Genetic Study of Cooking Quality in Rice

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ABSTRACT

Alkali-digestion index was studied as an indication of gelatinization temperature, with an intermediate index, such as found in Strain 186, being desirable in a dry cooking rice. IR 8 has an undesirable high index. Alkali-digestion index behaved as a qualitative character. The parent difference appeared to be governed by one pair of genes. Heritability estimates were very high. Consequently, selection on the individual plant basis would be highly effective.

Cooking behavior of milled rice has been emphasized in all breeding programs. Two physio-chemical properties of starch that affect the cooking quality of rice are gelatinization temperature and amylose content. Gelatinization is related to the cooking time while amylose content is associated with the texture of cooked rice. Longer cooking time is required for varieties with high gelatinization temperature. High amylose varieties that tend to get moist and sticky on cooking. A rapid method for estimating the gelatinization temperature is the rate of disintegration of milled rice in a dilute alkali solution. Low index of alkali-digestion indicates a high gelatinization temperature and vice versa.

Different groups of consumers have their own specific cooking quality preferences. In development of new varieties, quality of such kind preferred by consumers must be combined with other agronomic traits responsible for high yielding ability.

The objective of this study was to determine the breeding behavior and heritability of alkali-digestion index. A primary purpose of the research was to determine whether this character could be selected in the early generation or not.

Materials and Methods

The genetic material used in this study was derived from a cross of Strain 13d × 61 B1 186 (this will be referred simply as Strain 186), selections from the breeding program at the Rice Experiment Station, Crowley, Louisiana with IR 8. Strain 186 has high yield and the grain is long and clear with good cooking quality. IR 8 has high yield and the grain is of medium size, chalky and prone to breakage.

The F_2 seeds were sown along with the two parents on April 14, 1971. In 1972, 100 F_2 plant were randomly chosen from F_2 population. F_3 seeds from each of F_2 plants, comprising 100 F_3 lines, traced to a single F_2 plant. The 100 F_3 lines and two parents were arranged in a randomized complete block design with two replications.

The sample of grains from the F_2 and F_3 plants and the two parents were tested for alkali reactions. The alkali reaction of the seeds harvested from an F_2 plant is the expression of the F_3 endosperm. The hybrid materials tested from F_2 generation will be referred as F_3 lines. Similarly, the hybrid material tested from the F_3 plants will be referred to as F_4 families. The determination of alkali reaction was performed by following the procedure described by Little *et al.* (1). When the alkali reaction test of F_3 lines and F_4 families was performed, varieties Century Patna 231, Early Prolific, Blue Bonnet 50, Caloro and Colusa were used as controls along with the two parents. The spreading of each kernel was rated on a 7-point scale:

1. = kernel not affected
2. = kernel swollen
3. = kernel swollen, collar complete or narrow

4. = kernel swollen, collar complete and wide
5. = kernel split or segmented, collar complete or wide.
6. = kernel dispersed, merging with collar
7. = kernel completely dispersed intermingled and clear

Number of pairs of genes controlling a character was calculated by the method based on the proportion of homozygous F_3 lines.

Heritability was determined in the three forms. One form was expressed as the ratio of genotypic variance (V_G) to the total phenotypic variance (V_P). These two components were derived directly from analysis of variance. The second form was computed from parent-offspring regression. The third form is the use of phenotypic correlation between the F_3 line means and corresponding F_4 family means.

Results and Discussion

Number of genes controlling alkali-digestion index (ADI) : The means alkali-digestion indices (ADI) from the seeds of 74 plants of IR 8 and 50 plants of Strain 186 were 7.00 and 3.95 respectively. The environmental factors caused very little variation in the alkali digestion reaction of seeds of the two homozygous parents. Among 442 F_3 lines, 111 lines appear to have been

