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RESEARCH ARTICLE

Heterosis for ethanol yield and its attributing traits in sweet sorghum [*Sorghum bicolor* (L.) Moench]

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SUMMARY

An investigation was carried out to assess the extent of heterosis for ethanol yield and its attributing traits in 72 hybrids of sweet sorghum developed by crossing 4 lines with 18 testers in Line × Tester mating design during *Kharif* 2009 at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bangaluru. The mean sum of squares of parents, hybrids and parents vs hybrids was significant for all the characters except reducing sugars, indicating presence of sufficient heterosis for these traits. None of the crosses were superior for all the traits studied. However, the cross 'ICSA 324 × SEREDO' was the best as it had highest standard heterosis for the two economically important characters *viz.*, juice yield and ethanol yield. Majority of the crosses exhibited significant better parent heterosis for Brix per cent, juice yield, reducing sugars, total sugars, ethanol content, grain yield and ethanol yield indicating predominance of non-additive gene action in the genetic control of these traits. Most of the hybrids expressed significant standard heterosis for all the characters over the check NTJ 2.

Key Words **:** *Sweet sorghum,* Heterosis, Ethanol

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The recent policy of Indian Government for blending of alcohol in petrol to an extent of five per cent increased the demand for alternative and commercially feasible raw material like sweet sorghum for ethanol production which emerged as a supplementary crop to sugarcane in rainfed areas of the country (Reddy and Sanjana Reddy, 2003). Sweet sorghum is a special purpose sorghum with sugar-rich stalk almost like sugarcane. The sugar content varies from 16-23 per cent Brix. Besides having rapid growth, high sugar accumulation and biomass production potential, it has wider adaptability, tolerance to drought, water logging and saline-alkaline conditions. It can be grown with limited water and minimal inputs and can be harvested within a span of four months (Reddy and Sanjana Reddy, 2003). The juice has great potential for jaggery, syrup and bio-fuel (ethanol) production. Its high ethanol production ability is contributed by a few characters such as Brix per cent, juice yield, stalk sugar content and ethanol content. Sweet sorghum being an often cross pollinated crop offers a wide scope for the development of both varieties and hybrids by exploitation of additive as well as non additive genetic variance. Heterosis has been fully exploited by developing several high yielding grain sorghum hybrids (CSH-1 to CSH-21). However, heterosis for ethanol yield and its contributing traits such as Brix per cent and juice yield has not been exploited, as sweet sorghum breeding is still in its infancy. Hence, the present study was undertaken to assess the extent of heterosis of newly developed hybrids of sweet sorghum for ethanol yield and its attributing traits.

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MATERIALS AND METHODS

The experimental material used in the present investigation consisted of 72 crosses derived by crossing 4 male sterile lines with 18 testers (breeding lines) through line × tester mating design. These 72 hybrids and their 22 parents were grown in Randomized Block Design with two replications during *Kharif* 2009 at 'K' Block of Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru. Each entry was grown in single row of 3m length following the recommended spacing of 45cm × 15cm. In each entry, five competitive plants were randomly tagged and observations were recorded on Brix per cent, juice yield (ml/plant), reducing sugars (%), total sugars (%), ethanol content (%), grain yield (g/plant) and ethanol yield (ml/plant). The mean values of these five plants were computed for each entry for all the characters and were subjected to analysis of variance following the methods of Panse and Sukhatme (1967). The per cent heterosis of all 72 hybrids over their better parent (BP) and standard check (SC) NTJ 2 were computed as per the method suggested by Turner (1953) and Hayes *et al.* (1955).

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among the parents and hybrids for all the characters studied except reducing sugars. The mean sum of squares of parents vs hybrids was also significant for all the characters except reducing sugars, indicating presence of sufficient heterosis for these traits (Table 1).

