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Heterosis Studies in Fingermillet (*Eleusine coracana* (L.) Gaertn.)

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An experiment was conducted to estimate the heterosis for yield and yield attributing traits in fingermillet. In the present investigation, a set of half diallel crosses involving seven parents were used for studying the extent of heterosis. The trial was conducted at Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. The parent CO (Ra) 14 was used as a standard check. The relative heterosis for grain yield ranged from 8.12 (RIL 156 x GPU 45) to 33.02 (CO 9 x CO (Ra) 14) per cent. The heterobeltiosis for grain yield was observed between -12.65 per cent (PRM 801 x CO (Ra) 14) to 24.29 (CO 9 x CO (Ra) 14) per cent and standard heterosis for grain yield recorded was -12.65 (PRM 801 x CO (Ra) 14) to 24.29 (CO 9 x CO (Ra) 14) per cent. Among the hybrids, TNAU 1039 x CO (Ra) 14 and CO 9 x CO (Ra) 14 were identified as superior hybrids as they recorded high magnitude of *per se* performance and standard heterosis for number of productive tillers per plant, fingers per ear head, 1000 grain weight, harvest index and single plant grain yield. These heterosis will be exploited through selection of superior and trait specific genotypes in the segregating generations for the evolution of high yielding varieties.

Key words: *per se* performance, relative heterosis, heterobeltiosis, standard heterosis.

Fingermillet is one of the most important small millets grown in eastern Africa and southern India and it serves as a subsistent food and a nutritional security crop. It is an unavoidable food crop in traditional low input millet-based farming. To get maximum grain yield associated with best grain quality is the aim of the breeding programs. The use of heterosis for getting high yield with improved quality has been largely used in cross-pollinated crops. In self-pollinated crops evidences are available to confirm the potential use of heterosis (Haq and Laila, 1991), suggesting the easiest ways of commercial exploitation of genetic potential of wheat crops. Though *per se* performance of parental lines provides clues, reliable information on magnitude of heterosis for yield and yield attributing traits are of more helpful in selecting appropriate parents and desirable cross combinations for the exploitation of hybrid vigour. The present study was, therefore, undertaken to determine the extent of relative heterosis, heterobeltiosis and standard heterosis in fingermillet and to identify the most heterotic hybrids.

Materials and Methods

The experimental material consists of seven parents *viz*., CO 9, RIL 156, TNAU 1039, GPU 45, PRM 801, VL 149 and CO (Ra) 14. The parents were crossed in half diallel mating design (Griffing, 1956) and resulting 21 hybrids along with seven parents and standard check CO (Ra) 14 were evaluated in Randomized Complete Block Design with three replications during *kharif*, 2009 at Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. Recommended package of practices was followed for raising a good crop stand. The observations on five randomly selected competitive plants were recorded for days to 50 per cent flowering, plant height (cm), number of productive tillers per plant, number of fingers per ear head, longest finger length (cm), thousand grain weight (g), seed protein content (%), harvest index (%), single plant dry fodder yield (g) and single plant grain yield (g). Each character was analyzed separately using analysis of variance technique suggested by Panse and Sukhatme (1964) and heterosis was calculated in F_1 hybrids over mid parent, better parent and standard check CO (Ra) 14.

Results and Discussion

The analysis of variance for various yield and yield attributing traits are presented in table1. Analysis of variance showed significant differences among parents for all the ten traits studied. This revealed the presence of significant variability in the experimental material for all the characters under study. The crosses showed significant differences for all the traits studied, which indicated the existence of variability among the crosses.

The range of heterosis for yield and yield attributing traits are presented in table 2. The early maturing varieties are desirable in fingermillet under rainfed condition. The hybrid, TNAU 1039 x VL 149, exhibited highly significant negative relative

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Table 1. Analysis of variance for yield and yield attributing traits in fingermillet

Source	Degrees of freedom	Days to 50 % flowering	Plant height (cm)	No.of productive tillers per plant	No. of fingers per ear head	Longest finger length (cm)	Thousand grain weight (g)	Seed protein content (%)	Harvest index (%)	Single plant dry fodder yield (g)	Single plant grain yield (g)
Replication	2	0.33	8.67	0.04	0.04	0.01	0.01	0.003	0.27	0.27	0.06
Parents	6	92.2**	387.13**	4.44**	1.75**	5.18**	0.18**	1.47**	32.82**	9.94**	7.01**
Hybrids	20	15.44**	111.82**	1.40**	0.74**	0.38**	0.04**	1.80**	16.71**	2.91**	2.59**
Error	54	0.08	2.60	0.06	0.05	0.03	0.002	0.001	0.07	0.05	0.05

