



Heterotic Studies for Yield and Yield Attributing Characters in Finger Millet (*Eleusine coracana* L. Gaertn)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In the present investigation twelve crosses were generated by crossing three lines with four testers in Line x Tester mating design during *kharif* 2023 at Agricultural Research Station, Perumallapalle, Tirupati. Twelve crosses along with seven parents and check (Tirumala) were evaluated during *rabi* 2023-24 in Randomised Block Design with two replications at Agricultural Research Station,

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Perumallapalle, Tirupati. ANOVA revealed significant difference among genotypes for all characters studied. Heterosis studies helps in finding out superior hybrids over mid parent (Average heterosis), better parent (heterobeltiosis) and standard check (economic heterosis). Among the crosses, PPR1216 × VL 400 was identified as superior cross as it recorded high magnitude of *per se* performance and all three types of heterosis for days to 50% flowering, number of productive tillers per plant, number of fingers per ear and grain yield per plant. The heterosis will be exploited through selection of superior and character specific genotypes in the segregating generations for the evolution of high yielding varieties. Statistical analysis was carried out by using OP STAT and R Software.

Keywords: *Per se* performance; relative heterosis; heterobeltiosis; standard heterosis; finger millet.

1. INTRODUCTION

Finger millet is the primary food for millions in dry lands of eastern and central Africa and southern Asia. The most important development in plant breeding in recent years has been the use of heterosis or hybrid vigour in many self-pollinated species and has been the object of considerable study as a mean of increasing productivity of wheat and other cereals [1]. Ragi being a self-pollinated crop, exploitation of heterosis is the best option to further improve the grain yield and nutritional characters. Evidences are available to confirm the potential use of heterosis in self-pollinated crops [2]. Exploitation of variability created by hybridization through recombination breeding is the next major approach adopted in finger millet improvement programme [3]. In India the productivity level of finger millet is 1497 Kg ha⁻¹. To improve the productivity level in any crop can be exploited by using of heterosis during crop improvement programme. To get maximum grain yield associated with best grain quality is the aim of the breeding programs in any crop. Though *per se* performance of parental lines provides clues, reliable information on magnitude of heterosis for yield and yield attributing characters 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 finger millet and to identify the most heterotic hybrids.

2. MATERIALS AND METHODS

In the present investigation, three lines were crossed with four testers in a Line × Tester mating design [4] to generate 12 F₁ crosses. The 12 F₁ crosses along with seven parents and a standard check Tirumala were raised in Randomised block design with two replications at

Agricultural Research Station, Perumallapalle, Tirupathi during *rabi*, 2023-24. For emasculation, hot water method was followed and crossing was done through contact method. Hot water treatment was carried out at 48-52 °c for 2-5 minutes in the evening hours. Each entry was grown in two rows with a spacing of 22.5 cm between rows and 10 cm between plants. The following quantitative characters like days to 50% flowering, days to maturity, plant height, number of productive tillers per plant, ear head length, number of fingers per ear, grain yield per plant, fodder yield per plant, 1000 grain weight and harvest index were recorded in five randomly selected plants. Evaluation was done based on morphological characters like plant height, tiller number etc. Proper crop management practices were followed in order to raise good crop. The magnitude of heterosis was estimated over mid parent, better parent and standard check. The significance of heterosis was tested by using 't' test as suggested by Snedecor and Cochran [5] and Pascal and Wilcox [6].

$$\text{Heterosis over mid parent (\%)} = \frac{\bar{F}_1 - \bar{MP}}{\bar{MP}} \times 100$$

$$\text{Heterosis over better parent (\%)} = \frac{\bar{F}_1 - \bar{BP}}{\bar{BP}} \times 100$$

3. RESULTS AND DISCUSSION

The analysis of variance for various yield and yield attributing characters were exhibited significant differences indicated the availability of the variability (Table 1).

The range of heterosis for ten characters expressed by twelve crosses was estimated and represented in Table 2. Efficient crosses are the one which exhibits significant values for all three types of heterosis studied. For days to 50% flowering the crosses *viz.*, PPR 1216 × VL 400, PPR 1216 × Indravathi, PPR 1216 × VL 376,

Table 1. Analysis of variance for grain yield and yield attributing characters in finger millet genotypes (*Eleusine coracana* L.)

