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RESEARCH ARTICLE

Some of the potential doner parents for development of drought tolerance in *Rabi* sorghum

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SUMMARY

Using the line x tester design, combining ability analysis was done to study the drought tolerance in *Rabi* sorghum using five lines and 12 testers to generate total 60 hybrids. The estimates of gca effects revealed that among the five lines, the line MS 104A showed positively significant gca effect for grain yield per plant along with eight drought tolerance traits. Among the testers, M 35-1 was the best tester with significant gca effects for grain yield along with seven drought tolerance traits. Other promising testers sowing significant gca effects for grain yield and some of the other drought tolerance parameters were SPV-504, CSV-216 R, Ringni, Parbhani Moti and AKSV-13 R. Considering the results, the line MS 104 A and testers M 35-1, SPV-504, CSV-216 R, Ringni, Parbhani Moti and AKSV-13 R may be considered in the further breeding programme for the development of drought tolerant and high yielding hybrids in *Rabi* sorghum.

Key Words : Combining ability, Drought, GCA, *Rabi* sorghum

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Sorghum is the fifth most important cereal crop in the world after rice, wheat, maize and barley. Severe drought is common as the *Rabi* sorghum crop relies largely on the soil moisture stored during the preceding rainy season. The nature of the water stress in *Rabi* sorghum has been described as "terminal drought". Development of drought tolerant hybrid of *Rabi* sorghum is the major objective of the sorghum breeder. Combining ability studies are useful to identify the best general combiners which upon crossing would produce the best cross combination. The estimates of general combining ability are useful to predict the relative performance of different lines in hybrid combinations. The present study was therefore undertaken to identify potential donor parents for various physiological traits associated with drought tolerance though combining ability analysis which would be extensively used for the development of the drought tolerant *Rabi* sorghum hybrids.

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MATERIAL AND METHODS

Five lines *viz.*, MS 104 A, AKMS 69 A, AKMS 47 A, AKMS 45 A and AKMS 65 A were crossed with each of the 12 testers *viz.*, CSV 216R, AKR 354, AKR 365, AKR 371, AKR 373, Ringni, SPV 504, AKSV 13R, M35-1, P. Moti, AKR 372 and AKR 370 by using line x tester mating design to generate total 60 hybrids during *Rabi* 2005-2006. These 60 hybrids along with five lines and 12 testers were grown in Randomized Block Design with three replications at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Rabi* 2006-2007. All the recommended package of practices were followed during the corps growth to raise a good crop. The observations were recorded on five randomly selected plants from each treatment and each replication.

Observations were recorded on leaf area at 75 DAS, dry matter at harvest, chlorophyll content at 75 DAS, proline content, chlorophyll stability index, stomatal index, specific leaf weight, harvest index and gain yield per plant. The line x tester analysis was done as per the method suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among all the characters under study indicating considerable genetic diversity among the parents selected. The analysis of variance for combing ability showed that mean sum of squares due to females, was significant for all the characters studied except for leaf area at 75 DAS and proline content. Mean sum of squares due to males was significant for all the characters except stomatal index. The mean sum of squares due to female vs. male was highly significant for all the characters except dry matter at harvest. This indicated the presence of sufficient amount of wide genetic diversity among the parents used in the hybridization (Table 1).

Table 1 : Analysis of variance for combining ability

Sr. No.	Characters	Females	Males	Female x Males	Error
1.	Leaf area at 75 DAS	15.59	15.92*	15.98**	10.79
2.	Dry matter at harvest	573.39**	595.19**	630.16	42.89
3.	Chlorophyll content at 75 DAS	1.04**	0.70**	0.30**	0.11
4.	Proline content	14.99	37.24*	45.24**	17.36
5.	Chlorophyll stability index	4.02	8.98*	6.99*	4.21
6.	Stomatal index	5.94*	1.42	5.22**	1.66
7.	Specific leaf weight	0.327*	0.226	0.336*	7.081
8.	Harvest index	52.63**	136.64**	40.42**	12.56
9.	Grain yield per plant	35.03**	97.39**	32.57**	11.17

*and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Estimation of general combining ability effects of parents

Sr. No.	Parents	Leaf area at 75 DAS	Dry matter at harvest	Chlorophyll content at 75 DAS	Proline content	Chlorophyll stability index	Stomatal index	Specific leaf weight	Harvest index	Grain yield per plant
	Lines									
1.	MS 104A	0.57*	2.69**	0.21**	0.50	-0.02	-0.08	0.07**	1.17*	0.93*
2.	AKKMS 69	0.35	0.51	0.15**	-0.04	-0.04	-0.16	0.08**	-0.06	0.75
3.	AKMS 47	0.64**	-2.82**	0.12**	-0.76	-0.03	-0.12	0.04	-0.70	0.39
4.	AKRMS 45	1.06**	-2.64**	0.02	0.39	0.05*	0.47**	0.04	-1.15*	-1.04*
5.	AKRMS 66	-2.02**	-1.30	-0.08	-0.83	0.04	0.65**	-0.13**	-1.49**	-1.13**
	SE	0.25	0.86	0.05	0.55	0.03	0.17	0.03	0.47	0.44
	Testers									
1.	CSV 216R	0.82*	2.24	0.17*	0.08	-0.10**	0.06	0.06	3.14**	2.61**
2.	AKR 354	1.34**	3.31*	0.14	-2.56**	-0.05	0.60*	-0.05	1.06	1.39
3.	AKR 365	-1.21**	-3.78**	-0.17*	-0.60	0.02	0.33	-0.12*	-2.18**	-3.13**
4.	AKR 371	1.80**	2.38	-0.19*	-0.99	0.13**	0.56*	0.04	-1.75*	-2.21**
5.	AKR 373	0.61	2.24	-0.20**	-0.02	-0.04	0.07	0.05	-2.85**	-3.87**
6.	Ringni	0.74	3.29*	0.21**	0.33	-0.06	-0.47	0.11*	1.66*	3.39**
7.	SPV 504	1.05*	3.40*	0.17*	1.85*	-0.13**	-0.58*	0.06	1.16	2.07**
8.	AKSV 13R	-0.27	2.57	0.27**	3.29**	-0.06	-0.24	0.02	2.83**	2.22**
9.	M35-1	0.84*	3.62**	0.34**	2.95**	-0.07*	-0.35	0.14*	3.74**	3.61**
10.	P. Moti	0.64	1.98	0.21**	1.31	-0.07*	-0.04	0.11*	2.55**	1.62*
11.	AKR 372	-0.43	2.47	-0.06	0.70	0.01	0.37	0.04	-0.21	0.42
12.	AKR 370	0.87*	4.48**	-0.35**	-1.39	0.04	0.32	0.27**	-2.12**	0.65
	SE	0.42	1.43	0.08	0.91	0.04	0.28	0.06	0.77	0.73

