HETEROSIS IN INTERSPECIFIC AND INTERGENERIC PROGENIES OF SUGARCANE

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Abstract: Heterotic studies in interspecific and intergeneric hybrids of sugarcane involving six lines (Saccharum officinarum cv. Badila and five sugarcane varieties) and three testers [Saccharum wild relatives, Saccharum spontaneum, Erianthus arundinaceus and Miscanthus sacchariflorus (latter two related genera)] revealed pronounced hybrid vigour for cane yield, sugar yield and its attributes. Positive and significant relative heterosis was recorded for brix percent, sucrose percent, cane yield per plot and sugar yield per plot (L1 × T2, L3 ×T2, L5 ×T2). Also, significant positive heterobeltiosis was recorded for number of millable cane plot (L3 ×T2 and L5 ×T2). In general, L1, L3, L5 and T2 were found promising parents. The present study suggested that exploitation of L1 ×T2, L3 ×T2 and L5 ×T2 should be more rewarding for future sugarcane breeding programme.

Keywords: Sugarcane, Interspecific, intergeneric, relative heterosis, heterobeltiosis.

Introduction: Sugarcane is widely grown in the tropical and subtropical areas of the world and is an important crop in all of the countries of tropical Asia. Sugarcane belongs to the genus *Saccharum,* a complex genus characterized by high degree of polyploids and frequent aneuploidy. Two major species have contributed to the origin of current cultivars namely, the *Saccharum officinarum* and *Saccharum spontaneum.* Interspecific and intergeneric hybridization has provided the major break through in sugarcane breeding solving some of the disease problems but also providing additional and unexpectedly large increased yields, improved rationing ability and adaptability for growth under various stress condition (Rumke, 1934, Janakiammal, 1941, Price, 1967, Miller and Tai, 1992, Krishnamurthi, 1993, Amalraj, 2003, Anbanandan *et al.,* 2004, Rajeswari *et al.,* 2004).

The magnitude of heterosis provides a basis for determining genetic diversity and also serves as a guide to the choice of desirable parents (Loganathan *et al.,* 2001). The information on heterosis for cane yield, sugar yield and its attributes in interspecific and intergeneric progenies involving six lines and three testers in sugarcane is presented.

Materials and Methods: Six lines namely, *Saccharum officinarum* cv. Badila and sugaracne varieties (*Saccharum* species hybrid) *viz.,* CoC 671, CoC 85061, CoC 92061, Co 86032, CoG 93076 were crossed with three testers which are *Saccharum* wild relatives: *Saccharum spontaneum, Erianthus arundinaceus* and *Miscanthus sacchariflorus* (latter two are related genera) in an L ×T mating design. Eighteen cross combinations along with their nine parents were grown in a randomized block design with four replications. Both parents and F_1s were raised each in a 5 m row with a spacing of 80 cm. Standard agronomic and plant protection measures were adopted. The biometrical observations on cane length, internode length, cane thickness, cane weight, brix per cent, sucrose per cent, purity coefficient, commercial cane sugar per cent, number of millable canes per plot, cane yield per plot and sugar yield per plot were recorded. Heterosis was estimated over the mid parent (MP) and better parent (BP) and tested for significance as suggested by Wynee *et al.* (1970).

Results and Discussion : The estimates of mean squares were highly significant for all the characters indicating considerable diversity of parents. *per se* performance revealed the superiority of *Saccharum officinarum* cv. Badila (L_1) which recorded high mean values for eight traits namely, cane thickness, cane weight, brix per cent, sucrose per cent, purity coefficient, commercial cane sugar per cent, cane yield per plot and sugar yield per plot. The line Co 86032 (L_5) recorded high mean values for seven other traits namely internode length, brix per cent, sucrose per cent, purity coefficient, commercial cane sugar per cent, cane yield per plot and sugar yield per plot (Table 1). Hence, *Saccharum officinarum* cv. Badila (T_4) and CO 86032 (L_5) could be rated as desirable parents for hybridization to improve cane and sugar yield. Among the testers, *Erianthus arndinaceus* (T_4) recorded high mean values for traits namely cane length, internode length, cane thickness, cane weight, sucrose per cent, purity coefficient, commercial cane sugar per cent, cane yield per plot and sugar yield per plot. Hence, based on *per se* performance *Saccharum officinarum* cv. Badila (L_1), Co 86032 (L_5) and *Erianthus arundinaceus* (T_2) can be adjudged as superior parents.

