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4Research Article

Heterosis and Combining Ability in Pearl Millet

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Abstract

Among the 48 hybrids produced by (4) x tester (12) crossing programme, maximum positive standard heterosis for grain yield per plant over hybrid check, Aadishakti was observed in DHLB-16A x S-16/08 (36.88 %) followed by DHLB-14A x S-16/06 (34.74 %) and DHLB-16A x S-16/07 (26.29 %). The range of standard heterosis over check Aadishakti was -49.28 per cent (DHLB-14A x S-16/10) to 36.88 per cent (DHLB-16A x S-16/08). Among the hybrids with positive significant SCA effects for grain yield, the frequency of good x average combiner was more. Among the top ten hybrids one parent of five hybrids *viz.*, DHLB-16A x S-16/08, DHLB-16A x S-16/07, DHLB-8A x S-16/01, DHLB-8A x S-16/05 and DHLB-16A x S-16/12 found to be good general combiners. Among four females three lines DHLB-16A, DHLB-8A and DHLB-14A and among males S-16/07, S-16/08 and S-16/05 gave top yielding hybrid combinations. Among ten top performing hybrids, three hybrids *viz.*, DHLB-16A x S-16/08, DHLB-14A x S-16/06 and DHLB-16A x S-16/07 exhibited significant favorable heterobeltiosis, standard heterosis, GCA and SCA effects for yield and most of the related traits could be utilized for commercial cultivation after extensive testing in state and national trails.

Key words

Heterosis, Combining ability, GCA, SCA effects, pearl millet.

Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a highly cross-pollinated crop with protogynous flowering and wind borne pollination mechanism, which fulfils one of the essential biological requirements for hybrid development. India is a major producer of pearl millet both in terms of area (7.48 million ha) and production (9.41 million ton), with an average productivity is 1132 kg/ha (Anonymous, 2017). The quantum jump (from 303 kg to 1250 kg/ ha) in the productivity of pearl millet was possible mainly through development of hybrids by the utilization of cytoplasmic genetic male sterility system. Burton (1958) was the first to develop cytoplasmic male sterile line *Tift 23A* bred at Tifton, Georgia, USA. The improvement in pearl millet needs attention for the characters like early flowering, grain yield per plant, ear head length and girth, Fe and Zn content, number of tillers/plant. Keeping these things in view, the present study has been planned with the following objectives, to estimate the heterosis for yield and morpho-nutritional traits and to estimate the general and specific combining ability effects.

Materials and Methods

Forty eight crosses were made in line x tester mating design using four CMS lines as females and twelve testers as males at Bajra Research Scheme, College of Agriculture, Dhule, during summer 2016. The forty eight F_1s were evaluated in a Randomized Block Design, with two replications. The parents and hybrids were sown in two rows of 3 m length adopted of 15 x15cm having 50cm row to row and 15 cm plant to plant, during *Kharif*, 2016. All the agronomical practices and plant protection measures were followed as per recommendation. The observations were recorded on five randomly selected competitive plants in each replications for 48 hybrids and their respective parents and two hybrid checks *viz*., Aadishakti (SC-I) and Pratap (SC-II) on twelve characters *viz*., days to 50 per cent flowering, days to maturity, plant height, number of effective tillers per plant, ear head length(cm), ear head girth(cm), grain yield per plant(g), fodder yield per plant(g), 1000 seed weight(g), number of grains per cm^2, grain Fe content (ppm) and grain Zn content(ppm). For estimation of general and specific combining ability variances the line x tester analysis as outlined by Kempthorne (1957) was followed

Result and discussion:

Earliness is desirable character and helps to develop early maturing varieties. The cross DHLB-15A x S-16/01 recorded maximum negative heterosis over standard check Aadishakti (-13.86) and Pratap (-15.53). The two cross cbinations *viz*., DHLB-15AS-16/1(over SC-I:-11.88 and SC-II: -11.88) and DHLB-14A x S-16/01 (over SC-I: -9.90 and SC-II:-11.65) were also recorded negative heterosis over standard checks. The standard heterosis over checks for days to 50 per cent flowering was ranged from -13.86 (DHLB-15A x S-16/01) to 12.08 per cent (DHLB-16A x S-16/04). This observation might be helpful to isolate early maturing genotypes. Significant negative heterosis for days to 50 per cent flowering in hybrid have also been reported by Kulkarni *et al.,* (1993), Chavan and Nerkar (1994), Patil *et al.*, (1994) and Pachade (2006).

