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Heterosis for Juice Yield and Its Attributing Traits in Sweet Sorghum *Sorghum bicolor* (L.) Moench

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Abstract

An investigation was carried out to assess the extent of heterosis for juice yield and its attributing traits in 72 hybrids of sweet sorghum developed by crossing four lines with 18 testers in Line × Tester mating design during *kharif* of 2009. The mean sum of squares of parents vs hybrids was significant for all the characters except mean internodal length, indicating presence of heterosis for these traits. None of the crosses were superior for all the traits studied. However, the cross ICSA 749 × SPV 1411 was the best as it had highest mean performance for economically important characters. Majority of the crosses exhibited significant better parent heterosis for days to 50% flowering, cane height, cane weight, mean internodal length, juice volume, juice extraction percent and juice 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, Juice yield.

Sweet sorghum is special purpose sorghum with sugar-rich stalk almost like sugarcane. 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 (1). The juice has great potential for jaggery, syrup and biofuel (ethanol) production. Its high ethanol production ability is contributed by a few characters such as green stalk yield, juice yield, stalk sugar content and stalk juice extractability. The primary and most essential component of biomass is the stalk which contributes more than 70% of sweet sorghum biomass (2). The stillage after extraction of juice from sweet sorghum stalk can be used for co-generation of power. Truly, sweet sorghum is regarded as a multiple-utility '4F' crop as it is used for food, fodder, feed and fuel purposes. Sweet sorghum being an often cross pollinated crop offers a wide scope for the development of both varieties and hybrids by exploitation of additive and 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 contributing traits such as millable cane yield 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 juice yield and its attributing traits using the male sterile lines and breeding lines supplied by Directorate of Sorghum Research and ICRISAT, Hyderabad.

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* of 2009 at 'K' block of Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru. Each entry was grown in single row of 3 m length following the recommended spacing of 45 cm × 15 cm. In each entry, five competitive plants were randomly tagged and observations were recorded on

Table 1. Analysis of variance for juice yield and its attributing traits in sweet sorghum.

Sources of variation	df	Days to 50 per cent flowering	Cane height (cm)	Cane weight (g/plant)	Mean internodal length	Juice extraction per cent	Juice volume (ml/plant)	Juice yield (g/plant)
Replication	1	0.76	8.59	1.53	0.002	23.52	99.83	50.46
Entries	93	44.85**	3686.86**	13744.45**	53.63**	196.36**	3125.43**	3036.15**
Parents	21	46.08**	2822.26**	7171.84**	102.78**	124.44**	2002.29**	2028.58**
Hybrids	71	42.60**	2735.61**	13525.16**	39.85**	209.65**	3277.54**	3132.90**
Parents vs Hybrids	1	178.65**	89382.08**	180566.02**	0.001	464.61**	18913.41**	20591.61**
Error	93	0.25	4.55	98.64	0.57	5.02	117.17	16.27

days to 50 per cent flowering, cane height (cm), cane weight (g/plant), mean internodal length (cm), juice volume (ml/plant), juice extraction per cent and juice yield (g/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 (3). The per cent heterosis of all F_1 crosses over their better parent (BP) and standard check (SC) NTJ 2 were computed as per the method suggested earlier (4, 5).

Table 2. Selected crosses with superior heterosis over better parent, standard check and mean performance.

Characters	Crosses with high heterotic status over standard check	Heterosis over standard check	Heterosis over better parent	*Per se* performance
Days to 50 per cent flowering	ICSA 631 × SPV 1359	-11.38**	-23.24**	54.5
	ICSA 324 × ICSR 56	-10.98**	-25.00**	54.8
	ICSA 324 × ICSV 574	-10.57**	-21.15**	55.0
	ICSA 749 × ICSV 700	-8.94**	-20.00**	56.0
	ICSA 631 × ICSV 574	-8.13**	-19.00**	56.5
Cane height	ICSA 631 × E 36-1	119.15**	80.45**	314.7
	ICSA 324 × SPV 1359	112.33**	87.06**	304.9
	ICSA 731 × ICSV 700	101.04**	17.21**	288.7
	ICSA 731 × SPV 1411	100.77**	22.68**	288.3
	ICSA 324 × NTJ 2	99.44**	75.71**	286.4
Cane weight	ICSA 324 × ICSV 700	129.73**	86.13**	510.0
	ICSA 324 × NTJ 2	95.27**	95.27**	433.5
	ICSA 324 × ICSR 91005	93.24**	118.32**	429.0
	ICSA 749 × SPV 1411	91.67**	70.88**	186.0
	ICSA 324 × GD 65008	90.90**	77.41**	424.0
Mean internodal length	ICSA 631 × E 36-1	106.90**	62.45**	45.0
	ICSA 749 × ICSV 574	96.55**	61.93**	20.9
	ICSA 731 × ICSV 93046	57.93**	33.14**	24.0
	ICSA 324 × ICSR 160	56.78**	16.98**	34.1
	ICSA 731 × ICSV 700	51.03**	-2.67	32.8
Juice extraction per cent	ICSA 324 × SEREDO	12.75**	15.44**	67.6
Juice volume	ICSA 749 × SPV 1411	70.45**	80.72**	225.0
	ICSA 324 × NTJ 2	54.55**	54.55**	204.0
	ICSA 749 × ICSV 93046	53.03**	8.02	202.0
	ICSA 324 × SPV 1411	45.45**	54.22**	192.0
	ICSA 631 × NTJ 2	39.39**	39.39**	184.0
Juice yield	ICSA 749 × SPV 1411	68.80**	78.17**	224.5
	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

Results and Discussion

Analysis of variance indicated significant differences among the entries for all the characters. Parents and hybrids exhibited significant differences in respect of all the characters studied. The mean sum of squares of parents vs hybrids was significant for all the characters except mean internodal length, indicating presence of heterosis for these traits (Table 1).

Among 72 hybrids evaluated, none of the crosses were superior for all the traits studied. However, the hybrid ICSA 749 × SPV 1411 was superior for cane weight, juice volume and juice yield. Another hybrid ICSA 324 × NTJ 2 was superior for cane height, cane weight, and juice volume. The hybrids, ICSA 749 × ICSV 93046, ICSA 324 × ICSV 700 and ICSA 631 × E 36-1 expressed superiority for two characters each (Table 2). The cross ICSA 749 × SPV 1411 was the best since, it had highest mean performance for economically important characters.

All the seven characters exhibited significant better parent heterosis in majority of the crosses indicating predominance of non-additive gene action in the genetic control of these traits. This is in accordance with the results reported by earlier workers (6—10) in sorghum. Most of the hybrids expressed significant standard heterosis for all the characters over the check NTJ 2, whereas all the hybrids expressed significant standard heterosis for cane height which was in agreement with the findings of earlier workers (11, 12). The results of heterosis also indicated that, none of the hybrids was superior in respect of all the traits. However, considering significant heterosis over better parent, standard check and *per se* performance, six crosses viz., ICSA 631 × SPV 1359, ICSA 631 × E 36-1, ICSA 324 × ICSV 700, ICSA 631 × E 36-1, ICSA 749 × SPV 1411 and ICSA 749 × SPV 1411 exhibited significant higher standard heterosis over the check (Table 2). Further, all the superior hybrids for seven characters studied had ICSA 324 (among lines) and SPV 1411 (among testers) as one of the parents in their cross combinations. Hence, these parents can be utilized in realizing the superior heterosis for full exploitation of the crop for the economically important traits.

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