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GENETIC ANALYSIS FOR YIELD AND QUALITY TRAITS IN FORAGE PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.]

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SUMMARY

Genetic analysis was carried out in 28 F_1 hybrids and their 8 diverse parents for green fodder yield, its quality and other related traits in **kharif** and summer seasons. Predominant non-additive type gene effects for green forage yield as well as other yield contributing and quality traits were observed. The parents Giant bajra, RHRB-282 and RHRB-278 had good gca effects for green forage yield and component characters. The cross combinations viz., Giant bajra x RHRB-282, PMFT-907 x RHRB-278, RHRB-259 x RHRB-260, Giant bajra x PMFT-905 and PMFT-905 x PMFT-907 displayed significant and positive sca effects and heterosis over mid and better parent for green forage yield and other related traits in both the seasons. It was suggested to undertake multiple crossing programme among high general combiners for various traits and desirable segregants in early generation may be subjected to biparental mating for the accumulation of favourable genes for various forage yield and quality traits.

Key words : Pearl millet, genetic analysis, combining ability, gene action, heterosis

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is important food, feed and fodder crop in arid and semi-arid regions. Among cultivated cereals, it is an excellent forage crop because of its low hydrocyanic acid content. The green fodder which is rich in protein, calcium, phosphorus and other minerals contains oxalic acid within a safe limit. Being a C_4 species, it has tremendous potential for biomass production, most of which is accumulated in its vegetative parts. In order to make forage pearl millet as more remunerative crop, there is need to develop varieties and hybrids having faster growth, early to medium maturity and higher fodder yield with good fodder quality. To develop such fodder varieties/hybrids, knowledge and information of the genetic architecture are necessary. Remarkable improvement has been achieved for grain yield in pearl millet through exploitation of heterosis; however, little systematic breeding work and substantial improvement are being made for forage yield and forage quality of pearl millet. Keeping this in view, the efforts were made in present investigation to study the heterosis, identify the best combining parental lines, specific cross combinations and to study the gene action for improvement in forage yield and yield attributing and quality characters.

MATERIALS AND METHODS

The materials consisted of 28 F_1 hybrids and their eight diverse parents viz., Giant bajra, PMFT-904, PMFT-905, PMFT-907, RHRB-259, RHRB-260, RHRB-282 and RHRB-278. The F_1 hybrids were generated through half diallel and were planted during **kharif** 2009 and summer 2010 seasons at MPKV, Rahuri. The trials were conducted in RBD with three replications. Each entry was planted in two rows of 3.0 m length by keeping row to row distance 30 cm and within the row 10 cm. All the recommended agronomical practices and plant protection measures were followed as and when required to ensure good crop. Data were recorded on 15 competitive plants selected randomly for days to 50 per cent flowering, plant height (cm), number of tillers/plant, number of leaves/tiller, leaf area (cm^2), green forage yield (q/ha), dry matter yield (q/ha), crude protein (%), oxalic acid (%) and IVDMD (%). The combining ability analysis was carried out following method-2, model-1 of Griffing (1956). Magnitude of relative heterosis and heterobeltiosis was computed as per procedure suggested by Fonesca and Patterson (1968).

RESULTS AND DISCUSSION

The analysis of variance revealed that mean squares due to genotypes were significant for all the characters under study in both **kharif** and summer seasons (Table 1). The mean squares due to genotypes were further partitioned into mean squares due to parents, hybrids and parents vs. hybrids. The analysis of variance further revealed that the parents and hybrids differed significantly for all the characters in both the seasons except in case of parents for number of tillers and oxalic acid content in **kharif** seasons and in case of hybrids for number of tillers in **kharif** season which indicated diversity among parents and hybrids for majority of the characters under study. The mean squares due to parents *vs.* hybrids were significant for all the characters except for plant height in summer season, IVDMD in **kharif** season and number of tillers under both the seasons. This suggested the existence of the differences between parents and hybids for majority of the characters.