The standard heterosis over checks for days to maturity was ranged from -7.23 to 9.64 (Table 1). The hybrids showed higher magnitude of heterosis in desirable direction for days to maturity were DHLB-14A x S-16/01(-13.48), DHLB-15A x S-16/12 (-12.92) and DHLB-15A x S-16/06 (-9.25). Similar results were observed by Dass *et al.*, (1994), Kulkarni *et al.*, (1993) and Nerkar (1994). Out of the 48 hybrids three hybrids *viz.,* DHLB-15A x S-16/07 (over SC-I: -10.42 and SC-II: -1.93), DHLB-14A x S-16/09 (over SC-I: -9.78 and SC-II: -1.23) and DHLB-16A x S-16/11 (over SC-I: -9.0 and SC-II: -0.37) have shown significantly negative standard heterosis in desirable direction for plant height. The extent of the standard heterosis for palnt height ranged from -10.42 (DHLB-15A x S-16/07) to 11.44 (DHLB-16A x S-16/12). The cross DHLB-15A x S-16/07 recorded maximum negative hetrosis for plant height over standard check Aadishakti (-10.42 %). The results were in agreement with those of Chavan and Nerkar (1994), Patil *et al.*, (1994) and Patel *et al.*, (2008).

Effective tillers per plant is one of the important yield attributes and positive heterosis is desirable, the extent standard heterosis for number of effective tillers per plant ranged from -8.33 to 58.33 %. The hybrids DHLB-8A x S-16/10, DHLB-14A x S-16/08 and DHLB-15A x S-16/12 were exhibited significant high heterotic combinations for number of effective tillers per plant. The present result reported similarly by Kulkarni *et al.,* (1993), Pachade (2006) and Davada *et al.*, (2008).

For earhead length standard heterosis was ranged from -17.03 to 39.08 per cent. The maximum significant standard heterosis for earhead length was recorded by DHLB- 15A x S-16/11 over standard check Aadishakti (39.08 %) and Pratap (50.54 %), followed by DHLB-8A x S-16/02 and DHLB-14A x S-16/12. The present result reported were in agreement with those of Hapse *et al.*, (1986) and Chavan and Nerkar (1994).

The maximum positive standard heterosis for earhead girth over hybrid check Aadishakti was observed in DHLB-14A x S-16/05 (15.48 %) followed by DHLB-8A x S-16/01 (13.39 %). The range of standard heterosis was -15.90 (DHLB-15A x S-16/05) to 15.48 (DHLB-14A x S-16/05) over standard checks Aadishakti and Pratap. Bhamre (1986) and Chavan and Nerkar (1994) also found varied range of heterosis for earhead girth.

The hybrids having significant heterosis for grain yield per plant also had significant heterosis for one or more other morpho-nutritional characters, for which hybrid DHLB-16A x S-16/08 (36.88 % over hybrid check Aadishakti) and DHLB-14A x S-16/06 (34.74 % over hybrid check Aadishakti) showed very high percentage of heterosis also exhibited for three (days to 50 % flowering, fodder yield per plant and 1000 grain weight) and four (days to 50 % flowering, days to maturity,fodder yield per plant and 1000 grain weight) other characters, respectively. The range of standard heterosis for grain yield per plant was ranged from -49.98 % to 39.88 % and out of forty eight hybrids forty hybrids exhibited desirable significant heterosis over better parent. These results were in agreement to those studies conducted by Patil *et al.*, (1994), Vaghashiya *et al.*, (2009), Vagadiya *et al.,* (2010) and Thakare *et al*., (2014).

The range of standard heterosis for fodder yield per plant (g) was ranged from -38.44 (DHLB-15A x S-16/07) to 21.70 % (DHLB-16A x S-16/08) over check Aadishakti. The maximum positive standard heterosis for fodder yield per plant (g) recorded by DHLB-16A x S-16/08 over standard check Aadishakti (21.70 %) and Pratap (68.72 %). The maximum positive standard heterosis was recorded for 1000 grain weight by the hybrid RHRB-16A x S-16/02 over hybrid check Aadishakti (33.26 %) and Pratap (30.19 %) followed by DHLB-8A X S-16/02(over SC-I:-32.97 and SC-II:29.91).