Source of variation	D.f	Days to 50% flowering	Days to maturity	Plant height (cm)	No of productive tillers plant ¹	Ear head length (cm)	No of fingers ear head ⁻¹	Grain yield plant ⁻¹ (g)	Fodder yield plant ⁻¹ (g)	Test weight (g)	Harvest index (%)
Mean sum of squares											
Replications	1	1.60	32.40	34.2250	0.121	0.0120	0.1960	0.0050	1.4710	0.1820	1.3070
Treatments	19	132.6**	34.611**	360.137**	0.365**	2.223**	0.295**	13.601**	134.311**	0.526**	43.385**
Error	19	10.284	9.979	21.08	0.083	0.199	0.074	0.701	12.367	0.058	2.722

** Significant at 1% level

Table 2. Estimates of heterosis for yield and yield attributing characters in finger millet (*Eleusine coracana* L. Gaertn)

Crosses	Days to 50% flowering			Days to maturity			Plant height (cm)			Productive tillers per plant (No.)			Ear head length (cm)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
PPR1216 x VL400	-8.43 *	-9.52 *	-13.14 **	28.30 **	21.43 *	-5.36	5.44	2.13	54.84 **	28.30 **	21.43 *	47.83 **	3.61	-8.51	-4.44
PPR1216 x Indravathi	-10.91 **	-12.50 **	-16.00 **	22.81 **	9.38	-0.89	11.97 *	8.02	65.16 **	22.81 **	9.38	52.17 **	-14.89**	-14.89**	-11.11*
PPR1216 xVL376	-9.55 **	-15.48 **	-18.86 **	-8.2	-22.22 *	-9.38 **	13.55 *	10.27	66.29 **	-8.2	-22.22 *	21.74	-1.08	-2.13	2.22
PPR1216 x ER41	-13.02 **	-13.53 **	-16.00 **	34.69 **	32.00 **	-3.13	1.4	-9.60 *	64.03 **	34.69 **	32.00 **	43.48 **	2.92	-6.38	-2.22
Vakula xVL400	-14.74 **	-18.90 **	-24.00 **	8.47	3.23	-7.14 *	11.20 *	6.7	61.77 **	8.47	3.23	39.13 **	25.33**	20.51**	4.44**
Vakula x Indravathi	-12.26 **	-16.05 **	-22.29 **	-11.11	-12.5	-8.04 **	-5.08	-9.28	38.71 **	-11.11	-12.5	21.74	0.00	-8.51	-4.44
Vakula x VL376	-14.97 **	-15.54 **	-28.57 **	-22.39 **	-27.78 **	-10.27 **	-16.40 **	-19.57 **	21.29 *	-22.39 **	-27.78 **	13.04	8.24	0.00	2.22
Vakula x ER41	-16.35 **	-21.76 **	-24.00 **	-12.73	-22.58 *	-8.93 **	6.69	-5.69	71.13 **	-12.73	-22.58 *	4.35	21.29	20.51**	4.44
Hima x VL400	14.10 **	8.54 *	1.71	-8.47	-12.9	-0.89	-12.25 *	-16.91 **	25.97 **	-8.47	-12.9	17.39	-20.00**	-30.61**	-24.44**
Hima x Indravathi	12.26 **	7.41	-0.57	-33.33 **	-34.37 **	-0.45	-17.23 **	-21.94 **	19.35 *	-33.33 **	-34.37 **	-8.7	-27.08**	-28.57**	-22.22**
Hima x VL376	-2.04	-2.7	-17.71 **	-4.48	-11.11	-2.68	-19.10 **	-23.21 **	15.81	-4.48	-11.11	39.13 **	-7.37	-10.20*	-2.22
Hima x ER41	10.69 *	3.53	0.57	-1.82	-12.9	0.89	-23.16 **	-32.89 **	21.77 *	-1.82	-12.9	17.39	-26.86**	-34.69**	-28.89**
SE	2.74	3.16	3.16	0.23	0.27	3.22	4.08	4.72	4.72	0.23	0.27	0.27	0.36	0.46	0.46

