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Research Article

Exploitation of heterosis using diverse parental lines in Rabi Sorghum

Prabhakar and M. S. Raut

Abstract

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major crops for grain and fodder, widely grown in India under rain fed conditions. *Rabi* sorghum is grown in an area of 5.5 million hectares mainly in the states of Maharashtra, Karnataka and Andhra Pradesh with average productivity of 854 kg/ha. Despite low productivity, *Rabi* sorghum continues to be an important component of dry land economy in these states with fairly consistent area over many years. The low yields are mainly due to various abiotic and biotic stresses. Hybrid vigour and its commercial exploitation have paid rich dividends in *Kharif* sorghum leading to quantum jump in sorghum production. However, the progress in *Rabi* sorghum is limited and there is a need for critical studies on combining ability and heterosis involving diverse sources of breeding lines. Present study comprised a line x tester analysis involving 2 lines and 7 testers for exploitation of heterosis and assessing best combiners. Combining ability studies revealed the presence of significant differences due to lines, testers and line x testers, indicating the presence of variability. Considering the general combining ability effects of parents, female SL-19B and males SLR-13, SLR-24 and SLR-30 were good general combiners for grain yield and the female SL-12B and male SLR-10 and SLR-27 were good general combiners for earliness. The crosses SL-19B x SLR-13, SL-19B x SLR-17, SL-19B x SLR-30 and SL-19B x SLR-39 were identified for improving grain yield and crosses SL-12B x SLR-10, SL-12B x SLR-27 and SL-12B x SLR-39 were selected for breeding earliness.

Key words: Rabi sorghum, parental lines, combining ability, heterosis, exploitation

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the major crops for grain and fodder, which is widely grown in India under rainfed conditions. *Rabi* sorghum is grown over a total area of 5.6 million hectares mainly in the states of Maharashtra, Karnataka and Andhra Pradesh with average productivity of 854 kgs/ha .In spite of such low productivity, *rabi* sorghum continues to be an important component of dryland economy in these states with fairly consistent area over many years. The low yields are mainly due to various abiotic and biotic stresses (Prabhakar, 2002).

Hybrid vigour and its commercial exploitation have paid rich dividends in kharif sorghum leading to quantum jump in sorghum production (Rana et. al. 1997). However, the progress in rabi sorghum is limited and there is a need for critical studies on combining ability and heterosis involving diverse sources of germplasm and land races. The exploitation of heterosis by developing the hybrids is one of the quickest and simpler ways to improving productivity for grain as well as fodder yield with special reference to combining ability. This could be realized only when the sterile and restorer lines having the seasonal adaptability and desired combining ability are identified and used in the development of rabi sorghum hybrids (Prabhakar, 2002). The estimates of combining ability are useful to predict the relative performance of different lines in hybrid combinations.

The information on the nature and magnitude of gene action is important in understanding the genetic potential of a population and decide the breeding procedure to be adopted in a given population. Line x tester analysis is a precise method for obtaining such information when a large number of parents to be tested. Keeping these things in view, the present

Centre on Rabi Sorghum (Directorate of Sorghum Research), Solapur-413006.
E-mail: prabhakar@sorghum.res.in, raut@sorghum.res.in

study involved a line x tester analysis in rabi sorghum to develop suitable new rabi sorghum hybrid parents.

Materials and Method

Two lines of rabi sorghum viz., SL-12B and SL-19B were crossed with 7 testers viz., SLR-10, SLR-13, SLR-17, SLR-24, SLR-27, SLR-30 and SLR-39. The parents were crossed in a line x tester mating design during rabi 2007-08. All the 14 crosses along with parents were grown in rabi 2008-09 in a randomized block design with two replications in the research farm of Centre on Rabi Sorghum (DSR), Solapur. Each plot consisted of 4 rows of 4 meter length with a spacing of 45 x 15cm. Observations were recorded for three characters viz., days to flowering, days to maturity and grain yield per plant (g) on 10 randomly selected plants from each plot. Combining ability analysis was done following the method suggested by Kempthorne (1957). The F_1 hybrid performance was calculated as the estimate of heterosis over better parent (heterobeltosis) and the test of significance was done.

Result and Discussion

The analysis of variance for combining ability (Table 1) revealed the presence of significant differences due to lines, testers and lines x testers for all the characters studied indicating the existence of variability among parents and hybrids. The testers contributed a major share of variance for all the characters. The estimates of components of variance for gca were larger in magnitude than sca for all the characters indicating predominance of additive gene action. Similar results were reported by earlier workers (Nayeem and Bapat 1984, Madrap et.al. 1997 and Prabhakar 2002.)

The estimates of gca effects of lines and testers along with their per se performance are presented in Table 2. Among the lines SL-12B showed good general combining ability for days to flowering. The line SL-12B also exhibited highly significant gca in desirable direction for days to maturity. However, it showed negative gca effect for grain yield per plant. The line SL-19B was bad combiners for days to maturity since they showed significant gca effects in non-desirable direction. In testers, SLR-10 and SLR-27 were best general combiners for days to flowering and maturity and bad combiner for grain yield per plant. The line SL-19B was the best general combiner for grain yield per plant. The testers namely SLR-13, SLR-24 and SLR-30 were the best general combiners for grain yield per plant. Thus, considering the gca effects of parents, line SL-19B and testers SLR-13, SLR-24 and SLR-30 were good general combiners for grain yield per plant and the line SL-12B and testers SLR-10 and SLR-27 were good general combiner for earliness (days to flowering and maturity). The gca effects of parents and their per se performance indicated that the parent showing high mean performance also showed high general combining ability for grain yield per plant. Like wise, the line SL-12B and tester SLR-10 and SLR-27 which flowered and matured earlier than the rest showed the best general combining ability for earliness. Similar trend was reported by earlier workers (Prabhakar 2002, Pathak and Sanghi 1988, Patil and Bapat 1991 and Patil and Mistry 1997.) This suggests that in addition to gca effects, per se performance could also be considered as a criterion to select the parents in future breeding programme.