The range of standard heterosis for number of grains per cm^2 was ranged from -27.30 (DHLB-16A x S-16/02) to 20.10 % (DHLB-14A x S-16/09) over hybrid Aadishakti. The maximum heterosis for number of grains per cm^2 was recorded by DHLB-14A x S-16/09 over standard check Aadishakti (20.10 %) and Pratap (18.29 %). For grain Fe content the maximum positive significant standard heterosis was recorded in hybrids DHLB-8A x S-16/04(over SC-I:27.78 and SC-II:84.0), DHLB-15A x S-16/10(over SC-I:20.83 and SC-II:74.00) and DHLB-16A x S-16/06(over SC-I:13.89 and SC-II:64.00) over standard check Aadishakti and Pratap whereas for grain Zn content the maximum positive significant standard heterosis was recorded in three hybrids *viz*., DHLB-8A x S-16/08(over SC-I:17.65 and SC-II:21.21), DHLB-8A x S-16/03(over SC-I:14.71 and SC-II:18.18) and DHLB-8A x S-16/02 (over SC-I:11.76 and SC-II:15.15)over standard check Aadishakti and Pratap.

Hybrids with positive and significant SCA effects (Table 2) for grain yield were produced by almost all type of parental combinations (good x good, good x average, good x poor, average x good, average x average, poor x poor). The crosses with high SCA effects were in general combinations of parents with good x good, good x poor and good x average or average x poor GCA effects. This was represented in best three hybrids for grain yield per plant *viz.*, DHLB-16A x S-16/08 (good x average) and DHLB-14A x S-16/06 (average x average) and DHLB-16A x S-16/07 (good x average) had significant desired SCA effects and significant heterotic response over better parent as well as all over two standard checks while the frequency of good x average was more. Among top 10 hybrids, five hybrids *viz.*, DHLB-16A x S-16/08, DHLB-16A X S-16/07, DHLB-8A x S-16/01, DHLB-8A x S-16/05 and DHLB-16A x S-16/12 exhibited one of their parent found to be good general combiner (Table 3). Ingale (1999), Hapse (1989), Rasal (1992) and Thakare *et al*., (2014) reported presence of at least one or average general combiner for high SCA effects in most of the traits.

The high yield potential in cross combination (high X low) might be attributed due to good combiner while heterosis involved in high x high combiners involved interaction between positive x positive effects. Magnitude of heterosis expressed by hybrids varied between crosses and both positive as well as negative heterosis were expressed by different hybrids for various characters. In present investigation the performance of hybrids *viz.*, DHLB-16A x S-16/08, DHLB-14A x S-16/06 and DHLB-16A x S-16/07 had recorded more than the 50 per cent heterosis over both hybrids standard checks Aadishakti and Pratap and showed positive significant SCA effects for grain yield per ha, therefore these combinations are economically viable to exploit commercially. Similar by Sashi *et al.*, (2001), Unnikrishnan *et al.*, (2004), Sushir *et al.*, (2005) and Thakare *et al*., (2014).

Among the the female parents DHLB-16A, DHLB-8A and DHLB-14A and among males S-16/07, S-16/08 and S-16/05 gave top yielding hybrid combinations. In the present study, among top ten hybrid combinations three hybrids *viz.*, DHLB-16A x S-16/08, DHLB-14A x S-16/06 and DHLB-16A x S-16/07 were exhibited significant favorable heterobeltiosis, standard heterosis, GCA and SCA effects for grain yield and most of the components and quality traits, could be utilized for commercial cultivation after extensive testing in state and national trials.

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Table 1. Range of standard heterosis for yield, its components and quality and number of hybrids exhibiting significant heterosis.

SI. No	Characters	Range %	SE I	No. of hybrids showing desirable significant heterosis over			
				M. P.	B. P.	Aadishakti	Pratap
1	Days to 50 % flowering	-13.86 to 12.08	1.26	13	1	-	3
2	Days to maturity	-7.23 to 9.64	2.36	26	-	-	23
3	Plant height (cm)	-10.42 to 11.44	6.33	-	2	25	19
4	Number of effective tillers per plant	-8.33 to 58.33	0.07	13	4	20	2
5	Ear head length (cm)	-17.03 to 39.08	1.28	41	13	13	22
6	Ear head girth (cm)	-15.90 to 15.48	0.47	15	7	3	6
7	Grain yield per plant (g)	-49.98 to 39.88	4.65	46	40	3	20
8	Fodder yield per plant (g)	-38.44 to 21.70	5.19	48	43	1	17
9	1000 grain weight (g)	-20.96 to 33.26	0.47	34	24	12	11
10	Number of grains per cm^2	-27.30 to 20.10	0.84	22	12	3	2
11	Grain Fe content (ppm)	-30.56 to 27.78	2.1	7	1	5	41
12	Grain Zn content (ppm)	-17.65 to 17.65	1.19	4	1	10	15

