Identification of a Double Recessive Genotype for 'B' Genes Controlling Presence and Absence of Pigmented Testa in Sorghum[1]

Bhola Nath, A.O. Omran and L.R. House[2]

SUMMARY

Thirteen white grain cytoplasmic male-sterile (A) lines of sorghum (Sorghum bicolor (L.) Moench) without a pigmented testa were crossed to two white grain testers, IS 475 ($B_1B_1b_2b_2SS$) and BTx623 ($b_1b_1B_2B_2SS$), to determine genetic constitution of the A-lines with respect to the two 'B' loci which control presence and absence of pigmented testa in sorghum grain. Based on the grain color of F_1 plants, 12 of the lines were found to be of $b_1b_1B_2B_2$ constitution but one line was $b_1b_1b_2b_2$. The F_1 plants of this line in crosses with both the testers produced white grains without a testa. The utility of this line in breeding is discussed.

Index words: Cytoplasmic male-sterile (A) line, testers, tannins, testa.

INTRODUCTION

White grain sorghums free from tannins make superior food and feed (Armstrong et al.,1974; Fuller et al., 1966; Rooney et al., 1980). A large proportion of tannins in the grain is found in the testa layer. The presence and absence of a pigmented testa in sorghum grain is controlled by two complementary genes, B_1 and B_2. The two dominant 'B' genes in the presence of a 'S' (spreader) gene result in brown grain color with high tannins (Rooney et al., 1980).

Two types of white grain sorghums free from testa ($B_1B_1b_2b_2$ and $b_1b_1B_2B_2$) have evolved in nature. The breeding material developed in various regions of the world have one of the above two constitutions. In a hybridization program, when two white grain parents from different regions are crossed, pigmented testa frequently appears in the hybrids (B_1-B_2-). Such hybrids contain undesired tannins in the grain. This restricts the use of parental lines from one region with those from the other. In order to alleviate this restriction, it is essential that the parents of $b_1b_1b_2b_2$ types, especially A-lines are developed. So far no such A-line is reported from any where in the world. The purpose of this study was to search for such a combination among the lines derived from random mating populations, which offer greater scope of breaking tight linkages.

MATERIALS AND METHODS

Five newly converted male-steriles from non-restorer lines derived from random mating populations being improved at ICRISAT center and eight other

[1] A joint contribution from International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Patancheru, A.P., India and the University of Peradenia, Sri Lanka, and approved by ICRISAT as Journal Article No. JA-359,

[2] Sorghum Breeder, ICRISAT center; Visiting Professor, Intl. Prog., Texas A&M Uni., and Leader, Sorghum Improvement Program, ICRISAT, respectively.

white grain A-lines of hybrids developed and released by other programs were tested for 'B' genes. These 13 A-lines were crossed to two testers of known constitutions, IS 475 ($B_1B_1b_2b_2$SS) and BTx623 ($b_1b_1B_2B_2$SS). The F_1 crosses of A-lines and testers were grown in adjacent single rows of 2m length during the post-rainy season of 1983-84 on ICRISAT center's farm at Patancheru in India. The grain color of F_1 plants was noted and tannin content of the grain was estimated after three months of storage by vanillin hydrochloric acid (V- HCl) method (Price et al., 1978).

RESULTS AND DISCUSSION

All lines other than SPL 76A produced brown grains in crosses with IS 475 and white grains with BTx623 (Table 1), suggesting that they have $b_1b_1B_2B_2$ constitution. SPL 76A produced white grains in crosses with both the testers, indicating it to have the rare $b_1b_1b_2b_2$ constitution. The low tannin content in both the F_1's of SPL 76A confirmed the absence of the testa. There were large differences in the amount of tannins in white and brown grain hybrids - the minimum being a 20-fold difference in the two crosses of SPL 160A. Consistently low amount of tannins in white grains, coupled with high tannins in brown grains indicates that the low and high tannin type hybrids (B_1-b_2b_2S- or $b_1b_1B_2$-S- and B_1- B_2-S-) can be easily identified visually.