Analysis of variance for combining ability (Table 2) revealed that the mean squares due to gca and sca were significant for all the characters in both the seasons indicating importance of both additive and non-additive type of gene effects for the expression of all the characters studied. However, the genetic variance due to ó^{2}sca was of higher magnitude than that of ó^{2}gca for all the characters in both the seasons indicating the predominance of non-additive gene action in controlling these characters. These results are in accordance with the earlier reports of Hooda *et al.* (1978), Gopalan and Sree Rangasamy (1989), Quendeba *et al.* (1996), Rathore *et al.* (2004), Shanmuganathan *et al.* (2005), Rohitashwa *et al.* (2006), Kumar and Singhania (2007) and Suthamathi *et al.* (2007).

The gca estimates for forage yield and yield contributing characters in pearl millet (Table 3) indicated that none of the parents showed significant and desirable gca effects for all the characters in both the seasons. However, Giant bajra, RHRB-282 and PMFT-904 were good general combiners for majority of the characters. Among the parents, Giant bajra displayed significant gca effects in desirable direction for characters viz., plant

TABLE 1
Combined analysis of variance in **kharif** 2009 (E_1) and summer 2010 (E_2) for 10 characters in a 8 x 8 diallel set of pearl millet

S. No.	Characters	Season	Mean sum of squares (MSS)				
			Treatments	Parents	Hybrids	Parents vs. Hybrids	Error
		d. f.	35	7	27	1	70
1.	Days to 50% flowering	E_1	32.86**	29.42**	23.33**	313.97**	1.64
		E_2	51.53**	50.47**	37.20**	445.79**	1.80
2.	Plant height (cm)	E_1	822.48**	7493.98**	697.41**	4706.76**	24.41
		E_2	747.98**	1647.36**	541.24**	34.23	23.51
3.	No. of tillers/plant	E_1	0.72**	0.59	0.75	0.70	0.50
		E_2	0.23**	0.40**	0.19**	0.03	0.02
4.	No. of leaves/plant	E_1	1.55**	1.85**	1.44**	2.19**	0.18
		E_2	1.17**	3.59**	0.44**	3.89**	0.17
5.	Leaf area (cm^2)	E_1	3307.63**	6253.70**	2595.57**	1910.74**	108.63
		E_2	2318.92**	6942.90**	1001.65**	5517.30**	124.53
6.	Green forage yield (q/ha)	E_1	27948.01**	22033.18**	26327.95**	113093.39**	2789.77
		E_2	26622.41**	42253.60**	21717.42**	49638.87**	2118.15
7.	Dry matter yield (q/ha)	E_1	1587.37**	1616.92**	1486.38**	4107.48**	118.07
		E_2	889.80**	1648.85**	672.57**	1441.54**	100.07
8.	Crude protein (%)	E_1	1.83**	2.20**	1.60**	6.57**	0.22
		E_2	1.15**	1.01*	0.90**	8.98**	0.35
9.	Oxalic acid (%)	E_1	0.07**	0.01	0.08**	0.18**	0.01
		E_2	0.05**	0.05*	0.04*	0.37**	0.02
10.	IVDMD (%)	E_1	7.88**	5.63**	8.63**	0.001	0.89
		E_2	4.76**	5.07**	4.43**	6.10*	1.52

*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 2

Combining ability ANOVA for 10 characters of pearl millet in **kharif** 2009 (E_1) and summer 2010 (E_2) seasons

Character	Mean sum of squares (MSS)											
	Kharif 2008 (E_1)						Summer 2009 (E_2)					
	gca	sca	Error	σ^2gca	σ^2sca	σ^2gca/σ^2sca	gca	sca	Error	σ^2gca	σ^2sca	σ^2gca/σ^2sca
d. f.	7	28	70				7	28	70			
Days to 50% flowering	26.91**	6.96**	0.55	2.64	6.41	0.41	39.25**	11.66**	0.60	3.86	11.05	0.35
Plant height (cm)	672.11**	174.67**	8.14	66.40	166.53	0.40	820.27**	106.59**	7.84	81.24	98.75	0.82
No. of tillers/plant	0.31*	0.22*	0.09	0.02	0.10	0.18	0.16**	0.06**	0.01	0.01	0.05	0.32
No. of leaves/plant	0.50**	0.52**	0.06	0.04	0.46	0.10	1.61**	0.20**	0.05	0.11	0.41	0.78
Leaf area (cm^2)	2518.30**	748.60**	36.21	248.21	712.03	0.35	2636.33**	307.13**	41.51	259.48	265.63	0.98
Green forage yield (q/ha)	19381.16*	6799.72**	929.90	1845.14	5869.79	0.31	25515.88*	4713.70**	706.0	2480.98	4007.65	0.62
Dry matter yield (q/ha)	1120.18**	381.36**	39.56	108.08	342.00	0.32	551.65**	232.84**	33.36	51.83	199.48	0.26
Crude protein (%)	0.93**	0.53**	0.07	0.08	0.46	0.19	0.44**	0.37**	0.11	0.03	0.25	0.12
Oxalic acid (%)	0.03**	0.02**	0.005	0.002	0.016	0.13	0.03**	0.01*	0.007	0.002	0.007	0.29
IVDMD (%)	2.88**	4.15**	0.44	0.24	3.70	0.06	2.33*	2.39**	0.76	0.16	1.63	0.10