Table 2. Three best performing cross combinations, their GCA effects, SCA effects, heterobeltiosis and standard heterosis for various traits in Pearl millet.

Characters	Best performing hybrids	GCA effects P1 P2	SCA effects	Heterobeltiosis (%)	Standard heterosis over checks	
					Aadishakti	Pratap
Days to 50 % flowering	DHLB-15A x S-16/01	G x G	-3.11*	-16.35**	-13.86*	-15.53**
	DHLB-14A x S-16/01	A x G	-3.11*	-18.02**	-9.90*	-11.65**
	DHLB-15A x S-16/12	G x G	-3.86**	-20.54**	-11.88**	-13.59**
Days to maturity	DHLB-14A x S-16/01	A x A	-5.67*	-13.48**	-7.23	-8.88*
	DHLB-15A x S-16/12	G x A	-3.88	-12.92**	-6.63	-8.28*
	DHLB-15A x S-16/06	G x A	-1.76	-9.25*	-5.42	-7.10
Plant height (cm)	DHLB-15A x S-16/07	G x G	-6.81	28.29**	-10.42*	-1.93
	DHLB-14A x S-16/09	A x G	-11.14	2.50	-9.78*	-1.23
	DHLB-16A x S-16/11	P x G	-16.02*	7.57	-9.00*	-0.37
Number of effective tillers per plant	DHLB-8A x S-16/10	P x G	0.52**	35.71**	58.33**	46.15**
	DHLB-14A x S-16/08	G x A	0.55**	26.67**	58.33*	46.15**
	DHLB-15A x S-16/12	G x A	0.38	20.00**	50.00**.	38.46**
Ear head length (cm)	DHLB-15A x S-16/11	A x G	4.58**	26.89**	39.08**	50.24**
	DHLB-8A x S-16/02	A x G	3.08*	29.98**	32.53**	43.16**
	DHLB-14A x S-16/12	A x A	4.42**	36.09**	29.26**	39.62**
Ear head girth (cm)	DHLB-14A x S-16/05	A x A	1.90**	20.00**	15.48**	17.95**
	DHLB-8A x S-16/01	A x A	1.11*	20.44**	13.39*	15.81**

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	DHLB-8A x S-16/02	A x G	0.65	13.98*	12.55*	14.96*
Grain yield per plant (g)	DHLB-16A x S-16/08	G x A	11.34*	146.75**	36.88**	75.88**
	DHLB-14A x S-16/06	A x A	20.66**	150.09**	34.74**	73.13**
	DHLB-16A x S-16/07	G x A	11.87*	140.04**	26.29*	62.27**
Fodder yield per plant (g)	DHLB-16A x S-16/08	G x A	12.23*	138.10**	21.7*	68.72**
	DHLB-16A x S-16/07	G x A	14.86**	140.60**	17.52	62.94**
	DHLB-16A x S-16/05	G x A	6.20	110.98**	10.63	53.37**
1000 grain weight (g)	DHLB-16A x S-16/02	G x G	1.16*	20.83**	33.26**	30.19**
	DHLB-8A x S-16/02	A x G	2.11**	20.57**	32.97**	29.91**
	DHLB-16A x S-16/08	G x G	1.41**	38.28**	29.98**	26.99**
Number of grains per cm^2	DHLB-14A x S-16/09	A x G	2.57**	27.93**	20.10**	18.29**
	DHLB-8A x S-16/10	A x A	3.05**	12.81*	14.54*	12.81*
	DHLB-15A x S-16/07	A x A	2.42**	35.64**	12.81*	11.11
Grain Fe content (ppm)	DHLB-8A x S-16/04	A x A	23.62**	2.22	27.78**	84.00**.
	DHLB-15A x S-16/10	G x G	12.45**	-1.14	20.83**	74.00**
	DHLB-16A x S-16/06	A x A	13.79**	-9.89**	13.89**	64.00**
Grain Zn content (ppm)	DHLB-8A x S-16/08	G x G	2.56**	-2.44	17.65**	21.21**
	DHLB-8A x S-16/03	G x G	1.56	-4.88	14.71**	18.18**
	DHLB-8A x S-16/02	G x G	0.81	-7.32*	11.76**	15.15**