The mean performance and specific combining ability effects of top ranking 5 crosses with gca effects of their parents for grain yield per plant are presented in Table 3. The crosses which showed significant sca effect along with higher heterosis and per se performance were SL-19B x SLR-13, SL-19B x SLR-17 and SL-19B x SLR-30. High heterotic crosses showed significant sca effects with higher per se performance. It was noticed that the crosses SL-19B x SLR-13and SL-19B x SLR-30 which showed the highest sca effects had one parent with negative and other parent with positive gca effects. However, both the parents had positive gca effects for the crosses SL-12B x SLR-17 and SL-12B x SLR-30. Under such situation if additive genetic system is present in good combiner and complementary one in another acting in the same direction to maximize the expression of desirable attributes, then such crosses are expected to throw transgressive segregants in future generation. The findings suggested that it is very important to consider the heterosis, gca of the parents involved and per se performance of the crosses while selecting the best cross combinations. Thus, the combinations of poor x high or high x high combiners could result into the hybrids with high performance depending on the per se performance of the parents concerned. It is observed that the line SL-19B and testers SLR-13, SLR-24 and SLR-30 which were the best general combiners for grain yield per plant were involved in the crosses having higher sca effects. These crosses can be directly used in the breeding programme for improvement of grain yield.

The mean performance, sca effects and gca effects of parents for top ranking 5 crosses for days to flowering are given in Table 4. The crosses selected for earliness based on significant sca effects and heterosis in the desirable direction along with per se performance were SL-12B x SLR-10 and SL-12B x SLR-27. The crosses showed high heterosis in the desirable direction with significant sca effects and higher per se performance. Here also, the crosses which showed earliness had gca effects of one parent in the desirable direction. The line SL-12B and tester SLR-10 and SLR-27 which were the best combiners for earliness were involved in the selected crosses. It is necessary to select crosses based on heterosis and per se performance in addition to significant sca effects. These crosses can be directly used in breeding for earliness in rabi sorghum. Breeding for early rabi sorghum varieties and hybrids assumes great significance in view of the crop grown under rainfed condition. It would help to overcome the terminal moisture stress. The present investigation clearly indicated the importance of gca effects of parents and per se performance during choice of parents and consideration of heterosis and per se performance in addition to sca effects of crosses while selecting the best hybrid combinations. The parents SL-19B, SLR-13, SLR-24 and SLR-30 can be directly used for breeding for high yield and the parents SLR-10, SLR-27 and SL-12B for breeding for early varieties and hybrids in rabi sorghum.

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Table 1: Analysis of variance for combining ability for different characters in rabi sorghum

Source	Days to flowering	Days to maturity	Grain yield per plant
Replications	47.96	16.45	23.12
Crosses	5.31 **	20.63 **	523.82 **
Testers	9.05 **	31.05 **	504.68 **
Lines	6.12 *	47.16 **	640.65 **
Line x Tester	2.36 *	3.06 *	69.79 *
Error	0.97	1.67	39.23
Estimation of variance components:			
Lines	0.05	2.41	35.93
Testers	1.27	5.42	16.64
gca	0.35	2.76	26.25
sca	-0.11	5.37	56.43

* and ** significant at 5 and 1 percent, respectively.

Table 2: General combining ability effects for characters in rabi sorghum

	Days to flowering	Days to maturity	Grain yield per plant
Lines			
SL-12 B	-0.364 **	-1.876 *	-6.413**
SL-19 B	0.364 **	1.876*	6.413**
Testers			
SLR-13	-1.237	0.378	7.830**
SLR-10	- 0.376 *	-0.349	-1.668
SLR-17	-1.432 **	-2.565**	-1.672
SLR-24	0.167	-0.956	5.235**
SLR-30	3.034	4.987**	5.159 **
SLR-27	-1.326 **	-3.213**	-2.861
SLR-39	1.170 **	1.723**	-12.023 **
S.E. for .Lines	0.031	0.146	1.17
S.E. for Testers	0.072	0.235	3.02

* and ** significant at 5 and 1 percent respectively.

Table 3: Mean performance and sca effects of top ranking five crosses with gca effects of their parents for grain yield per plant.

Crosses	Per se	sca	gca of parent	
			P_1	**P_2**
SL-19 B x SLR-13	89.3	13.58**	-4.341*	20.682**
SL-19 B x SLR-17	85.6	6.41*	5.261*	-2.736
SL-19 B x SLR-30	79.2	11.85**	6.023*	-5.834*
SL-12 B x SLR-30	73.4	2.107	5.733*	1.464
SL-12 B x SLR-17	69.5	7.63**	3.007	1.314

* and ** significant at 5 and 1 percent, respectively.

Table 4: Mean performance and sca effects of top ranking five crosses with gca effects of their parents for days to flowering.

Sl. No	Crosses	Per se	sca	gca of parent	
				P_1	P_2
1.	SL-12 B x SLR-10	67.0	-1.429**	0.742	-3.298**
2.	SL-12 B x SLR-27	68.0	-1.785**	1.190*	-4.063**
3.	SL-12 B x SLR-39	68.0	0.036	-0.895*	-5.140**
4.	SL-19 B x SLR-39	71.0	1.271*	-1.793**	-4.282**
5.	SL-19 B x SLR-24	71.5	-2.563**	-0.901*	0.679

* and ** significant at 5 and 1 percent, respectively.