*,**Significant at P=0.05 and P=0.01 levels, respectively.

TABLE 3

General combining ability effects (gca) of eight parents for different characters of pearl millet in **kharif** 2009 (E_1) and summer 2010 (E_2)

S. No.	Parents	Env.	Days to 50% flowering	Plant height (cm)	No. of tillers/ plant	No. of leaves/ plant	Leaf area (cm^2)	Green fodder yield (q/ha)	Dry matter yield (q/ha)	Crude protein (%)	Oxalic acid (%)	IVDMD (%)
1.	Giant Bajra	E_1	2.65**	10.76**	0.01	0.42**	23.72**	45.88**	7.91**	0.36**	-0.03	0.98**
		E_2	2.83**	17.31**	0.12**	0.76**	36.66**	69.54**	9.60**	0.07	-0.08**	0.48
2.	PMFT-904	E_1	-0.92**	- 9.06**	0.11	-0.18**	-0.61	-27.33**	- 8.28**	0.14	-0.02	-0.22
		E_2	-0.47*	-5.60**	-0.05	0.08	-1.55	8.56	3.23*	0.10	-0.03	0.38
3.	PMFT-905	E_1	0.05	6.25**	0.22*	0.09	12.75**	33.52**	10.36**	0.14	0.01	0.02
		E_2	-1.73**	4.16**	-0.01	-0.12	-7.30**	-70.20**	-10.40**	-0.01	0.00	0.42
4.	PMFT-907	E_1	-1.12**	1.27	-0.14	0.05	3.37	-5.19	-4.23*	0.05	-0.02	-0.69**
		E_2	-2.13**	-2.23**	-0.04	-0.20**	-6.63**	16.08*	0.07	-0.11	0.03	-0.37
5.	RHRB-259	E_1	-2.25**	- 7.92**	-0.12	-0.22**	-14.87**	-36.19**	-10.90**	-0.24**	0.03	-0.19
		E_2	-2.13**	-13.94**	-0.11**	-0.37**	-13.87**	-69.10**	-11.60**	0.03	-0.02	-0.72**
6.	RHRB-260	E_1	-0.72**	-10.53**	-0.30**	-0.24**	-27.59**	-67.57**	-13.40**	-0.20*	0.07**	0.15
		E_2	-0.10	-3.94**	-0.19**	-0.18**	-12.90**	21.10**	0.04	-0.15	0.04*	-0.50
7.	RHRB-282	E_1	0.28	7.41**	0.06	0.15*	-2.78**	60.62**	14.55**	0.31**	-0.09**	0.46*
		E_2	1.60**	3.16**	0.11**	0.04	-0.92	46.35**	4.41*	0.39**	-0.09**	0.40
8.	RHRB-278	E_1	2.02**	1.84*	0.17	-0.07	6.01**	-3.75	4.05*	-0.54**	0.05*	-0.50*
		E_2	2.13**	1.08	0.18**	0.01	6.52**	19.86**	4.65**	-0.32**	0.08	-0.10
	SE±	E_1	0.22	0.84	0.10	0.07	1.77	9.02	1.85	0.08	0.02	0.20
		E_2	0.23	0.83	0.03	0.07	1.90	7.85	1.70	0.10	0.02	0.26

*,**Significant at P=0.05 and P=0.01 levels, respectively.

