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Estimates of Genetic and Environmental Variability in Soybeans¹

Herbert W. Johnson, H. F. Robinson, and R. E. Comstock²

RECENT studies on a number of characters of soybeans have been directed toward estimation of heritability, that is, the fraction of variance in phenotypic expression that arises from genetic effects. However, the different methods employed do not necessarily estimate the same thing. For example, variance and regression methods of estimating heritability of F_2 plant differences estimate the same thing only if all gene effects are additive. The nature of the selection units (plant, plot, mean of several plots, etc.) and sampling errors also influence greatly the magnitude of heritability estimates. Therefore, any meaningful comparison of the estimates obtained in different situations must include a careful evaluation of the methods and materials employed.

Heritabilities of individual plant differences were estimated by Weber and Moorthy (5), using data on spaced plants of four varieties and the F_1 and F_2 of three crosses involving the varieties. Variance among plants within the F_1 's and the varieties was equated to environmental variance and subtracted from variance among F_2 plants to obtain estimates for genotypic variance. Heritability, the ratio of genotypic variance to F_2 variance, of yield was estimated to be 0, 13, and 60% in the three F_2 populations. The estimates for other characters were much more consistent from population to population and averaged as follows: flowering time, 75.6; maturity date, 75.3; period from flowering to maturity (fruiting period), 55.7; plant height, 62.0; seed weight, 54.3; and oil percentage, 54.7. Using the same method except that estimates of environmental variances were based only on variance among plants within the parent varieties, Mahmud and Kramer (4) estimated the heritability of yield and height in the F_2 of a varietal cross to be 43.4 and 40.6%, respectively. As pointed out by Weber and Moorthy, these estimates of genotypic variance contain variance due to genotype-environment interaction effects as well as genotypic variance.

Heritability of individual plant differences also may be estimated by the regression of progeny means on the performance of single plant parents. Bartley and Weber (1),

using F_2 and F_3 parents, obtained estimates for yield, plant height, and maturity date, which averaged 15, 66, and 85%, respectively. Using the same method for F_2 parents, Mahmud and Kramer (4) obtained estimates of 5.9, 35.3, and 50.3% for yield, height, and maturity, respectively.

The regression of F_4 line means on F_3 line means estimates heritability of differences among the F_3 line means. Such estimates by Bartley and Weber (1) were 45, 62, and 92% and by Mahmud and Kramer (4), 77, 91, and 100% for yield, height, and maturity date, respectively. The F_3 and F_4 lines were evaluated in different years in the first case and each F_3 line and its F_4 progeny were evaluated in subplots of the same whole plot in the second.

The purpose of the present investigation was to estimate for two segregating populations of soybeans (1) genetic variance among F_3 lines in the F_4 and F_5 generations, (2) variance due to genotype-environment interactions, and (3) progress to be expected from selection.

MATERIALS AND METHODS

Field Experiments and Data Collected

Two populations of F_3 lines of soybeans were studied in the F_4 and F_5 generations. Eighty-nine lines resulting from the cross Roanoke \times Palmetto, (population 1), and 64 lines from the cross N42-26 \times Seminole (population 2) were evaluated. Each line traced to the seed of a randomly chosen F_2 plant. In both populations, lines in the F_4 generation were grown in 1950 and the F_5 generation in 1951. Population 1 lines were grown at McCullers and Statesville, N. C., and Monetta, S. C. (later referred to as Location 1, 3, and 2, respectively). Population 2 lines were grown only at McCullers and Monetta. Lines in each population were arranged in a randomized block design with 2 replications at each location in the 2 years, with a different randomization for each test. The plots were single, 19-foot rows, with 3-foot spacings between the rows. The seed were drilled at a spacing of 8 viable seed per foot of row. In 1950, growing conditions were good at all locations with above average rainfall that was well distributed throughout the season, except for a short period of drought late in the growing season at location 2. In 1951, conditions were good early in the growing season, but a severe late-summer drought occurred at all three locations. The plots at locations 2 and 3 were not harvested, and yield at location 1 was only 67% as high as in 1950.

A 16-foot section of each row was harvested for yield and chemical data were obtained from analysis of a 60-g. sample of beans from each plot. Characters measured on a plot basis were as follows: (1) time of flowering—recorded as the number of days from emergence to the date when half the plants in the plot were flowering; (2) fruiting period—recorded as the number of days from flowering to maturity; (3) maturity—recorded as the number of days from Sept. 1 to the date when all pods were ripe; (4) yield of seed in grams per plot (variances and means were converted to a bushels per acre basis for presentation); (5) seed weight—recorded as grams per 100 seed (based on weight of 200 seed per

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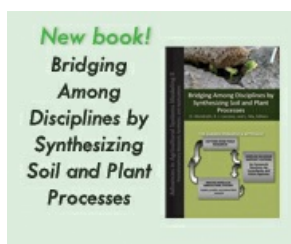
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