The mean performance is the primary criterion to evaluate the merit of hybrid. Kadambavanasundaram (1980) and Nadarajan (1986) reported that *per se* performance of hybrids appeared to be a useful index for judging the hybrids. Based on *per se,* the hybrids *Saccharum officinarum* Badila ×*Erianthus arundinaceus* (L_1 ×T_2) and Co 86032 ×*Erianthus arundinaceus* ($L_5 \times T_2$) performed better based on the mean performance for traits cane yield per plot and sugar yield per plot and their components. Most of the hybrids with tester *Erianthus arundinaceus* (T_2)

exhibited higher mean performance for all the traits (Table 1) which stressed the importance of parental selection in hybridization programmes.

Information on the magnitude of heterosis is the pre-requisite in the development of hybrids. A good hybrid should manifest high amount of heterosis for commercial exploitation. High and low positive heterosis observed was mainly due to varying genetic composition between parents of different crosses for the components characters (Rajesh and Gulsan, 2001). Positive and significant relative heterosis for brix per cent, sucrose per cent, cane yield per plot and sugar yield per plot were recorded by the hybrid *Saccharum officinarum* cv. Badila × *Erianthus arundinaceus* ($L_1 \times T_2$) which corroborate with the report of Rajeswari *et al.* (2004) for brix per cent and sucrose per cent. Positive and significant relative heterosis for cane length, brix percent, number of millable cane per plot, cane yield per plot and sugar yield per plot were recorded by the hybrid CoC 85061 × *Erianthus arundinaceus* ($L_5 \times T_2$). The hybrid Co 86032 × *Erianthus arundinaceus* ($L_5 \times T_2$) recorded positive and significant relative heterosis for internode length, number of millable cane per plot and sugar yield per plot and also it showed positive and significant heterobeltiosis for number of millable cane per plot (Table 2). Therefore, from the foregoing discussion, it may be concluded that the above three hybrids can be adjudges as best and can be exploited for hybrid vigour to increase the cane yield and sugar yield potential in sugarcane.

