Combining Ability for Degree of Fill in ae Endosperm of Maize

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THE potential value of amylose to industry was pointed out by Dimler (3) and has been demonstrated by the rapid growth in the production of corn (Zea mays L.) of high amylose content.

Many attempts have been made to ascertain the effects of specific genes and gene-combinations on the amylose-amylopectin ratio in order that an effective breeding program for obtaining a high-amylose hybrid corn could be established. The interaction of sugar-1 (su₁) and dull (du₁), as reported by Cameron (1), increased the amylose level to approximately 65% of the starch fraction. Neither gene was very effective alone, and the presence of homozygous recessive su₁ in the genotype resulted in a highly wrinkled kernel with little starch. Dunn, Kramer, and Whistler (4) reported that the triple recessive su₁du₁du₁ increased the amylose fraction to 77%, but again this increase in amylose content was at the expense of total starch.

Vineyard and Bear (5) first reported a mutant gene, amylose extender (ae), which increased amylose content to the 50 to 60% range without extensive loss of total starch.

Duclos (6) found a reduction in yield associated with homozygous recessive ae locus. The variation from line to line indicated that modifiers were present that interacted with ae and resulted in a reduction of yield. He concluded that there was an effect of the ae gene and its linkage block that resulted in reduced kernel weight.

In a recent study by Crane (2), it was found that higher amylose content in pooled data was slightly associated with a slight collapse or shrinkage of the mature kernel. However, the correlations between degree of collapse and percent amylose were nonsignificant within six of eight families of random inbreds. Crane concluded that plump kernels and higher amylose content may be selected simultaneously.

It is hypothesized that various modifiers when present with the ae gene, determine the degree of "fill" in ae kernels. Degree of fill may vary from a plump, or well filled endosperm to a collapsed, or much reduced endosperm. This study deals with a trait that affects yield, namely, the degree of endosperm fill that appears in the inbreds and subsequently may be expressed in the hybrids. The more extreme expression of collapsed ae endosperm is similar in morphological effect to either the shrunken or the sugary-1 endosperm.

MATERIALS AND METHODS

Ten inbred lines homozygous for ae were selected for this study and crossed in a diallel series. Five were established cornbelt lines homozygous for ae and five were ae lines developed by backcrossing to a heterozygous ae ae material for one to three generations. Each line was selfed 2 to 4 generations. Each line was visually classified into 1 of 3 classes, plump, intermediate, or collapsed, degree of kernel collapse it demonstrated. When the degree of individual kernels on a given ear was not considered, of collapse was considered consistent.

An objective measurement was devised for the material obtained. By the use of a "split-ear" pollination, amylose and normal endosperm kernels were obtained from a homozygous normal endosperm type dent corn.

After the silks were cut back and attained a proper length (1 1/2 inches), they were equally divided by placing a 3 x 5 card on the edge of the ear opposite the stalk, pushing the card through the silks and toward the stalk. The card was in place, one individual self-pollinated, while another pollinated the remainder of the ear. A new card was used for each pollination. When pollination was completed, the shoot was replaced to prevent injury, then the ear was bagged with a tassel bag. When the bag was being replaced, care was taken to avoid complete interchange between the two groups of silks.

After harvest, samples of 100 ae and 100 normal (when 100 were not available) were removed from positions on opposite sides of the ear and each set was kept in individual packets. The packets representing kernels from a given ear contained equal numbers of kernels to take kernels from each silks where a full seed set was obtained from equivalent areas on the ear. Weight, volume, and gravity comparisons between the normal and ae lines were made to establish the relative degree of fill of kernels.

The combining ability analysis of diallel crosses was conducted by Griffing (5), and used in this study, was Model I, method 4. Griffing points out that in order to obtain unbiased estimates of combining ability, the parental data must not be included in the analysis.

RESULTS AND DISCUSSION

Analyses of variance showed significant differences existed between entries.

The F₁ weight ratios (ae/normal) and volume ratios (ae/normal) were ranked in descending order. Generally, of crosses occurred in both rankings. Except for crosses with inbred Oh43ae which are generally closer to the normal phenotype in volume than in weight, the site is true for crosses involving inbred 355ae, weight is generally closer to that of the normal phenotype than its volume.

On the basis of the original visual classification, ratings suggest that either visual classification is correlated with classification based on objective measurements or that environment is important in the expression of collapse.