Crosses	Fingers per ear (No.)			Grain yield per plant (g)			Fodder yield per plant (g)			1000 grain weight (g)			Harvest index (%)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
PPR1216 x VL400	40.00 **	40.00 **	20.69*	55.64 **	30.41 **	38.76 **	14.43	6.01	-32.35 **	19.73 *	2.13	-11.65	29.41 **	18.02	81.42 **
PPR1216 x Indravathi	25.49 *	23.08*	10.34	8.41	3.48	10.11	-10.92	-18.69 **	-37.15 **	8.43	0.33	-13.21	16.67	4.24	60.22 **
PPR1216 x VL376	-9.68	-24.32 **	-3.45	-9.04	-11.3	-5.62	39.44 **	38.41 **	-10.35*	27.05 **	21.84 *	5.4	-30.45 **	-32.25 **	4.15
PPR1216 x ER41	30.77 **	25.93 *	17.24	19.63 *	8.76	15.73	-12.34	-18.55 **	-39.44 **	16.16	10.34	-4.55	28.17 **	11.71	71.71 **
Vakula x VL400	5.66	0	-3.45	33.33 **	-0.76	46.07 **	17.02 *	8.29	-30.74 **	42.18 **	23.79 **	1.99	14.81	-5.94	86.60 **
Vakula x Indravathi	-3.7	-7.14	-10.34	4.1	-13.74*	26.97 **	-18.75 **	-25.76 **	-42.62 **	14.39	8.28	-10.8	20.48 *	-3.03	92.37 **
Vakula x VL376	-23.08 **	-32.43 **	-13.79	-17.65 *	-30.53 **	2.25	14.63*	13.92	-26.22 **	11.33	9.31	-9.94	-24.08 **	-34.14 **	30.65*
Vakula x ER41	-12.73	-14.29	-17.24	-34.77 **	-48.09 **	-23.60 *	-7.08	-13.57	-35.74 **	16.84 *	13.62	-6.39	-25.99 **	-41.69 **	15.68
Hima x VL400	-1.89	-7.14	-10.34	-45.01 **	-61.61 **	-30.34 **	40.87 **	27.20 **	-14.11 **	-12.02	-21.18 *	-39.20 **	-49.60 **	-58.94 **	-17.34
Hima x Indravathi	-14.81	-17.86	-20.69*	-41.44 **	-55.11 **	-18.54	27.35 **	19.30 **	-7.79	-10.65	-12.71	-32.67 **	-44.56 **	-55.62 **	-10.66
Hima x VL376	-13.85	-24.32 **	-3.45	-33.20 **	-47.99 **	-5.62	-9.18	-11.03	-39.92 **	42.29 **	40.25 **	11.36	-15.12*	-26.82**	47.32**
Hima x ER41	-12.73	-14.29	-17.24	-43.93 **	-58.51 **	-24.72 *	15.48 *	10.19	-18.08 **	-16.59	-16.97	-35.37 **	-41.40**	-54.08*	-7.55
SE	0.24	0.28	0.28	0.74	0.86	0.86	2.86	3.30	3.30	0.22	0.25	0.25	1.45	1.68	1.68

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

PPR 1216 × ER 41, Vakula × VL 400, Vakula × Indravathi, Vakula × VL 376 and Vakula × ER 41 recorded significant negative values for all three types of heterosis suggesting the contribution of dominant gene action with negative effects.

The early reports clarified that early maturing types can be obtained from crosses with negative heterosis. None of the crosses recorded significant negative values for days to maturity for all three types of heterosis. For plant height most of the crosses recorded significant positive values for standard heterosis. Significant positive heterosis was observed in PPR 1216 × VL 400 and PPR 1216 × ER 41 for productive tillers per plant, PPR 1216 × Indravathi for ear head length, PPR1216 × VL 400 for number of fingers per ear and PPR1216 × VL 400 for grain yield per plant. Values In the present study, the cross PPR 1216 × VL 400 exhibited significant positive values for all three types of heterosis for grain yield per plant. Similar results previously reported by Suresh [7], Ravi Kumar et al. [8], Mahadevaiah [9], Sivagurunathan [10], Priyadarshini et al. [11], Parashuram et al. [12], Savitha et al. [13] and Divya et al. [14] in finger millet.

4. CONCLUSION

In the present study PPR1216 × VL 400 showed favourable heterosis for all the three types of heterosis for grain yield and hence may be utilized in future finger millet yield improvement.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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