* and ** indicate significance of values at P=0.05 and 0.01, respectively

The estimates of general combining ability effects (Table 2) indicated that out of five lines, the line MS 104A was good general combiner for grain yield per plant (0.93*) along with five drought tolerance traits *viz.*, leaf area ratio at 75 DAS (0.57*), dry matter at harvest (2.69**), chlorophyll content at 75 DAS (0.21**), specific leaf weight (0.07**) and harvest index (1.17*). Similarly this line also recorded the highest *per se* performance of the grain yield per plant among the five lines. Similar results were obtained by Kathod *et al.* (2002) and reported that MS 104 A line performed best in yield attributes and also was good combiner. Salunke *et al.* (1996) found MS 104A as a good combiner for yield and also good for physiological components like leaf area index, total dry matter per plant, and harvest index.

Among the testers, M 35-1 showed desirable gca for grain yield per plant (3.61**) along with seven physiological parameters associated with drought tolerance *viz*., leaf area ratio at 75 DAS (0.84**), dry matter at harvest (3.62**), chlorophyll content at 75 DAS (0.34**), proline content (2.95**), chlorophyll stability index (-0.07*), specific leaf weight (0.14**) and harvest index (3.74**). Among the twelve testers, M 35-1 was top ranking for the grain yield per plant which indicated that the improved performance of this tester under the water stress condition was due to one or more of the above associated drought tolerance parameters. Narkhede *et al.* (2004) found that M 35-1 gave better performance for characters such as total dry matter per plant and grain yield per plant under drought stress condition. Reddy *et al.* (2012) also reported M 35-1 as the variety tolerant to terminal moisture stress with stable yields of grain and stover.

Another tester SPV 504 has also transmitted desirable genes for grain yield per plant (2.07**) along with six physiological parameters like leaf area ratio at 75 DAS (1.05*), dry matter at harvest (3.40*), chlorophyll content at 75 DAS (0.17**), proline content (1.85*), chlorophyll stability index (-0.13**),and stomatal index (-0.58*). Rao *et al.* (1994) recorded that SPV 504 was good genotype under water stress.

CSV 216 R was also good general combiner for grain yield per plant (2.61**) along with the four drought tolerance parameters like leaf area ratio at 75 DAS (0.82**), chlorophyll content at 75 DAS (0.17*), chlorophyll stability index (-0.10*) and harvest index (3.14**).

Ringni can also be used as one of the parents for the development of the drought tolerant hybrids as it has shown the desirable and significant gca effects for grain yield per plant (3.39**) along with the four drought tolerance parameters like leaf dry matter at harvest (3.29**), chlorophyll content at 75 DAS (0.21**), specific leaf weight (0.11*) and harvest index (1.66*).

Parbhani Moti also need to be used in the hybridization programme for the development of high yielding and drought tolerant hybrids in *Rabi* sorghum as this tester also showed the desirable and significant gca effects for grain yield per plant (1.62*) as well as the four drought tolerance parameters like chlorophyll content at 75 DAS (0.21**), chlorophyll stability index (-0.07*), specific leaf weight (0.11*) and harvest index (2.55**).

In the present study another tester AKSV 13 R was also found to be better general combiner for grain yield per plant (2.22**) along with three parameters associated with drought tolerance like chlorophyll content at 75 DAS (0.27**), proline content (3.29**) and harvest index (2.83**).

Reddy *et al.* (2012) reported that chlorophyll stability index is associated with desiccation tolerance under terminal water deficit condition and can be used as one of the reliable selection criteria in rapid screening for post rainy adapted genotypes for drought tolerance.

All these six testers *viz*. M 35-1, SPV-504, CSV-216 R, Ringni, Parbhani Moti and AKSV-13 R alongwith one line *i.e*. MS-104 A having high gca effects and better *per se* performance need to be exploited for future breeding programme to develop high yielding drought tolerant hybrids in *Rabi* sorghum. Consideration of *per se* performance in combination with combining ability estimates was reported to provide a better criteria for the choice of superior parents in hybridization programme (Rao,1972). Results of the present study also revealed that the parents showing high mean performance also showed high general combining ability for grain yield per plant. This suggested that in addition to gca effects, *per se* performance could be also be considered as a criterion to select the parents in future breeding programme.

Thus, in view of these high gca effects and better per se performance of parents for drought tolerance and grain yield, their utilization in hybridization programme may result in getting superior segregants with their better tolerance.

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