RADIATION INDUCED MUTATIONS FOR BREEDING OF SORGHUM

A. BRETAUDEAU
Rural Polytechnic Institute,
Katibougou, Koulikoro, Mali

Abstract

Several sorghum cultivars of Mali were irradiated with different doses of gamma rays and compared with the Caudatum types. Radio-sensitivity studies suggested that the local types were less sensitive to radiation than the introduced types. Whereas the local varieties survived dose of 300 Gy, in Caudatum types, seed germination and growth were significantly reduced at 200 Gy. Several agronomically important mutants were obtained among the progeny of the local types. Some of the mutants were shorter and had improved panicle characteristics. Radiation-induced variation was observed in several characters such as plant height, resistance to lodging, plant architecture, drought tolerance, panicle length and compactness, seed size and color, seed quality (viterous or floury) and protein content, glume color and structure, flowering date (early and late maturity), and tillering capacity. One mutant was drought tolerant. Promising mutants were selected and are presently under evaluation in the National List Trials to confirm their potential and future release. Selected variants have been also crossed with local types to obtain promising material.

1. INTRODUCTION

Sorghum is the second most important crop after pearl mille in Mali, and is grown on approximately 650,000 ha. The main varieties grown are local which have good grain quality and are well adpted to the climatic conditions. However, they are poor in yield (800 kg/ha), and have tall stalks (5 to 6 m) and prone to lodging. In order to combine the desired characters, several local types were crossed with an introduced Caudatum type which has short height and is high yielding. Although, all the promising progenies had good yield, they had poor grain quality. It seemed that there was a linkage between the two characters. Hence, we initiated a mutagenic program to enhace genetic variability in the local varieties, and to select desired mutants for producing varieties with impoved agronomic performance or to use them as parents in crosses to improve the local varieties. Our objective was to obtain well adapted varieties with 2.5 to 3.5 m stalk-length, with resistance to lodging, high yield (2,000 to 3,000 kg/ha), and good grain quality for making meal or 'couscous'.

2. MATERIALS AND METHODS

2.1. Material

The following varieties from different races of sorghum were irradiated: CSM388 and IPS0001 Guinea gambicum types, CSM228 Guinea margaritiferum type, Gadiaba durra type and SC a Caudatum type.

2.2. Methods

Dry seeds with about 12% moisture were sent for irradiation to IAEA Laboratory, Seibersdorf and to Lausanne Univeristy. In Seibersdorf, the seeds were irradiated with gamma ray doses of 20, 25, 30 KR at a rate of 880 rad/min; at Lausanne Univeristy, the doses were 10, 15, 20 KR at a rate of 3,000 rad/min. M_1, M_2 and M_3 progenies were grown as single plants, and self-pollinated. From M_2 onwards, each line had ca. 52 hills, and pedigree selection method was folllowed.

3. RESULTS

3.1. Radiation-sensitivity studies

The results obtained by Sanogo [1] indicated that Caudatum type (SC) was more sensitive to radiation than the local varieties and that the radiation increased seedling lethality and plant sterility in M_1 generation (Table I). Irradiation reduced stalk-length in all cases. Reduction in stalk-length of local varieties is very important for resistance to lodging and for increasing plant density in the field.

TABLE I. SOME POLYGENIC CHARACTERISTICS OF M_1 PLANTS*

Variety/Dose (kr)	Plant-stalk after 35 days (cm)	Number of plant with tillers	Number of early plant	Number of grains per panicle
CSM388 0	119.0	0	0	2569
20	119.0	16	0	2760
25	109.0	7	4	3196
30	100.5	5	0	2948
Gadiaba 0	90.0	0	0	2657
20	85.5	5	4	3382
25	80.0	3	0	3784
30	65.5	2	0	3780
CSM228 0	99.2	0	0	420
20	103.5	7	0	802
30	106.0	2	0	1309
SC 0	64.2	0	0	3779
20	58.0	8	4	3930
25	47.5	6	0	1937
30	44.5	3	0	2778

* Mean of 20 M_1 plants

3.2. Genetic variability

3.2.1. Spectrum of changes in plant characteristics

The spectrum of genetic variation observed in M_3 generation is given in Table II. It shows that mutagenesis can induce changes in many characters of sorghum including yield components [2, 3, 4]. Some times, more than two characters were changed. All the variations observed in the caudatum type were lost after four generations, and suggests unstable or environmental variation. In local varieties, a number of mutants were stable from the fifth generation; others continued to segregate in the subsequent generations.