Among 72 hybrids evaluated, none of the crosses was superior for all the traits studied. However, the hybrid 'ICSA 324 × NTJ 2' and 'ICSA 324 × ICSR 93034' were superior for four traits *viz.*, Brix per cent, total sugars, ethanol content and ethanol yield. Another hybrid 'ICSA 324 × SEREDO' was superior for juice yield, reducing sugars and ethanol yield, while the hybrid 'ICSA 731 × SPV 1411' was superior for ethanol content, grain yield and ethanol yield. The hybrid 'ICSA 324 × SEREDO' was identified as the best cross as it was superior for the two economically important traits *viz.*, juice yield and ethanol yield. The hybrid 'ICSA 731 × SPV 1411' was also identified as another best cross as it has manifested superiority for both grain yield and ethanol yield which can be utilized as a dual purpose hybrid.

Majority of the crosses exhibited significant better parent heterosis for all the seven characters studied indicating predominance of non-additive gene action in the genetic control of these traits. This is in accordance with the results reported by of Ganesh *et al.* (1996), Senthil and Khan (1997), Chaudary *et al.* (2003), Rajashekhar *et al.* (2007) and Sandeep *et al.* (2009) in grain / sweet sorghum. Most of the hybrids expressed significant standard heterosis for all the characters over the check NTJ 2, whereas only ten hybrids expressed significant standard heterosis for grain yield. Similar findings were reported by Rajguru *et al.* (2005) and Vinaykumar (2009). The results of present study also indicated that, no single hybrid was superior in respect of all the traits studied. However, considering the extent of significant heterosis expected by hybrids over their parent, standard check and *per se* performance, five crosses *viz.*, 'ICSA 324 × NTJ 2', 'ICSA 749 × SPV 1411', 'ICSA 631 × ICSV 25263', 'ICSA 731 × SPV 1359', 'ICSA 731 × SPV 1411' were identified as best hybrids (Table 2). Further, it was observed that, all the superior hybrids for seven characters studied had ICSA 324 followed by ICSA 731 (among lines) NTJ 2, SEREDO and SPV 1411 (among testers) as one of the parents in their cross combinations. Hence, these parents can be further utilized in developing new superior hybrids for full exploitation of the crop for the economically important traits.

Table 1 : Analysis of variance for ethanol yield and its attributing traits in sweet sorghum

Source of variation	df	Brix per cent	Juice yield (g/plant)	Reducing sugars (per cent)	Total sugars (per cent)	Ethanol content (per cent)	Grain yield (g/plant)	Ethanol yield (ml/plant)
Replication	1	0.29	50.46	0.002	0.23	0.50	0.08	0.007
Entries	93	13.91**	3036.15**	0.10	10.65**	10.66**	287.17**	50.99**
Parents	21	12.31**	2028.58**	0.13	9.40**	4.27**	387.46**	13.83**
Hybrids	71	13.09**	3132.90**	0.10	10.04**	10.30**	254.90**	53.85**
Parents vs hybrids	1	105.95**	20591.61**	0.0001	81.51**	170.38**	472.18**	685.91**
Error	93	0.07	16.27	0.0044	0.05	0.17	19.85	0.99

** indicates significance of values at p=0.01, respectively

Table 2 : Selected crosses with superior heterosis over better parent, standard check and mean performance for ethanol yield and its attributing traits

