1 is mated to a second large-seeded parent.

The primary objective of the study was to evaluate the frequency of segregates from the three population types. A secondary objective was to evaluate the reliability of single-plant selection for seed size.

Eight large-seeded lines and four normal-size lines or cultivars were used to develop four sets of populations. Each set consisted of two large-seeded parents and one normal-size parent. The three parents were used to form three populations: a large-seeded × large-seeded population, a large-seeded × normal-size population, and a large-seeded × (large-seeded × normal-size) population. For each set, 330 entries were evaluated in a randomized complete-block design at two locations with two replications at each location. The entries consisted of 100 $F_{2:3}$ lines from each population and ten entries of each parent. Entries were grown in single-row plots and each

entry was harvested in bulk. Seed size was measured by weighing 400 random seeds from each plot.

Results

The large-seeded × large-seeded populations had the highest percentage of lines with seed size equal or greater than the large-seeded parents in the population. The range for percentage of acceptable segregates was 82 to 98% with an average of 92% across the four sets. Transgressive segregation for seed size larger than the parents averaged 8% and transgressive segregation for seed size smaller than the parents averaged 8% across the four sets. The large-seeded × normal-size populations had the lowest percentage of lines with seed size equal or greater than the large-seeded parent in the population. The range for percentage of acceptable segregates was 0 to 16% with an average of 5% across the four sets. Lines with seed size equal or greater than the large-seeded parent in the three-parent populations ranged from 20 to 56% with an average of 41% across the four sets.

Conclusions

For the development of large-seeded cultivars, large-seeded × large-seeded and three-parent populations resulted in the highest frequency of acceptable segregates. A large-seeded × normal-size population may be more effective if the seed size of the normal parent was closer in size to the large-seeded parent. The seed size of the normal-size parent in the three-parent populations can also influence the number of acceptable segregates obtained.

The cost effectiveness of selection for seed size on a single-plant basis was evaluated for each population type. In large-seeded × large-seeded populations, single-plant selection was not cost effective because the majority of the segregates have acceptable seed size. In the large-seeded × normal-size populations, single-plant selection was not cost effective because of the low frequency of acceptable segregates. Selection on a single-plant basis in the three-parent populations was considered to be cost effective.

Developing Lipoxygenase-free Cultivars

A trait being introduced into large-seeded soybeans is the absence of the three lipoxygenase enzymes that produce the beany flavor. The absence of the lipoxygenase isozymes can improve the off-flavor of some soy products (Torres-Penaranda, 1998; King, 2001). Backcrossing is being used develop lipoxygenase-free versions of large-seeded cultivars. The first one will be available for commercial production in 2002.

References

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