Table 1. Mean performance of parents and hybrids

Genotypes/ Hybrids	Cane length (cm)	Internode length (cm)	Cane thickness (cm)	Cane weight (kg)	Brix percent	Sucrose percent	Purity coefficient	Commercial cane sugar percent	No. of millable cane per plot	Cane yield per pot (kg)	Sugar yield per plot (kg)
L1	180.60	7.52	**3.50**	**2.50**	**22.30**	**19.90**	**89.30**	**13.83**	**28.90**	**72.42**	**10.03**
L2	200.25	8.08	3.10	1.60	19.97	17.23	86.02	11.75	35.80	56.42	6.62
L3	209.55	7.78	3.50	1.63	18.23	15.65	85.93	10.67	35.95	57.78	6.92
L4	189.90	7.55	2.88	1.47	19.55	16.42	83.95	11.05	39.60	58.33	6.45
L5	204.85	**8.50**	2.77	1.60	**20.18**	**17.55**	**87.05**	**12.05**	37.00	**59.25**	**6.12**
L6	174.75	7.10	3.00	1.47	17.35	14.58	84.08	9.83	35.15	52.78	5.20
T1	249.50	19.10	1.50	0.25	7.15	4.17	58.07	2.17	49.45	12.43	0.25
T2	**290.15**	**23.18**	**2.12**	**0.43**	7.12	**4.38**	**61.18**	**2.38**	**42.40**	**18.70**	**0.43**
T3	95.85	12.03	0.75	0.04	8.05	3.02	37.77	0.75	61.05	2.50	0.02
L1 X T1	193.92	12.35	2.50	0.87	13.10	9.20	70.35	5.60	38.30	32.97	1.85
L1 X T2	226.30	14.90	2.60	0.90	16.40	13.40	81.50	8.90	45.38	39.18	3.50
L1 X T3	115.28	11.03	1.75	0.53	8.18	4.93	60.05	2.63	33.07	17.00	0.48
L2 X T1	210.23	15.13	2.60	0.63	11.87	9.03	75.80	5.72	46.93	30.35	1.80
L2 X T2	244.00	15.06	2.60	0.50	12.15	9.55	78.60	6.22	50.45	25.83	1.65
L2 X T3	104.95	8.05	1.63	0.48	8.55	5.52	64.77	3.15	34.35	16.57	0.55
L3 X T1	228.90	9.92	2.65	0.58	11.33	9.08	80.20	5.98	44.65	26.05	1.58
L3 X T2	262.63	14.08	2.75	0.70	13.55	10.17	75.13	6.45	53.27	37.78	2.45
L3 X T3	113.95	9.75	1.87	0.60	7.17	4.22	58.65	2.20	32.45	18.78	0.40
L4 X T1	221.70	13.15	2.38	0.65	13.28	9.85	74.10	6.20	35.25	23.28	1.47
L4 X T2	241.98	15.50	2.50	0.80	14.00	11.33	80.98	7.50	41.50	33.15	2.52
L4 X T3	105.45	9.02	1.80	0.48	8.58	5.62	65.70	3.25	31.70	15.03	0.50
L5 X T1	222.28	14.30	2.52	0.58	11.67	9.28	79.20	6.05	44.52	26.15	1.68
L5 X T2	247.28	17.53	2.60	0.78	13.70	10.32	75.30	6.57	50.52	38.75	2.60
L5 X T3	107.70	9.33	1.63	0.65	8.98	6.05	67.70	3.60	37.05	23.82	0.82
L6 X T1	192.97	14.08	2.50	0.60	11.08	8.35	75.13	5.28	40.20	25.47	1.37
L6 X T2	225.75	17.35	2.57	0.67	12.65	9.80	77.22	6.30	45.70	31.30	2.02
L6 X T3	120.23	9.63	1.68	0.50	6.80	3.78	55.67	1.90	35.77	18.67	0.38
Commercial Mean	191.89 ± 5.29	12.28 ±0.05	2.38 ± 0.02	0.83 ± 0.02	12.70 ± 0.05	9.72 ± 0.04	72.94 ± 0.26	6.22 ± 0.04	40.98 ± 0.26	32.25 ± 0.74	2.62 ± 0.14
SD	0.58	0.10	0.01	0.04	0.10	0.08	0.53	0.07	0.52	1.47	0.28

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Table 2. Heterosis (%) of the progeny over better parent & mid parent

