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Short Communication

Genetic analysis of certain morpho-physiological characters in *rabi* sorghum

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The productivity of *rabi* sorghum in India (611 kg ha^{-1}) is lower compared to *kharif* sorghum (1000 kg ha^{-1}) [1]. Unlike *kharif* scenario, wherein perceptible area is under hybrids, much of post rainy season sorghum area is still under local cultivars or land races. Therefore, there is a need for the development of hybrids adapted to post rainy season, to enhance production and productivity levels. Use of *rabi* based cytoplasmic male sterile and restorer lines is a recent concept, based on which two hybrids *viz.*, CSH 15R and 19R with yield potential of 3.0-3.5 t ha^{-1} were released. For further yield improvement, it is necessary that heterosis level and stability of productivity under *rabi* production system should be improved [2]. An attempt has been made in the present investigation to estimate the nature of gene action and to identify good general combiners for grain yield as well as certain physiological characters important for *rabi* adaptation, by combining ability analysis.

Eight diverse parental lines of sorghum (42 B, 104 B, R 98-82, SPSFPR 94033 B, SPSFR 94023 B, R 98-264, SPV 86 and Swati) all originating from India, were crossed in diallel design (all possible combinations). The resultant F_1 hybrids along with parents were grown in randomized block design with three replications at the experimental fields of the National Research Center for Sorghum, Hyderabad during 2001-2002 *rabi* season. The plot size consisted of two rows of 3.0 m length with spacing of 45 cm × 15 cm.

Data on morpho-physiological characters were recorded on five randomly selected plants from each plot, for days to 50% flowering, plant height, leaf area index, no. of leaves per plant, per cent green leaves at maturity, dry weight of stem at flowering and relative water content. Leaf area index (LAI) and relative water content (RWC) of leaves were measured, as suggested by [3] and [4] respectively. The combining ability analysis was carried out according to Griffing's [5] method II model I with assumption that there were no reciprocal differences.

Significant differences existed among genotypes with respect to various characters as evident from analysis of variance for combining ability.

Gene action (additive or non additive) governing inheritance of a particular trait can be measured in terms of general and specific combining ability estimates, where general combining ability effects are mostly indicative of additive gene action and specific combining ability effects depict non-additive gene action. A comparison of magnitude of variance components due to *gca* and *sca* confirmed the nature of gene action in controlling the expression of characters. The ratio of *gca*/*sca* indicated preponderance of *sca* effects to *gca* effects for all characters under study thus non additive gene action played important role in controlling these traits.

Among the parents, 42 B, 104 B, SPSFR 94023 B, R 98-264 and SPV 86 exhibited significant negative *gca* effect for days to 50% flowering, hence considered as good general combiners for breeding early hybrids (Table 1).

Identification of physiologically efficient genotypes is essential to increase yield potential of *rabi* sorghum. Since moisture stress and low temperature form the basic environment in which *rabi* sorghum is grown, role of physiological traits in addition to yield components is considered beneficial.

Among the physiological traits, significant positive *gca* effect was exhibited by only four parents (R 98-82, R 98-264, SPSFR-94033 B and SPV 86) for leaf area index, whereas for number of leaves per plant, only one parent (R 98-264) recorded significant positive *gca* effect. Three out of eight parents (SPSFPR 94033 B, SPSFR 94023 B and R 98-264) showed significant positive *gca* effect for per cent green leaves at maturity under terminal drought. As these characters form a base to total effective photosynthetic area at different stages, parents with good combining ability for these

Table 1. General combining ability effect of parents for morphophysiological characters in *rabi* sorghum

Parent	Days to 50% flowering	Plant height	Leaf area index	No. of leaves/plant	Green leaves at maturity	Dry weight of stem	Relative water content
42 B	–1.66**	–8.39**	–0.08*	–0.16	–5.05**	–4.54**	–1.33**
104 B	–0.95**	7.76**	–0.33**	–0.64**	–1.85	4.46*	2.02**
R98-82	2.08**	4.67**	0.14**	0.07	–0.12	0.17	1.55**
SPSFPR 94033B	0.62**	–0.04	0.13**	0.15	1.98*	0.35	–3.89*
SPSFR 94023B	–0.52**	–18.87**	–0.10**	–0.12	9.33**	–6.35**	1.41**
R98-264	–0.55**	–5.99**	0.15**	0.43**	2.72**	–3.90**	–5.43**
SPV-86	–1.31**	5.86**	0.16**	0.13	–2.75**	2.98**	2.12**
Swati	1.07**	15.01**	–0.06	0.14	–4.25**	6.83**	3.56**
Range							
Minimum	–1.31	–18.87	–0.33	–0.64	–5.05	–6.35	–5.43
Maximum	2.09	15.01	0.16	0.43	9.33	6.83	3.56
SE (gi)	0.14	0.55	0.04	0.09	0.98	0.38	0.41

*,**Significant at 5 and 1 % levels of probability, respectively.