3.2.2. Selected mutants and their potential

The selected mutants are described below:

MIG-SOR86-30-03: Several studies indicate that this mutant is drought tolerant. This mutant shows deep rooting system, high photosynthesis [6, 7] and tolerance to drought [8].

TABLE II. VARIATION OBSERVED WITH DIFFERENT DOSES OF GAMA RAYS IN M_2 GENERATION OF 4 SORGHUM VARIETIES

Variety	CSM388			GADIABA			CSM228			SC		
Dose (kr)	20	25	30	20	25	30	20	25	30	20	25	30
Variation observed												
Vigour	+	+	+	-	+	-	-	-	-	-	-	-
Tillering	+	+	+	+	+	+	-	-	-	-	-	-
Axial tillers	-	-	-	+	-	-	+	+	+	+	+	+
Sterility	+	+	-	+	+	-	-	-	-	+	+	+
Semi-sterility	+	+	-	-	-	-	-	-	-	-	-	-
Panicle length	-	-	-	-	-	+	-	-	-	-	-	-
Crooked panicle	-	+	-				-	-	-	-	-	-
Erect panicle				+	-	-						
Loose panicle				+	+	-				-	-	-
Compact panicle	+	-	-				-	-	-			
Black glumes	+	-	+	-	-	-	-	-	-			
Big grains	+	-	+	-	-	-	-	-	-	-	-	-
Grains shape	+	-	-	-	-	-	-	-	-	-	-	-
Short types	-	-	-	-	-	-	-	-	-	-	-	-
Late maturity	+	-	-	-	-	-	-	-	-	-	-	-
Early maturity	-	+	-	+	-	-	-	-	-	+	-	-
High yield	+	+	+	+	+	+	+	+	+	-	-	-

(+ = variation observed; - = variation not observed; columns with no sign indicate that the characteristic did not show variation)

Under drought MIG-SOR86-30-03 lost about 25% of yield; in contrast, the control showed 100% loss in yield. However, under normal conditions it is less productive compared to the parent; but has improved grain quality. It seems to combine for drought tolerance with grain quality.

- MIK-SOR86-25-11: This mutant is about 25% less productive than his parent, but has short duration of growth. It is more adapted than the parent to Sahelian region.

- MIK-SOR86-25-16: This mutant is lodging resistant and has high protein content. Cooking quality is lower than the parent, but is acceptable to the farmers.

- MIK-SOR86-30-41: This mutant is more lodging resistant and produces about 25% more yield than the parent CSM388. Stalk length is reduced by approximately 50 cm.

- MID-SOR88-10-01 and MID-SOR-88-10: These two mutants yield more than their parent by about 35%. The first mutant has a long panicle (about 55 cm compared to that of the parent (25 cm), and there is a change in grain structure. In the second mutants, the panicle is about 50 cm with high grain density. Grain is the same size as in the parent but is more viterous.

- MIK-SOR86-25-16: This mutant is lodging resistant and has a high protein content; cooking quality is lower than the parent, but acceptable.

- MIP-SOR90-30-23 is more lodging resistant and gives 25% more yield than the parent.

4. CONCLUSIONS

The results show that mutagenesis allows breeders to get sorghum types for African farmers [5], who like a variety which is less tall than their local types but more tall than the introduced types. The stalks are used for cooking, making houses, and fodder. The second and no less important parameter is grain cooking quality. The local varieties have good cooking quality but less productive; the caudatum type is used in America for animal feed and so grain quality is less important. The new varieties developed through mutagenesis of local types combine the advantages of medium size, good grain quality and high productivity. One of them is drought tolerant and will be used to improve the local varieties. Some of the mutants are now being tested in farmers fields.

ACKNOWLEDGEMENTS

I wish to thank International Atomic Energy Agency for the continued help and financial support during the course of these investigations.

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