Heritable and Nonheritable Relationships and Variability of Agronomic Characters in Successive Generations of Soybean Crosses

B. G. Bartley and C. R. Weber

Permanent gain from selection, in the sense of resemblance between offspring and their parents, depends on the degree of relationship between genotype and phenotype. Total variance of an attribute in a segregating population is composed of a heritable portion, an environmental portion, and a portion due to genotype-environment interaction. Heritable variance is divided into: (1) additively genetic variance, (2) dominance variance, or the interaction of alleles, and (3) epistatic variance, or the interaction of nonallelic genes. The correspondence between genotype and phenotype of a trait is expressed by heritability. Heritability is defined as the ratio of additive genetic variance to total variance.

The purpose of this study was to estimate heritability in the narrow sense of four agronomic characters in the F2 and F3 generations from their relations with their respective F2 and F4 generations using three soybean crosses.

Techniques for partitioning phenotypic variance into its components have been described by Mather (6). Covariance of F3 progeny means and their F2 parents was shown by Fisher, Immer, and Tedin (1) to provide an estimate of genetic variance in the F2. The accuracy of this estimate depends on the degree of dominance. Regressions of F4 progeny means on F3 plants and on F3 progeny means provide similar estimates of heritability among F3 plants and F3 progeny means. Panse (7) obtained heritabilities of about 50% for staple length in two cotton crosses by regression of F3 progeny means on F2 plants.

Weiss, Weber, and Kalton (11) showed that replicated soybean progeny tests of F3 and F4 plants correlated with their respective F3 and F4 lines in different years provided reliable prediction values for maturity date, plant height, and lodging resistance. Yield correlations on these same progenies were much lower and were considered hazardous for prediction purposes. The high variability in yield was attributed to seasonal fluctuations.

Literature on quantitative inheritance in soybeans has been reviewed extensively by Kalton (3). Literature on maturity and height determinations on single early segregating generations were found useful for predicting the performance of progeny from the F2. Yield and lodging of single plants were a reliable value for selection purposes. Seed yield of F2 or progeny row basis has been found to be responsive to seasonal fluctuations.

Mahmud and Kramer (5) reported that heritability for yield, maturity, and height from one cross were much higher when estimates of F3 and F4 were grown in the same season than when different spacings and seasons were involved. They reasoned that this would provide good estimates of their F4 shift and interactions of generations with environmental factors were controlled.

Estimates of heritability for maturity date, seed yield and seed compositional characters were obtained by Lush (4) in the F2—F3 of an interspecific cross, G. max-G. ussuriensis. Heritability reported for maturity date was 86%. Estimates of heritability for seven soybean varieties in the F2 of three intervarietal crosses were calculated using within-plot variances of F2 plants. Genotypic variation in the broad and narrow sense was large for maturity date and height, but generally low for seed yield.

MATERIALS AND METHODS

All cross combinations among three varieties, Hawkeye, and Lincoln, of the cultivated soybean max, were used in this study. Crosses were made in 1946 and F1 hybrids grown in the greenhouse during spring of 1946-47. Succeeding generations were grown at the Agronomy Farm, Ames, Iowa.

The F2 plants were grown in a space-planted nursery to obtain sufficient seed to plant a replicated test. In each cross four F2 rows, each occurring at random, were planted with 240 seeds per row. A row of each parent adjacent to rows containing their respective F2's. Seeds were 8 inches apart in rows 40 inches wide. Seed yield, height were recorded on each individual F2 and each parental row. The number of plants harvested was as follows: Hawkeye × Ottawa Mandarin, 868; Ottawa Mandarin, 828; and Lincoln × Hawkeye 188 competitive F2 plants were selected for F3 progeny test with the exception of a few plants chosen for their appreciable differences. A few plant.