*Significant at P=0.05, **Significant at P=0.01

heterosis (-13.35), heterobeltiosis (-16.67) and standard heterosis (-14.35) for days to 50 per cent flowering. For plant height, GPU 45 x PRM 801 depicted significant negative relative heterosis (-12.93), TNAU 1039 x GPU 45 showed significant negative heterobeltiosis (-23.12) and standard heterosis (-30.04). For number of productive tillers per plant, the hybrid TNAU 1039 x CO (Ra) 14 had high heterotic value in desirable direction which was revealed in relative heterosis (74.36), heterobeltiosis (67.78) and standard heterosis (67.78). Regarding number of fingers per ear head, GPU 45 x CO (Ra) 14 showed significant and maximum positive relative heterosis (26.29) and standard heterosis (13.62). The hybrid GPU 45 x VL 149, depicted significant and positive heterosis over the better parent (20.99). Similar results were reported in finger millet by Suresh (1988) for days to flowering (negative), productive tiller number per plant and finger number.

Table 2. Range of heterosis for yield and yield attributing traits in fingermillet

Characters	Heterosis over	Range of heterosis		Best heterotic hybrids	No. of hybrids in desired direction
Days to 50 % Flowering	M P	-13.35	11.50	TNAU 1039 x VL 149	8
	B P	-16.67	6.44	TNAU 1039 x VL 149	15
	S H	-16.60	6.55	TNAU 1039 x VL 149	12
Plant height	M P	-12.93	33.03	GPU 45 x PRM 801	4
	B P	-23.12	11.96	TNAU 1039 x GPU 45	9
	S H	-30.04	11.96	TNAU 1039 x GPU 45	11
Number of productive tillers per plant	M P	13.99	74.36	TNAU 1039 x CO (Ra)14	19
	B P	15.22	67.78	TNAU 1039 x CO (Ra)14	11
	S H	-17.33	67.78	TNAU 1039 x CO (Ra)14	9
Number of fingers per ear head	M P	-18.42	26.29	GPU 45 x CO (Ra)14	11
	B P	-22.22	20.99	GPU 45 x VL 149	8
	S H	-22.58	13.62	GPU 45 x CO (Ra)14	3
Longest finger length (cm)	M P	-8.54	27.86	CO 9 x RIL 156	10
	B P	-33.82	16.20	RIL 156 x PRM 801	8
	S H	-26.15	19.27	GPU 45 x VL 149	7
Thousand grain weight (g)	M P	-10.30	18.79	TNAU 1039 x GPU 45	9
	B P	-12. 94	16.28	PRM 801 x VL 149	6
	S H	-7.50	25.00	PRM 801 x VL 149	10
Seed protein content (%)	M P	-31.89	35.76	GPU 45 x VL 149	10
	B P	-38.72	23.69	GPU 45 x VL 149	3
	S H	-29.26	14.15	GPU 45 x VL 149	3
Harvest index (%)	M P	-4.24	41.36	CO 9 x CO (Ra)14	21
	B P	3.95	38.55	CO 9 x CO (Ra)14	16
	S H	3.95	44.28	CO 9 x CO (Ra)14	21
Single plant dry fodder yield (g)	M P	-16.00	1.93	RIL 156 x PRM 801	1
	B P	-18.64	-2.37	--------	---------
	S H	-15.12	7.83	RIL 156 x PRM 801	9
Single plant grain yield (g)	M P	8.12	33.02	CO 9 x CO (Ra)14	20
	B P	-12.65	24.29	CO 9 x VL 149	18
	S H	-12.65	24.29	CO 9 x CO (Ra)14	12

MP- Mid Parent BP- Better Parent SH- Standard Heterosis

The crosses, CO 9 x RIL 156, RIL 156 x PRM 801 and GPU 45 x VL 149 depicted significant and highest positive heterosis over MP (27.86), BP (16.20) and SH (19.27) for the longest finger length. For thousand grain weight TNAU 1039 x GPU 45 (18.79) and PRM 801 x VL 149 (16.28 and 25.0) depicted significant relative heterosis, hetero beltiosis and standard heterosis in desirable direction, respectively.