Table 2. Role of *sca* in top ranking hybrids for morphophysiological characters in *rabi* sorghum

Character/cross		Mean	*sca*	gcai	gcaj	gca status
Days to 50% flowering (CD = 0.92)						
104 B × SPSFR 94023 B	2 × 5	72.70	–2.85**	–0.95*	–0.32*	H × H
42 B × R 98-82	1 × 3	74.20	–2.88**	–1.66*	2.08**	H × L
42 B × R98-264	1 × 6	74.70	–0.50	–1.66*	–0.55*	H × H
42 B × SPSFPR 94033 B	1 × 4	74.80	–3.58**	–1.66*	–0.62*	H × H
104 B × R98-82	2 × 3	74.50	–3.48**	–0.95*	2.08**	H × L
Plant height (cm) (CD = 3.67)						
R98-82 × SPV 86	3 × 7	172.20	22.67**	4.67**	5.86**	H × H
104 B × Swati	2 × 8	159.70	4.93**	7.76**	15.01**	H × H
104 B × SPV86	2 × 7	156.80	11.24*	7.76**	5.86**	H × H
Leaf area index (CD = 0.29)						
42 B × R98-82	1 × 3	4.15	0.90*	–0.08*	0.14**	L × H
R98-264 × SPV86	6 × 7	4.01	0.51*	0.15**	0.16**	H × H
SPSFPR 94033 B × R98-264	4 × 6	3.98	0.51*	0.13**	0.15**	H × H
SPSFPR 94033 B × SPV86	4 × 7	3.97	0.49*	0.13**	0.16**	H × H
Green leaves at maturity (%) (CD = 6.53)						
SPSFR 94023 B × R98-264	5 × 6	74.30	19.23**	9.33**	2.72**	H × H
SPSFPR 94033 B × Swati	4 × 8	62.00	21.21**	1.98*	-4.25**	H × L
104 B × R98-264	2 × 6	59.30	15.41**	–1.85	2.72**	L × H
R98-82 × SPV86	3 × 7	59.30	19.15**	–0.12	–2.75**	L × L
Relative water content (%) (CD = 1.39)						
104 B × Swati	2 × 8	73.80	12.64*	2.02**	3.56**	H × H
42 B × SPV-86	1 × 7	70.80	21.88*	–1.33**	–5.43**	L × L
SPV 86 × Swati	7 × 8	64.50	3.11	2.12**	3.58**	H × H
Dry weight of stem at flowering (g) (CD = 2.55)						
R 98-82 × swathi	3 × 8	60.83	11.36**	0.17	6.83**	L × H
42B × SPV-86	2 × 7	60.00	8.87**	4.46**	2.98**	H × H
SPSPR 940033B × Swati	4 × 8	59.87	6.36**	0.35	6.83**	L × H
SPV 86 × Swati	7 × 8	59.50	3.37	2.98**	6.83**	H × H
No. of leaves per plant (CD=0.5)						
42 B × R98-264	1 × 6	11.80	1.15**	–0.16	0.43**	L × H
SPSFPR 940033B × R 98-264	4 × 6	11.70	0.75**	0.15	0.43**	L × H
R 98-264 × SPV-86	6 × 7	11.53	0.60	0.43**	0.13	H × L
SPV 86 × Swati	7 × 8	11.27	0.63	0.13	0.14	L × L

*,**Significant at 5 and 1 % levels of probability, respectively.

traits are of immense value. Newly bred parent R 98-264 found to be general combiner for all these traits, and would play important role in drought adaptation in *rabi*. The parents 104 B, R 98-82, SPV 86 and Swati showed significant positive *gca* effect for plant height and RWC. The RWC is a measure of drought adaptation and plant height contributes to fodder yield, which are important under *rabi* situation.The importance of *gca* effects for various characters was earlier reported by several researchers for days for 50% flowering and leaf area index [6], number of leaves per plant [7], dry weight of stem [8] and harvest index [9].

Specific combining ability effects were significant in almost all the crosses for majority of traits studied, similar to the earlier reports of [10-12]. However, it is hybrid yield or high mean value of the characters which is important irrespective of the magnitude of *sca* effect. The role of *sca* effect in hybrids with highest mean value for different characters is examined. The overall perusal of *sca* effects of different characters in the present investigation indicated that *sca* effect and *per se* performance of the crosses were not closely related as noticed in many crosses for different traits. Thus, the hybrid with high *per se* performance need not be the one with high *sca* effect and vice versa (Table 2).

High *sca* effects for various characters in majority of crosses had high × high combiner parents, similar to reports of [13-14]. The crosses with high mean and involving high × high *gca* parents are useful for pedigree breeding programme to develop improved parental lines. Hence it is proposed to breed parental lines with high *gca* to produce high *sca* effects in hybrid combination. However, present study doesn't support the use of crosses with high *sca* for line development.

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