For selection to be effective, genetic variability must be present in the breeding materials. Thus, the success of a breeding program depends in part upon choosing breeding stock which has sufficient genetic variability. The use of exotic germ plasm in maize (Zea mays L.) to increase genetic variability and to introduce new sources of possible heterosis has already begun. More effective use of such material may be possible when estimates of the amount and type of genetic variation are available for populations incorporating exotic germ plasm in varying amounts and from various sources.

The theory and methods for the study of genetic variability in maize were presented by Comstock and Robinson (2). Their designs permit estimation of additive and non-additive portions of the genetic variance, which provides an indication of the most effective breeding procedure as well as a means of comparing different populations.

Estimates of genetic variances in maize are now available from several sources. These include estimates for F_2 and advanced generation populations from a cross of two inbred lines (5, 10), for open-pollinated varieties (4, 7, 12, 14, 16; as well as several theses (8), for synthetics (8), and for collections of inbred lines (13, 15).

MATERIALS AND METHODS

The West Indian Composite was developed by William L. Brown of Pioneer Hi-Bred Corn Company, Johnston, Iowa. In the winter of 1952–1953, commercial single crosses and inbreds of U. S. origin were crossed with high-yielding varieties of the West Indies which have shown promise of being superior breeding materials (1). On the basis of plant and ear height, 177 open-pollinated ears were selected from these crosses. The seed from those ears were bulked to form the base population of the West Indian Composite, which was grown in small, isolated, open-pollinated blocks in Iowa for 5 more generations with no less than 200 ears saved each year. In 1959, 161 open-pollinated ears were progeny tested and 68 were selected on the basis of yield, grain and ear quality, and stalk strength. A part of the bulked remnant seed from these 68 ears was planted in 1960 to provide the West Indian Composite matings for this study. The composition of the seed parents which supplied the base population of this composite is listed in Table 1. Brown also developed the Corn Belt Composite from the ten commercial inbred lines used in the West Indian Composite. It was handled in the same manner as was the West Indian Composite. Minimum selection was practiced in both composites during five of the six generations of open-pollination.

To obtain seed for the Design I experiments, plants each were grown with the first plant used as parent and the other 6 plants used as females. At harvest four successfully pollinated females were selected from each row to constitute each male. Such male groups were obtained for each population resulting from these crosses represented 256 full-sib families for each population. These were planted in 1961, at the Peanut Belt Experiment Station, North Carolina, and on May 4, 1961, at Pioneer Hi-Bred Johnston, Iowa.

At each location the experimental area was divided into 32 blocks, and 16 of these blocks were randomly assigned to each population. The blocks were subdivided to provide a uniform distribution of the material in each block. To each block at Johnston, 4 half-sib (16 full-sib) families were assigned at random, and these were calculated using the procedure for randomized block designs. Plant and ear height were measured in inches from the base of the plant to the tip of the node bearing the top ear, respectively. Ear number as the total number of ears per plot and yield weight of grain, measured to the nearest tenth of a pound. In North Carolina the weight was taken as uniform moisture. In Iowa field weight was taken at 15.5% ear moisture with the aid of moisture determinations made at harvest.

For each population analyses of variance and covariance were computed for each character and each pair of characters. The form of the analysis of variance at each location is given by Comstock and Robinson (3, Table 30). The corresponding analysis of covariance has the same form with components of covariance in place of the components of variance having the appropriate means squares from the appropriate variances of male effects, \( \sigma_m^2 \), and female effects due to females mated to the same male, \( \sigma_f^2 \), for each trait studied. A corresponding procedure for estimating covariance components from the corresponding genetic interpretations associated with these estimates is given by Comstock and Robinson (9).

The genetic correlation coefficients were computed from the procedures presented by Moore and Robinson (9). The combined analysis over both locations, estimates location interaction variances can be obtained.

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Estimates of Genetic Variance in Adapted and Exotic Populations of Maize

Major M. Goodman

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