The hybrid, GPU 45 x VL 149, showed significant and maximum positive heterosis over MP (35.76), BP (23.69) and SH (14.15) for seed protein content. The cross, CO 9 x CO (Ra) 14 showed significant and maximum positive heterosis over MP (41.36), BP (38.55) and SH (44.28) for harvest index. The hybrid RIL 156 x PRM 801 recorded significant and highest positive heterosis over MP (1.93) and SH (7.83) for single plant dry fodder yield. None of the crosses showed significant positive heterobeltiosis for single plant dry fodder yield.

The *per se* and standard heterosis should be given due importance for exploitation of commercial hybrids. The *per se* performance and standard heterosis for selected hybrids are presented in table 3. Among the 21 hybrids, the hybrids CO 9 x CO (Ra) 14, TNAU 1039 x CO (Ra) 14 and VL 149 x CO (Ra) 14 were valued as the best hybrids based on *per se* performance and standard heterosis for grain yield, earliness and number of productive tillers, and they further advanced to evolution of high yielding varieties by pedigree breeding method due to additive x additive nature of epistatic gene action.

Table 3. *Per se* performance and standard heterosis for selected hybrids in fingermillet

Characters	Hybrids with superior *per se*, *sca* effect and standard heterosis	*Per se* performance	Standard heterosis
Days to 50% flowering	TNAU 1039 x VL 149	61.67**	-14.35**
	GPU 45 x CO (Ra) 14	61.67**	-14.35**
Plant height (cm)	TNAU 1039 x GPU 45	94.67**	-30.04**
	CO 9 x RIL 156	108.17**	-19.89**
	CO9 x TNAU 1039	103.97**	-12.02**
Number of productive tillers/ plant	CO9 x CO (Ra) 14	10.40**	44.22**
	TNAU 1039 x CO (Ra) 14	10.07**	67.78**
	VL 149 x CO (Ra) 14	9.69**	53.33**
Number of fingers/ ear head	CO 9 x CO (Ra) 14	10.57**	13.62**
	TNAU 1039 x CO (Ra) 14	10.50**	12.90**
	VL 149 x CO (Ra) 14	10.43**	12.19**
Longest finger length (cm)	GPU 45 x VL 149	8.67**	19.27**
	VL 149 x CO (Ra) 14	8.53**	17.43**
Thousand grain weight (g)	PRM 801 x VL 149	3.33**	25.00**
	CO 9 x GPU 45	3.30**	23.75**
	TNAU 1039 x GPU 45	3.27**	22.50**
Seed protein content (%)	GPU 45 x VL 149	11.83**	14.15**
	VL 149 x CO (Ra) 14	10.57**	1.93**
Harvest Index (%)	CO9 x CO (Ra) 14	46.01**	44.28**
	TNAU 1039 x CO (Ra) 14	45.51**	42.71**
	VL 149 x CO (Ra) 14	44.7**	40.19**
Single plant dry fodder yield (g)	RIL 156x PRM 801	29.85**	7.83**
	GPU 45 x PRM 801	29.2**	5.48**
	RIL 156 x GPU 45	29.33**	5.95**
Single plant grain Yield (g)	CO9 x CO (Ra) 14	20.11**	24.29**
	TNAU 1039 x CO (Ra) 14	19.79**	22.34**

*Significant at P=0.05, **Significant at P=0.01

Similar results of *per se* performance, *sca* effects and standard heterosis, GPU 28 x CO13 and CO 12 x TRY1 were identified as the best hybrids for grain yield by Shailaja *et al.* (2010), Sumathi *et al.* (2005) reported higher heterosis for grain yield and Gupta and Kumar *et al.* (2009) reported higher heterosis for grain yield. Similarly, Shankar (1982) recorded high heterosis for productive tiller number, tiller number per plant and grain yield. Hence, advancing these hybrids and effecting further selection in segregating generations will be helpful to develop high yielding varieties.

Due to the difficulty in hybrid seed production, commercialization of these hybrids is not possible immediately. Hence, these heterosis could be exploited through selection of superior and trait specific genotypes in the segregating generations for evolution of high yielding varieties.

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