Characters	Crosses with high heterotic status over standard check	Heterosis over standard check	Heterosis over better parent	*Per se* performance
Brix per cent	ICSA 324 × NTJ 2	35.06**	35.06**	18.3
	ICSA 324 × ICSR 93034	22.14**	33.07**	16.6
	ICSA 324 × ICSR 160	20.30**	46.19**	16.3
Juice yield	ICSA 749 × SPV 1411	68.80**	78.17**	224.5
(ml/plant)	ICSA 324 × SEREDO	54.89**	54.89**	120.0
	ICSA 749 × ICSV 93046	53.38**	8.22**	204.0
	ICSA 324 × ICSV 700	45.11**	53.17**	116.5
	ICSA 631 × ICSV 91005	45.11**	53.17**	72.5
Reducing sugars	ICSA 631 × ICSV 25263	36.67**	36.67**	2.0
(per cent)	ICSA 731 × ICSR 196	33.33**	11.11**	2.0
	ICSA 324 × SEREDO	30.00**	39.29**	2.0
	ICSA 731 × GD 65008	30.00**	30.00**	2.0
	ICSA 324 × ICSV 111	30.00**	8.33*	2.0
Total sugars	ICSA 324 × NTJ 2	34.58**	34.58**	16.2
(per cent)	ICSA 324 × ICSR 93034	21.67**	32.73**	14.6
Ethanol content	ICSA 731 × SPV 1359	113.11**	76.87**	13.0
(per cent)	ICSA 324 × NTJ 2	103.28**	103.28**	12.4
	ICSA 324 × ICSR 196	99.18**	48.17**	12.1
	ICSA 731 × SPV 1411	98.36**	65.75**	12.1
	ICSA 731 × ICSV 111	97.54**	65.07**	12.0
Grain yield	ICSA 731 × SPV 1411	81.51**	53.19**	108.0
(g/plant)	ICSA 631 × SEREDO	39.50**	9.93	83.0
	ICSA 731 × ICSV 91005	35.29**	30.89**	80.5
	ICSA 631× ICSV 111	34.45**	34.45**	80.0
Ethanol yield	ICSA 324 × NTJ 2	212.35**	212.35**	25.3
(ml/plant)	ICSA 324 × SEREDO	179.07**	318.52**	22.6
	ICSA 324 × ICSR 93034	163.58**	295.37**	21.3
	ICSA 731 × ICSV 93046	160.49**	78.81**	21.1
	ICSA 731 × SPV 1411	156.17**	226.77**	20.7

** indicates significance of values at p=0.01, respectively

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REFERENCES

Chaudhary, S. B., Narkhede, B.N. and Pawar, S.V. (2003). Hybrid vigour involving diverse cytosteriles of sorghum [*Sorghum bicolor* (L.) Moench]. *J. Soils & Crops,* **13**: 162-164.

Ganesh, S., Khan, A. K. F. and Senthil, N. (1996). Heterosis studies for grain yield characters in sweet sorghum. *Madras Agric. J*., **83**: 655-658.

Hayes, H.K., Immer, F.R. and Smith, D.C. (1955). *Methods of plant breeding*. Mc. Graw Hill Book Co., Inc., New York., 551pp.

Panse, V.G. and Sukathme, P.V. (1967). *Statistical methods for agricultural workers*, ICAR, New Delhi, 145 pp.

Rajashekhar, M. K. (2007). Studies on heterosis, combining ability, stability and molecular diversity in sweet sorghum [*Sorghum bicolor* (L.)*Moench*]. *Karnataka J. Agric. Sci*., **20**: 889-893.

Rajguru, A.B., Kashid, N.V., Kamble, M.S., Rasal, P.N. and Gosavi, A.B. (2005). Heterotic response for grain yield and yield components of *Rabi* sorghum [*Sorghum bicolor* (L.) Moench]. *J. Maharashtra Agric. Univ*., **30**: 292-295.

Reddy, B.V. and Sanjana Reddy, P. (2003). Sweet sorghum characteristics and potential. *ISMN.,* **44** : 26-28.

Sandeep, R.G., Gururaja Rao, M.R., Chikkalingaiah and Jagadeesh, B.N. (2009). Heterosis studies in sweet sorghum [*Sorghum bicolor* (L.) Moench]. *Indian J. Crop Sci*., **4**:87-91.

Senthil, N. and Khan, A. K. F. (1997). Heterosis in sweet sorghum hybrids. *Madras Agric. J*., **84**: 47-49.

Turner, J. H., Jr. (1953). A study of heterosis in upland cotton-I, Yield of hybrids compared with varieties, *Agron. J*., **45**: 487-490.

Vinaykumar, R. (2009). Genetic analysis of bio-energy traits in sweet sorghum [*Sorghum bicolor* (L.) Moench]. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, BENGALURU, KARNATAKA (India).

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