Hybrids		L1 X T1	L1 X T2	L1 X T3	L2 X T1	X T2	L2 X T3	L3 X T1	L3 X T2	L3 X T3	L4 X T1	L4 X T2	L4 X T3	L5 X T1	L5 X T2
Cane length (cm)	MP	-9.83**	-3.86**	-16.60**	-6.53**	-0.49**	-29.11**	-10.28**	5.11**	-25.38**	0.90**	0.81**	-26.19**	-2.17**	-0.09**
	BP	-22.29**	-22.01**	36.17**	-15.76**	-15.91**	-47.59**	-8.27**	9.49**	-45.62**	-11.16**	-16.60**	44.47**	-10.93**	-14.78**
Internode length	MP	-7.23**	-2.93**	12.79**	11.32**	-0.16**	-19.90**	-26.14**	-9.05**	-1.52**	-1.31**	0.90**	-7.79**	3.62**	10.66**
	BP	-35.34**	-35.71**	-8.32**	-20.81**	-32.69**	-33.06**	-48.04**	-39.27**	-18.92**	-31.15**	-33.12**	-24.95**	-25.13**	-24.38**
Cane thickness (cm)	MP	0.01**	-7.56**	-17.65**	13.05**	-0.48**	-15.58**	6.00**	-2.22**	-11.76**	8.57**	0.01**	-0.69**	18.13**	6.12**
	BP	-28.07**	-25.71**	-50.00**	-16.13**	-16.13**	-47.58**	-24.29**	-21.43**	-46.43**	-17.39**	-13.04**	-37.39**	-9.01**	-6.31**
Cane weight (kg)	MP	-36.36**	-38.46**	-58.06**	-32.43**	-50.62**	-42.07**	-38.67**	-31.71**	-27.93**	-24.64**	-15.79**	-37.29**	-37.84**	-23.46**
	BP	-65.00**	-64.00**	-79.00**	-60.94**	-68.75**	-70.31**	-64.62**	-52.94**	-63.08**	-55.93**	-45.73**	-67.80**	-64.06**	-51.56**
Brix percent	MP	-11.04**	-11.47**	-46.13**	-12.44**	-10.33**	-38.98**	-10.74**	-6.90**	-45.39**	-0.56**	-4.97**	-37.86**	-14.55**	-0.37**
	BP	-41.26**	-26.46**	-63.34**	-40.55**	-39.17**	-57.20**	-37.86**	-25.65**	-60.63**	-32.10**	-28.39**	-56.14**	-42.13**	-32.09**
Sucrose percent	MP	-23.57**	-10.40**	-57.30**	-15.65**	-11.57**	-45.43**	-8.45**	-1.62**	-54.75**	-4.37**	-8.89**	-42.16**	-14.61**	-5.82**
	BP	-53.77**	-32.66**	-72.25**	-47.61**	-44.56**	-67.92**	-42.01**	-34.98**	-73.00**	-40.03**	-31.05**	-65.75**	-47.15**	-41.17**
Purity coefficient	MP	-4.53**	8.32**	-5.49**	5.20**	6.79**	4.64**	11.39**	2.14**	-5.17**	4.35**	11.59**	7.95**	9.15**	1.60**
	BP	-21.22**	-8.73**	-32.75**	-11.89**	-8.63**	-24.70**	-6.66**	-12.57**	-31.74**	-11.73**	-3.54**	-21.74**	-9.02**	-13.50**
Commercial cane	MP	-30.00**	-9.88**	-63.98**	-17.77**	-11.86**	-49.00**	-7.00**	-1.15**	-61.49**	-6.24**	-11.73**	-44.92**	-14.74**	-8.84**
	BP	-59.49**	-35.62**	-81.01**	-51.28**	-47.02**	-73.19**	-44.03**	-39.58**	-79.39**	-43.89**	-32.13**	-70.59**	-49.79**	-45.44**
No. of millable cane per plot	MP	-2.23**	27.28**	-26.46**	10.09**	29.03**	-29.07**	4.57**	35.94**	-33.09**	-20.83**	1.22**	37.01**	3.01**	27.27**
	BP	-22.55**	7.02**	-45.82**	-5.11**	18.99**	-43.73**	-9.71**	25.65**	-46.85**	-28.72**	-2.12**	-48.08**	-9.96**	19.16**
Cane yield per plot (kg)	MP	-22.27**	14.02**	-54.62**	-11.88**	0.11**	-43.74**	-25.85**	0.21**	-37.70**	-34.20**	-13.92**	-50.60**	-27.03**	0.58**
	BP	-54.47**	-45.91**	-76.53**	-46.21**	-54.23**	-70.62**	-54.95**	-34.62**	-67.50**	-60.09**	-43.16**	-74.24**	-55.86**	-34.60**
Sugar yield per plot (kg)	MP	-63.99**	13.49**	-90.54**	-47.64**	10.01**	-83.45**	-56.10**	10.33**	-88.48**	-55.97v	10.26**	-84.54**	-54.58**	11.33**
	BP	-81.55**	-65.09**	-95.26**	-72.83**	-75.09**	-91.70**	-77.26**	-64.62**	-94.22**	-73.13**	-60.85**	-92.25**	-76.49**	-63.51**