height, leaf area, green forage yield and dry matter yield in both the seasons, while for IVDMD in **kharif** and number of leaves and oxalic acid in summer season. The parent RHRB-282 showed high significant desirable gca effects for plant height, green forage yield, dry matter yield, crude protein, crude fibre and oxalic acid in both the seasons. Similarly, parent PMFT-905 had significant desirable gca effect for plant height, number of tillers, leaf area, green forage yield and dry matter yield in **kharif** season. The parents, PMFT-904, RHRB-259 and RHRB-260 showed significant and negative gca for days to 50 per cent flowering. Similarly, parent RHRB-278 showed significant and positive heterosis for plant height, leaf area and dry matter yield in both the seasons.

It was observed that the parents who were high performing were also good general combiners for respective characters. In present investigation, the results revealed that the parents Giant bajra, RHRB-282 and RHRB-278 had relatively high degree of correspondence between *per se* performance and their gca effects for almost all the characters, which could be ascribed to predominant role of additive and additive x additive gene action for inheritance of these traits. Therefore, in selection of parents for hybridization due weightage should be given to *per se* performance along with their gca effects.

The top ranking crosses based on significant sca effects for green forage yield in both the seasons are given in Table 4 (**kharif**) and Table 5 (summer). Most of the crosses with high sca effects in both the seasons were associated with high *per se* performance. The cross Giant bajra x RHRB-282 exhibited high significant sca effect coupled with high mean performance for green forage yield and other four yield contributing characters viz., days to 50 per cent flowering, plant height, leaf area and dry matter yield in **kharif** 2008. This cross combination was derived from the parents having good x good combining ability. Similarly, the cross combinations viz., Giant bajra x PMFT-905, PMFT-907 x RHRB-278, PMFT-904 x RHRB-282 and PMFT-905 x PMFT-907 in **kharif** 2008; PMFT-907 x RHRB-278, Giant bajra x RHRB-260 and PMFT-905 x PMFT-907 in summer 2009 exhibited significant effect for green forage yield and most of the yield contributing and quality characters. One or both the parents involved in these combinations was average or good combiners.

The cross combination viz., RHRB-259 x RHRB-259 of low x low performing parents also exhibited high positive and significant sca effect for green forage yield and other most of the yield contributing and quality traits in both the seasons. The significant sca effects for forage yield and its components were also observed earlier by Rathore *et al.* (2004), Shanumuganathan *et al.* (2005) and Kumar and Singhania (2007).

The crosses with high sca effects as well as *per se* performance having at least one or both parents as good general combiner for green forage yield would yield desirable transgressive segregants in later generations, if additive genetic system present in good general combiner and the complementary epistatic effects in F_1 act in same direction to maximize the desirable plant attributes. Some crosses showed poor sca effect even though they involved good x good general combiners. Such results are feasible due to lack of genetic diversity between the two parents involved. The results indicate that high general combiners for various traits may be included in a multiple crossing programme and desirable segregants in early generation may be subjected to biparental mating for the accumulation of favourable genes for various forage yield and quality traits.

Fifteen and thirteen crosses in **kharif** and summer seasons, respectively, displayed significant positive heterosis over mid parent. While only 10 and 5 crosses in **kharif** and summer seasons, respectively, displayed significant positive heterosis over better parent for green forage yield. Among them, the highest magnitude of significant and positive heterosis over mid parent and better parent was exhibited by PMFT-907 x RHRB-278 in **kharif** and RHRB-259 x RHRB-260 in summer season. The high positive heterosis for green forage yield was also reported by Pachade (2006), Patel *et al.* (2008) and Vagudiya *et al.* (2010).

The top ranking crosses on the basis of their *per se* performance, sca effects, relative heterosis and heterobeltiosis for green forage yield and yield contributing characters in **kharif** and Summer seasons (Tables 4 and 5, respectively) displayed difference in their ranking, which suggested that crosses exhibiting high sca effects would not necessarily give either highest mean value or high heterotic effect and *vice versa*.