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Table 3.Performance of the hybrids in relation to *per se* values, heterosis and Combining ability for grain yield per plant (g) and other characters

SI. No.	Hybrids	*Per se* values for		Desirable heterosis for grain yield per plant (g)		sca effects for		gca combination for grain yield per plant	Useful and significant for components traits hetrobeltiosis
		grain yield per plant (g)	total no. of traits	SC (%) (Aadishakti)	BP (%)	grain yield per plant (g)	Useful and significant for components traits		
1	DHLB-16A x S-16/08	70.30	7	36.88**	146.75**	11.34**	GY/P, FY/P, 1000 GW	G x A	D 50 % F, GY/P, FY/P,1000 GW
2	DHLB-14A x S-16/06	69.20	7	34.74**	150.09**	20.66*	GY/P, FY/P, 1000 GW	A x A	D 50 % F, DM, GY/P, FY/P,1000 GW
3	DHLB-16A x S-16/07	64.86	7	26.29**	140.04**	11.87**	GY/P, FY/P, Fe C	G x A	D 50 % F, DM, GY/P, FY/P
4	DHLB-8A x S-16/01	64.38	7	25.35	128.78**	9.33	EHG	G x A	EHG, GY/P, FY/P
5	DHLB-8Ax S-16/05	63.24	7	23.13	124.73**	5.85	1000 GW	G x A	GY/P, FY/P,1000 GW, No. G/CM^2
6	DHLB-16A x S-16/12	61.22	5	19.20	94.35**	7.81	-	G x A	D 50 % F, GY/P, FY/P
7	DHLB-16A x S-16/05	61.00	6	18.77	121.66**	3.69	Fe C	G x A	GY/P, FY/P
8	DHLB-8A x S-16/02	59.30	7	15.46	100.27**	2.35	EHL, 1000 GW	G x A	D 50 % F, EHL, EHG, GY/P, FY/P,1000 GW
9	DHLB-8Ax S-16/04	58.84	8	14.46	109.10**	4.47	DM, Fe C	G x A	D 50 % F, DM, EHL, EHG, GY/P, FY/P
10	DHLB-8A x S-16/10	57.86	8	12.85	105.97**	9.51	ET, GY/P, No. G/CM^2	G x P	D 50 % F, DM, ET , GY/P, FY/P, No. G/CM^2

*, ** denote significant at 5% and 1% levels, respectively; G= Good parent having significant gca effects in desired direction; A= Average parent having either positive or negative but non-significant gca effects; P= Poor parent having significant gca effects in undesired direction.

D 50 % F	:	Days to 50 per cent flowering	DM	:	Days to maturity
PLH	:	Plant height (cm)	ET	:	Number of effective tillers per plant
EHL	:	Earhead length (cm)	EHG	:	Earhead girth (cm)
GY/P	:	Grain yield per plant (g)	FY/P	:	Fodder yield per plant (g)
1000 GW	:	1000 grain weight (g)	No. G/CM^2	:	Number of grains per cm^2
Fe C	:	Grain Fe content (ppm)	Zn C	:	Grain Zn content (ppm)

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Table 4. Heterosis for different traits in pearl millet.