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L5 X T3	-28.37**	-47.42**	-9.14**	-22.45**	-7.80**	-41.44**	-20.73**	-59.38**	-36.40**	-55.51**	-41.19**	-65.57**	8.47**	-22.23**	-43.75**	-70.12**	-24.43**	39.31**	-22.83**	-59.79**	-76.91**	-88.42**
L6 X T1	-9.04**	-22.67**	7.74**	-26.31**	11.11**	-16.67**	-30.43**	-59.32**	-9.59**	-36.17**	-10.93**	-42.71**	5.70**	-10.65**	-12.08**	-46.31**	-4.96**	-18.71**	-21.86**	-51.83**	-49.54**	-73.56**
L6 X T2	-2.88**	-22.20**	14.62**	-25.13**	0.49**	-14.17**	-28.95**	-54.24**	-3.37**	-27.09**	-3.43**	-32.76**	6.33**	-8.15**	3.28**	-35.88**	17.86**	7.78**	-12.42**	-40.69**	-28.00**	-61.06**
L6 X T3	-11.14**	-31.20**	0.65**	-19.96**	-10.67**	-44.17**	-33.99**	-66.10**	-46.46**	-60.81**	-57.10**	-74.10**	-8.62**	-33.78**	-64.07**	-80.66**	-25.62**	-41.40**	-32.43**	-64.61**	-85.63**	-92.79**

*Significant at 5% level ; ** Significant at 1% level

References :

1. Amalraj, V. Taxonomy and floral biology of Saccharum and related genera. National level winter school and “Sugarcane Breeding and Genetics in Retrospect and Prospects”. Sugarcane Breed Inst., Coimbatore,(2003). 25-35.
2. Anbanandan, V., S. Rajeswari, K. Saravanan and J. Ganesan. Studies on genetic divergene analysis in sugarcane (Saccharum officinarum L.). In: National seminar on hybrid breeding in crop plants held on 3-4 March 2004, at Annamalai University, Annamalainagar, India.
3. Janakiammal, E.K. Intergeneric hybrids of Saccharum. J. Genet., 41:(1941). 217-253.
4. Kadambavanasundaram. 1980. Combining ability as related to gene action in cotton (Gossypium hirsutum L.) Ph.D. Thesis, Tamil Nadu Agrl. Univ., Coimbatore, India.
5. Krishnamurthi, M. Alternation of conventional with unconventional means of breeding in sugarcane. 7th International Congress of Society for the advancement of breeding researchers in Asia and Oceana, (1993).p. 80.
6. Loganathan, P., K. Saravanan and J. Ganesan. Heterosis for yield and yield components in greengram. Legume Res., 24: (2001).77-81.
7. Miller, J.D. and P.Y.P. Tai. Use of plant introductions in sugarcane cultivar development. Crop Sci., 20: (1992).137-149.
8. Nadaraja. Genetic analysis of fibre characters in cotton (Gossypium hirsutum L.). (1986).Ph.D. Thesis Tamil Nadu Agrl. Univ., Coimbatore, India.
9. Prices, S. Interspecific hybridization in sugarcane breeding. Proc. Int. Soc. Sugaracne Technol., 12: (1967).1021-1026.
10. Rajesh, K. and Gulsan. Expression of heterosis in hot pepper. Capsicum annum and egg. Plant News Lett., 20: (2001).38-41.
11. Rajeswari, S., V. Anbanandan, K. Shanmugasundaram, S. Thirugnanakumar and M. Krishnamurthi. Wide hybridization and exploitation of heterosis in sugarcane (Saccharum officinarum L.). In: National Seminar on hybrid breeding in crop plants held on 3-4 March, 2004 at Annamalai University, Annamalainagar, India.
12. Rumke, C.L.J. Saccharum – Erianthus Bastardan. Arch. Suik. Ned. Indie., 42 (2): (1934). 211-261.
13. Wynne, J.C., D.A. Emery and P.W. Rice. Combining ability estimates in Arachis hypogaea L. field performance of F1 hybrids. Crop. Sci., 10(6): (1970).713-715.

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