Table 1: Grain color and tannin content of the grains of F_1's and genotypes assigned to their parents.

Lines	Genotypes*	Testers**			
		IS 475 ($B_1B_1b_2b_2$SS)		BTx623 ($b_1b_1B_2B_2$SS)	
		Grain color	Tannin§ content	Grain color	Tannin§ content
SPL 76A	$b_1b_1b_2b_2$	white	0.01	white	0.02
SPL 85A	$b_1b_1B_2B_2$	brown	1.78	white	0.02
SPL 118A	$b_1b_1B_2B_2$	brown	1.78	white	0.04
SPL 160A	$b_1b_1B_2B_2$	brown	1.00	white	0.05
SPL 199A	$b_1b_1B_2B_2$	brown	2.45	white	0.02
CK60A	$b_1b_1B_2B_2$	brown	4.53	white	0.07
2219A	$b_1b_1B_2B_2$	brown	5.63	white	0.04
2077A	$b_1b_1B_2B_2$	brown	5.92	white	0.07
296A	$b_1b_1B_2B_2$	brown	3.97	white	0.04
36A	$b_1b_1B_2B_2$	brown	5.08	white	0.06
SB 323A	$b_1b_1B_2B_2$	brown	2.82	white	0.03
BTx623A	$b_1b_1B_2B_2$	brown	4.20	white	0.04
Kaffinum A	$b_1b_1B_2B_2$	brown	3.63	white	0.03

* Assigned on the basis of grain color of F_1 plants.

** F_1 crosses with IS 475 were male-fertile, while crosses with BTx623 were male-sterile and observations were recorded on open-pollinated grains.

§ Mean of two estimates in milligrams of catechin per 100 mg sample by V-HCl method (Price et al., 1978).

The male-sterile SPL 76A (Rs/R-20-682-5-1) having $b_1b_1b_2b_2$ constitution was developed from a line derived from Rs/R random mating population which was synthesized by intercrossing and random mating a large number of unidentified genotypes for 'B' genes. Two cycles of recurrent selections were practised before deriving the lines from the population. Apparently, SPL 76A should be a recombinant of $B_1B_1b_2b_2$ and $b_1b_1B_2B_2$ types. SPL 76A can be used as a seed parent for developing tannin free hybrids in combination with white grain restorers of any origin. Its use in a crossing program will promote development of more lines with $b_1b_1b_2b_2$ constitution.

ACKNOWLEDGMENT

We are grateful to Dr. F.R. Miller, Associate Professor, Texas A&M University, College Station, TX, USA for giving information on the genetics of testers used in this study. Our thanks are due to Mr. N.S. Rao, Biochemistry Lab., ICRISAT for analysing samples for tannin content.

REFERENCES

1. Armstrong, W.D., J.C. Rogler, and W.R. Featherston. 1974. Effect of tannin extraction on the performance of chicks fed on bird resistant sorghum grain diet. Poult. Sci. 53:714-720.
2. Fuller, H.L., D.K. Potter, and A.P. Brown. 1966. The feeding value of grain sorghum in relation to the tannin content. Bull. N.S. 176. Ga. Agric. Exp. Stn. Athens. Ga.
3. Price, M.L., S, Van Scoyoc, and L.R. Butler. 1978. A critical evaluation of the vanillin reaction as an assay for tannins in sorghum grain. J, Agric. Food Chem. 26:1214.
4. Rooney, L.W., M.E. Blakely, F.R. Miller, and D.T. Rosenow. 1980. Factors affecting the polyphenols of sorghum and their development and location in the sorghum kernel. Pages 25-35 In Polyphenols of Cereals and Legumes. J. Hulse (ed), IDRC-145 e. Ottawa, Ontario, Canada: IDRC

Received 2nd January, 1985