	Hybrids/crosses	Days to 50% flowering				Days to maturity				Plant height (cm)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
1	**DHLB-8A** x S-16/01	2.35	0.00	7.92*	5.83	-1.17	-2.87	1.81	0.00	21.43**	8.37	1.96	11.62*
2	8A x S-16/02	-6.36*	-7.21*	1.98	0.00	-1.99	-2.82	3.61	1.78	23.82**	10.50*	3.96	13.81**
3	8A x S-16/03	-12.33**	-12.73**	-4.95	-6.80	-3.41	-4.49	2.41	0.59	20.20**	6.37	2.00	11.67*
4	8A x S-16/04	-8.62**	-13.82**	4.95	2.91	-8.89**	-11.83**	-1.20	-2.96	32.88**	24.27**	5.43	15.42**
5	8A x S-16/05	-0.91	-1.80	7.92*	5.83	0.00	-1.67	6.63	4.73	20.84**	10.83*	-1.91	7.39
6	8A x S-16/06	-7.48*	-9.17**	-1.98	-3.88	4.32	4.02	9.04*	7.10	32.31**	21.04**	7.73	17.93**
7	8A x S-16/07	-10.00**	-10.81**	-1.98	-3.88	-4.84	-5.65	0.60	-1.18	31.38**	27.81**	-5.62	3.32
8	8A x S-16/08	-4.50	-6.19	4.95	2.91	-1.98	-3.35	4.22	2.37	25.38**	16.97**	-0.24	9.21
9	8A x S-16/09	-11.69**	-16.39**	0.99	-0.97	-1.12	-3.80	6.63	4.73	26.59**	16.39**	2.44	12.15*
10	8A x S-16/10	-6.22*	-10.09**	-2.97	-4.85	-5.88	-8.05*	-3.61	-5.33	22.12**	12.20*	-1.08	8.30
11	8A x S-16/11	-7.98**	-10.09**	-2.97	-4.85	-5.23	-6.32	-1.81	-3.55	23.46**	15.61**	-2.20	7.07
12	8A x S-16/12	-7.69**	-8.93**	0.99	-0.97	-2.84	-3.93	3.01	1.18	13.66**	1.08	-4.16	4.93
13	**DHLB-14A**x S-16/01	-15.35**	-18.02**	-9.90*	-11.65**	-10.98**	-13.48**	-7.23	-8.88*	35.91**	16.84**	9.93*	20.34**
14	14A x S-16/02	-9.91**	-9.91**	-0.99	-2.91	-6.48	-6.74	0.00	-1.78	20.98**	4.00	-2.15	7.12
15	14A x S-16/03	-8.60**	-9.01**	0.00	-1.94	-5.62	-5.62	1.20	-0.59	35.45**	15.53**	10.78*	21.28**
16	14A x S-16/04	-10.26**	-14.63**	3.96	1.94	-6.04	-8.06*	3.01	1.18	45.05**	30.37**	10.61*	21.09**
17	14A x S-16/05	-5.41	-5.41	3.96	1.94	-4.47	-5.00	3.01	1.18	30.62**	15.25**	2.00	11.67*
18	14A x S-16/06	-6.48*	-9.01**	0.00	-1.94	-7.69*	-8.99*	-2.41	-4.14	28.96**	13.52**	1.03	10.60*
19	14A x S-16/07	-12.61**	-12.61**	-3.96	-5.83	-2.54	-2.81	4.22	2.37	38.34**	36.20**	-4.89	4.12
20	14A x S-16/08	-8.93**	-9.73**	0.99	-0.97	-4.76	-5.03	2.41	0.59	19.76**	7.40	-8.41	0.27
21	14A x S-16/09	-5.58*	-9.84**	8.91*	6.80	0.55	-1.09	9.64*	7.69	15.89**	2.50	-9.78*	-1.23
22	14A x S-16/10	-10.90**	-15.32**	-6.93	-8.74*	-4.65	-7.87*	-1.20	-2.96	22.18**	7.99	-4.79	4.23
23	14A x S-16/11	-10.70**	-13.51**	-4.95	-6.80	-6.32	-8.43*	-1.81	-3.55	34.10**	20.69**	2.10	11.78*
24	14A x S-16/12	-1.35	-1.79	8.91*	6.80	-1.12	-1.12	6.02	4.14	20.79**	3.51	-1.86	7.44

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Table 4 cont…..

