Effects of Height Mutations on Grain Yield in Sorghum

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DWARF mutations have played an important role in the development of grain sorghum (Sorghum vulgare Pers.) varieties in the United States. The phenotypic expression of reduced plant height caused by these mutations is obviously advantageous for mechanical harvesting. However, mutations frequently produce several phenotypic expressions, some of which may not be advantageous and others of which may not be obvious. Thus, the genes for brachytic dwarfsness exploited by the sorghum breeder may have certain disadvantages which either are not obvious or are not sufficiently great to offset their advantages.

Comparisons of mutant genes for dwarfsness in existing varieties with their ancestral “normal” genes for tallness in old varieties are difficult to make. Numerous genetic differences between the new and the old varieties likely exist at other than the major loci affecting internode length. However, tall mutants which have occurred in long time inbred lines of sorghum can be compared with the dwarf lines from which they arose. Comparisons between the mutant and parental lines might indicate whether or not genes for brachytic dwarfsness in sorghum are inferior to their “normal” alleles for yield and other quantitative characters.

The purpose of this paper is to report the results of attempts to determine whether or not certain tall mutants are superior to the dwarfs from which they arose in respect to grain yield and several other quantitative characters in different genetic types of grain sorghum.

MATERIALS AND METHODS

The series of studies reported here includes experiments of different types conducted over a period of 5 years. As a matter of convenience these experiments are referred to as experiment 1, experiment 2, etc.

Experiment 1. Five crosses were made in 1958 using a tall mutant form of male sterile ‘Combine Kafir 60’ as the female parent. This line, which will be referred to henceforth as C.K. 60, was heterozygous for dwarfsness at one locus. Male parents were ‘Norghum’, ‘Redbine 60’, ‘Plainsman’, ‘Combine 7078’, and C.K. 60 (B line). All the male parents except Norghum have a common genotype (dw Dw dw dw) at the major loci influencing internode length (2). However, 2 or possibly 3 loci are dominant in Norghum.

Seed from the 5 crosses were planted in 1959 on a farm near Urbana, Illinois, in a randomized complete block design with 4 replications. Plots consisted of 3 rows, each 20 feet long and spaced 40 inches apart. Planting was accomplished by dropping 2 or 3 seeds at 1-foot intervals in the rows. When seedlings were 8 to 10 inches in age, heads were covered with paper bags before any appreciable damage was incurred, but heads of many tillers were covered before they were bagged. Consequently, data were recorded for main heads only in experiment 2.

Experiment 2. Additional crosses were made in 1959 between the heterozygous tall male-sterile C.K. 60 line, Norghum, and Plainsman. Corresponding crosses were made with homozygous recessive male-sterile C.K. 60 as the male parent. Seed from these combinations were planted in 1960 with 5 replications on the Agronomy South Farm at Urbana, Illinois. This arrangement permitted a comparison of each line with its progeny segregating in a 1:1 ratio for the tall mutant gene, which contained only homozygous recessive plants in the cross.

Observations were recorded for the comparison of plots containing all recessives, plots with half heterozygotes and half homozygous dominant, and plots with half heterozygotes and half homozygous dominant.

Experiment 3. A second study was conducted in 1962 using seed from crosses in 1959. Normal combine 7078 (dWdW) and a form of 7078 in which another tall allele (probably dw) was in the homozygous dominant state were used as male parents in combination with both plants in the all mutant line of C.K. 60. These four genotypes were segregated in a 1:1 ratio for the 4 major height loci. The Fi, A3197 X 7078, is the A line or male sterile form of 3197, and different height variations of 7078. A3197 is similar to C.K. 60 and has the same genotype for the 4 major height loci. The F1, A3197 X 7078, well known commercially as RS610. Four of the 7078 parents were derived from a single heterozygous tall mutant plant while the other 2 were derived from another such plant. Thus the 4 tall tall homozygotes used as parents were used in experiment 3. Two were derived from a single heterozygous tall mutant plant while the other 2 were derived from another such plant.

Experiment 4. In 1962, a set of 8 crosses as well as selfed seed of 7078 parents were planted in a split-plot randomized complete block design with 4 replications. Main plots consisted of the 8 crosses as well as selfed seed of 7078 parents were planted in a split-plot randomized complete block design with 4 replications. Main plots consisted of each of the heterozygous tall mutant plants and the dwarf homozygous tall 7078 parents.

In 1963, seed of the 8 crosses as well as selfed seed of 7078 parents were planted in a split-plot randomized complete block design with 4 replications. Main plots consisted of each of the heterozygous tall mutant plants and the dwarf homozygous tall 7078 parents.