The information obtained from the study clearly indicated that, for green forage yield, the cross combinations viz., Giant bajra x RHRB-282, PMFT-907 x RHRB-278, RHRB-259 x RHRB-260, Giant bajra x PMFT-905 and PMFT-905 x PMFT-907 displayed significant and positive sca effects and heterosis over mid and better parent in both the seasons. These crosses

TABLE 4

Best crosses having mean performance, significant specific combiners and heterosis for green forage yield and their performance for other traits in pearl millet during **kharif** 2009 (E_1)

Cross combination	Mean GFY	sca effect	Heterosis (%) over		Significant sca effects in desirable direction to related characters	Heterosis in desirable direction to related characters
			MP	BP		
Giant bajra x RHRB-282	853.90	165.88	35.93	28.88	Days to 50% flowering, plant height, leaf area and dry matter yield	Days to 50% flowering, plant height, leaf area, dry matter yield and crude protein
PMFT-907 x RHRB-278	726.33	153.74	47.70	44.08	No. of leaves, leaf area, dry matter yield, crude protein, oxalic acid and IVDMD (%)	Plant height, number of leaves, dry matter yield, crude protein, oxalic acid and IVDMD (%)
RHRB-259 x RHRB-260	596.70	118.95	38.42	33.64	Plant height, dry matter yield and crude protein	Plant height, number of leaves, dry matter yield and crude protein (%)
Giant bajra x PMFT-905	755.14	94.21	20.33	13.98	Plant height, number of leaves, leaf area, dry matter yield, oxalic acid and IVDMD (%)	Days to 50% flowering, plant height number of leaves, leaf area, dry matter yield, crude protein, oxalic acid and IVDMD (%)
PMFT-904 x RHRB-282	697.53	82.71	30.74	17.46	Days to 50% flowering, leaf width, leaf area, leaf weight, stem weight, L : S ratio, NDF and IVDMD (%)	Days to 50% flowering, plant height, leaf width, leaf area, leaf weight, stem weight, crude protein, NDF and IVDMD (%)
PMFT-904 x RHRB-260	567.08	80.45	27.59	19.83	Leaf area, dry matter yield, and IVDMD (%)	Days to 50% flowering, plant height and dry matter yield
PMFT-904 x RHRB-259	596.70	78.70	29.75	26.09	Plant height, number of leaves, leaf area, dry matter yield, crude protein and oxalic acid (%)	Days to 50% flowering, plant height, number of leaves, dry matter yield and crude protein
PMFT-905x PMFT-907	681.07	71.21	27.06	14.93	Days to 50% flowering, leaf area, dry matter yield, oxalic acid and IVDMD (%)	Days to 50% flowering, plant height, leaf area, dry matter yield, oxalic acid and IVDMD (%)
PMFT-905 x RHRB-282	740.24	65.08	24.87	24.74	Plant height, number of leaves, dry matter yield	Days to 50% flowering, plant height and dry matter yield

TABLE 5

Best crosses having mean performance, significant specific combiners and heterosis for green forage yield and their performance for other traits in pearl millet during summer 2010 (E_2) season

Cross combination	Mean GFY	sca effect	Heterosis (%) over		Significant sca effect in desirable direction to related characters	Heterosis in desirable direction to related characters
			MP	BP		
PMFT-907 x RHRB-278	564.61	87.57	39.54	34.31	No. of tillers, dry matter yield, crude protein, oxalic acid and IVDMD (%)	Days to 50% flowering, dry matter yield, crude protein, oxalic acid and IVDMD (%)
RHRB-259 x RHRB-260	434.15	83.21	56.15	51.80	Days to 50% flowering, plant height, leaf area and dry matter yield	Days to 50% flowering, plant height, number of tillers, leaf area, dry matter yield, crude protein (%)
Giant bajra x RHRB-282	632.82	75.83	15.95	0.34	-	Days to 50% flowering
PMFT-905 x PMFT-907	453.70	66.77	25.18	7.93	Days to 50% flowering, plant height, number of leaves and dry matter yield	Days to 50% flowering, plant height, dry matter yield, crude protein,oxalic acid and IVDMD (%)
PMFT-907 x RHRB-282	560.49	56.97	27.20	13.91	No. of tillers	No. of tillers, crude protein and oxalic acid (%)
RHRB-282 x RHRB-278	556.99	49.68	31.09	20.85	Days to 50% flowering,, plant height and dry matter yield	Days to 50% flowering, plant height and dry matter yield
PMFT-907 x RHRB-282	560.49	56.97	27.20	13.91	No. of tillers	No. of tillers, crude protein and oxalic acid (%)
RHRB-282 x RHRB-278	556.99	49.68	31.09	20.85	Days to 50% flowering,, plant height and dry matter yield	Days to 50% flowering, plant height and dry matter yield