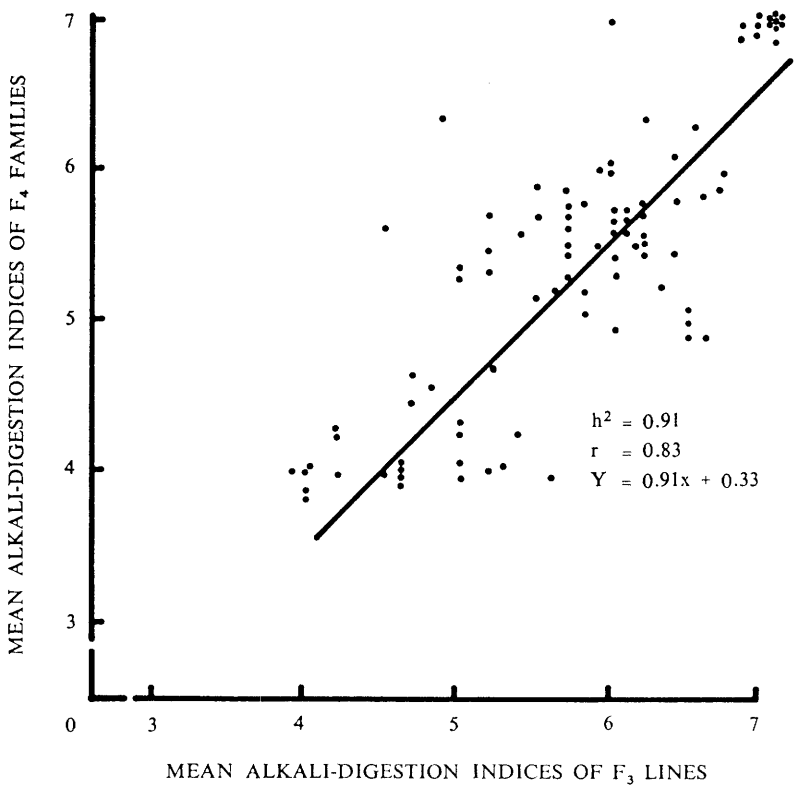

Fig. 1. Scatter diagram showing relationship between mean alkali-digestion index of the F_4 families and mean alkali-digestion index of the F_3 lines from which F_4 families were derived.

rived from F_2 plants which were homozygous r the genotype of the IR 8 parent, a frequency approximately 25 percent. This evidence ggests that the difference in ADI between the rents is controlled by a single pair of genes. wever, other lines of evidence which were as nclusive indicated that more than one pair genes was involved: the apparent occurrence transgressive segregation for lower indices an the lower index parent, the apparent currence of homozygous lines with indices tween those parents, considerably fewer than percent of the lines appeared to behave like e Strain 186 parent, and fewer than 50 percent the lines segregated for the phenotypes of th parents. Most of the results, however, dicate that the difference was governed by more an one pair of genes, possibly a major gene air plus modifiers.

When the relationship between the behavior the F_3 and corresponding F_4 seeds in respect ADI was taken in to account. The frequency of F_3 lines which appeared to possess the homo-gous genotype of Strain 186, the low index rent approaches 25 percent the evidence dicates strongly that difference between the rents in ADI is controlled by one pair of nes.

Heritability of ADI: The heritability of ADI. timated by the variance components method as 0.88 which is very high and indicates that lection among single plants should prove to be ghly. By the regression method, a value of 91 was estimated for the heritability of ADI. It is noted that there is a good agreement in heritability values estimated by the both methods.

Correlation between ADI from the 100 F_3 lines and their F_4 families was calculated. This estimate is a measure of association between the parent and their offspring. It also indicates the degree of heritability in the character. The correlation coefficient was 0.83 for ADI. This value was highly significant and indicates a close agreement between mean ADI of F_3 lines and their F_4 families.

In Fig. 1 is represented a scatter diagram that illustrates the strong positive association between the behavior of the F_3 lines and their F_4 families in respect to ADI. Most of the F_3 lines that had average indices of 4 and 7 bred true in the F_4.

Application to plant breeding : The results obtained in F_3 and F_4 indicates that the inheritance of ADI behaved more as a qualitative trait than as a quantitative one, with one pair of genes controlling the difference between the two parents. Consequently, heritability values estimated by three methods were found to be relatively high. The information suggests strongly that there should be no difficulty in obtaining F_3 lines having the desirable ADI comparable to the Strain 186. The selection among individual plants in F_2 and late generations should be highly effective.

Literature Cited

1. LITTLE, R.R. *et al.* 1958. Differential effect of dilute alkali on 25 varieties of milled rice. Cereal Chemistry, 25 : 111-126.