Heterozygosis and Hybrid Vigor in Maize

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Hybrid vigor usually is defined as the superior vigor of certain hybrids in comparison with their parents. There is no convincing evidence that it differs in kind from other manifestations of vigor. It is a well known, highly important, and poorly understood genetic phenomenon. The work reported here was conducted primarily to learn if possible how the additions of measured degrees of heterozygosis would affect hybrid vigor. Would the expression of hybrid vigor increase additively or in some other way? The results and interpretation of the experiment raise certain questions regarding related breeding problems and these are discussed in the context.

Literature

The literature on hybrid vigor is too extensive for a comprehensive review here. The reader is referred to reviews by Whaley (19), Sprague (18), and Richey (15). Richey concludes "(a) that the interaction of dominant favorable genes remains the most probable explanation for hybrid vigor, (b) that the relative importance of hybrid vigor and of inherent productiveness as causes of the high yields of corn hybrids is not known, but (c) that the evidence continues to accumulate that the highest yields tend to be obtained when the best products of selection are used in hybrid combinations." Thus the proposal made by Bruce (1) and by Keeble and Pellow (10) in 1910 and by Jones (9) in 1917 that heterosis might be accounted for by the action of dominant genes still stands without successful disputation in any essential point.

Richey and Sprague (16) found the grain yields of backcrosses to be almost exactly half way between those of the parent inbred lines and those of the F2 single crosses.

Neal (14) compared the grain yields of parent inbred lines, and the F1 and F2 generations of single crosses, three-way crosses, and double crosses. His results were in close agreement with the theoretical expectation that yields decrease in linear order from the F2 hybrids to the inbred lines as heterozygosis decreases. This is in accordance with the formula proposed by Wright (21). Neal reported the expected loss in heterozygosis from the F1 to the F2 generation of a three-way cross as 33.8%. The writer would expect 37.5% rather than the 33.3% reported by Neal. Using three inbred lines, A, B, and C, the F2, (A×B) (C×C) × (A×B) (C×C), involves 16 cross combinations. Ten are heterozygous and six, or 37.5%, are homozygous. That would improve the agreement between his data and the linear order of decrease.

Materials and Methods

The experiment involved four inbred lines and various combinations among them. Three of the lines had been self-pollinated for 10 or more successive generations. The fourth line was sib-pollinated backcrossed inbreds. Each of the seven kinds listed in Table 1 were used in hybrid combinations. Thus the proposal made by Bruce (1) and by Keeble and Pellow (10) in 1910 and by Jones (9) in 1917 that heterosis might be accounted for by the action of dominant genes still stands without successful disputation in any essential point.

Seed of the seven kinds listed in Table 1 were used for hand pollination. These established four degrees and were produced so that each inbred line was comparedly to each kind of seed. Any two lines were combined in exactly the same relation and in the same frequencies with the other two lines and with themselves.

Sib-pollinated seed of the inbreds was used so it be at no disadvantage when compared with the material used.

The field plots were 4 by 10 hills checkrowed, inches apart. The two outer rows of each plot had the equivalent of seven successive selfings by crossing sibs. They may safely be assumed highly inbred. The purpose of this experiment, and no two were done with the same two kinds of seed.

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The field plots were 4 by 10 hills checkrowed, inches apart. The two outer rows of each plot were left unused. Each of the seven groups shown in Table I was represented by 24 plots. Where the 24 plots of a group were distributed equally between the entries each in two-fold replication, the distribution was such that each entry appeared once in each combination. The group was such that each entry appeared once in each quarter of the field. The group was divided into six groups, the number of which was such that each entry appeared once in each quarter of the field. The group was analyzed separately as six randomized blocks. The group having four entries each in six randomized blocks. The group having four entries each in six randomized blocks. The group having four entries each in six randomized blocks. The group having four entries each in six randomized blocks. The group having four entries each in six randomized blocks. The group having four entries each in six randomized blocks.