exhibited significant and positive sca effects for at least one or more yield contributing characters. This appeared appropriate as yield being complex character dependent on number of component characters and suitable recombination of genes governing these characters might have produced promising hybrids. The cross combination RHRB-259 x RHRB-260 consisted of poor x poor gca parents for green forage yield and other traits. The poor combining parents are highly responsive to the heterozygosity due to non-additive gene effect.

The crosses with high sca effects as well as *per se* performance having at least one or both parents as good general combiner for green forage yield would yield desirable transgressive segregants in later generations, if additive genetic system present in good general combiner and the complementary epistatic effects in F_1 act in same direction to maximize the desirable plant attributes (Langham, 1961). The results indicate that high general combiners for various traits may be included in a multiple crossing programme and desirable segregants in early generation may be subjected to biparental mating for the accumulation of favourable genes for various forage yield and quality traits.

REFERENCES

Fonesca, S., and F. L. Patterson. 1968 : Hybrid vigour in a seven-parent diallel cross in common winter wheat (*T. aestivum*). *Crop Sci.*, **8** : 85-88.

Gopalan A., and S. R. Sree Rangasamy. 1989 : Studies on the combining ability of forage attributes in pearl millet (*Pennisetum typhoides* L.). *Forage Res.*, **15** : 91-97.

Griffing, B. 1956 : Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Bio. Sci.*, **9** : 484-493.

Hooda, M. S., Solanki, K. R., and C. Kishor. 1978 : Genetics of some forage characters in pearl millet. *Forage Res.*, **4** : 127-131.

Kumar, S. R., and D. L. Singhania. 2007 : Heterosis and combining ability of pearl millet [*Pennisetum glaucum* (L.) R. Br.] hybrids involving diverse CMS lines and restorers. *Res. on Crops*, **8** : 620-624

Langham, D. C. 1961 : The high-low method of improvement. *Crop Sci.*, **1** : 376-378.

Pachade, A. B. 2006 : Genetic analysis in forage bajra [*Pennisetum glaucum* (L.) R. Br.]. Unpublished M. Sc. (Agri.) thesis, MPKV, Rahuri, India.

Patel, K. Y., G. U. Kulkarni, and D. R. Patel. 2008 : Heterosis and combining ability studies for fodder yield and its components in pearl millet. *J. Maharashtra Agric. Univ*., **33** : 9-12.

Quendeba, B., W. W. Hanna, G. Ejeta, W. E. Nyquist, and J. B. Santini. 1996 : Forage yield and digestibility of African pearl millet landraces in diallel with missing cross. *Crop Sci.*, **36** : 1517-1520.

Rathore, V. S., D. L. Singhania, and M. L. Jakhar. 2004 : Combining ability of diverse restorers of pearl millet [*Pennisetum glaucum* (L.) R. Br.] for grain yield and its components. *Indian J. Genet.*, **64** : 239-240.

Rohitashwa, R. V. Singh, and O. P. Khedar. 2006 : Genetic variability for dry fodder yield in pearl millet (*Pennisetum glaucum* L.). *Crop Res.*, **31** : 250-252.

Shanmuganathan, M., A. Gopalan, and K. T. Mohanraj. 2005 : Combining ability analysis of dual purpose pearl millet genotypes. *Intl. Sorghum Millets Newsl.*, **46** : 95-97.

Suthamathi, P., K. Geetha, and P. Sumathi. 2007 : Combining ability studies on quality characters in cumbu napier hybrids. *Indian J. Genet.*, **67** : 203-205.

Vagudiya, K. J., K. K. Dhedhi, H. J. Joshi, A. S. Bhadelia, and H. B. Vekariya. 2010 : Studies on heterosis in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Agric. Res. Commun. Centre J.*, **30** : Online.