	Hybrids/crosses	Days to 50% flowering				Days to maturity				Plant height (cm)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
25	**DHLB-15A** x S-16/01	-14.29**	-16.35**	-13.86*	-15.53**	-3.64	-5.36	-4.22	-5.92	28.76**	5.77	-0.49	8.94
26	15A x S-16/02	-9.52**	-14.41**	-5.94	-7.77*	-4.42	-8.47*	-2.41	-4.14	26.54**	3.95	-2.20	7.07
27	15A x S-16/03	-8.13**	-12.73**	-4.95	-6.80	-4.12	-8.43*	-1.81	-3.55	36.71**	11.47*	6.89	17.02**
28	15A x S-16/04	-10.81**	-19.51**	-1.98	-3.88	-2.87	-9.14*	1.81	0.00	36.94**	17.29**	-0.49	8.94
29	15A x S-16/05	-4.76	-9.91**	-0.99	-2.91	-5.26	-10.00*	-2.41	-4.14	33.84**	12.65*	-0.29	9.15
30	15A x S-16/06	-7.84*	-10.48**	-6.93	-8.74*	-6.27	-9.25*	-5.42	-7.10	32.16**	10.99*	-1.22	8.14
31	15A x S-16/07	-2.86	-8.11*	0.99	-0.97	-4.42	-8.47*	-2.41	-4.14	37.49**	28.29**	-10.42*	-1.93
32	15A x S-16/08	-9.43**	-15.04**	-4.95	-6.80	-7.33*	-11.73**	-4.82	-6.51	28.61**	9.92	-6.26	2.62
33	15A x S-16/09	-4.07	-13.11**	4.95	2.91	-0.58	-6.52	3.61	1.78	24.07**	4.67	-7.87	0.86
34	15A x S-16/10	-5.53	-6.00	-6.93	-8.74*	-3.05	-4.22	-4.22	-5.92	25.26**	5.60	-6.89	1.93
35	15A x S-16/11	4.43	1.92	4.95	2.91	3.61	1.18	3.61	1.78	27.60**	9.42	-7.43	1.34
36	15A x S-16/12	-15.64**	-20.54**	-11.88**	-13.59**	-8.82*	-12.92**	-6.63	-8.28*	25.50**	2.78	-2.54	6.69
37	**DHLB-16A**x S-16/01	-2.42	-2.88	0.00	-1.94	4.76	4.76	6.02	4.14	29.55**	12.01*	5.38	15.36**
38	16A x S-16/02	-6.54*	-9.91**	-0.99	-2.91	-3.77	-6.21	0.00	-1.78	34.24**	16.06**	9.19*	19.54**
39	16A x S-16/03	-4.23	-7.27*	0.99	-0.97	-2.31	-5.06	1.81	0.00	23.90**	6.27	1.91	11.56*
40	16A x S-16/04	0.18	-7.97**	12.08**	9.90**	1.13	-3.76	7.83	5.92	33.97**	21.15**	2.79	12.53*
41	16A x S-16/05	-1.87	-5.41	3.96	1.94	0.57	-2.78	5.42	3.55	30.03**	15.41**	2.15	11.83*
42	16A x S-16/06	-3.85	-4.76	-0.99	-2.91	-4.99	-6.36	-2.41	-4.14	25.41**	11.04*	-1.17	8.19
43	16A x S-16/07	-8.41**	-11.71**	-2.97	-4.85	-7.83*	-10.17*	-4.22	-5.92	54.15**	52.8**	6.70	16.81**
44	16A x S-16/08	-5.56	-9.73**	0.99	-0.97	-2.59	-5.59	1.81	0.00	37.02*	23.62**	5.43	15.42**
45	16A x S-16/09	-4.00	-11.48**	6.93	4.85	-5.11	-9.24*	0.60	-1.18	24.38**	10.67*	-2.59	6.64
46	16A x S-16/10	-4.43	-5.83	-3.96	-5.83	-2.40	-2.98	-1.81	-3.55	35.93**	20.85**	6.55	16.65**
47	16A x S-16/11	3.38	2.88	5.94	3.88	1.18	0.59	3.01	1.18	18.80**	7.57	-9.00*	-0.37
48	16A x S-16/12	-6.05*	-9.82**	0.00	-1.94	-2.31	-5.06	1.81	0.00	36.39**	17.53**	11.44*	22.00**
CD at 5 %		3.12	3.60	3.60	3.60	5.87	6.78	6.78	6.78	15.83	18.27	18.27	18.27
CD at 1 %		4.16	4.81	4.81	4.81	7.83	9.04	9.05	9.04	21.12	24.39	24.39	24.39

*, ** denotes level of significance at 5% and 1 %, respectively and SC-I-Aadishakti, SC-II-Pratap.

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Table 4 cont…..

	Hybrids/crosses	No. of effective tillers /plant				Ear head length (cm)				Ear head girth (cm)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
1	**DHLB-8A** x S-16/01	-17.24**	-20.00**	0.00	-7.69	18.74*	8.39	7.21	15.80	24.31**	20.44**	13.39*	15.81**
2	8A x S-16/02	-21.43**	-21.43**	-8.33	-15.38	44.35**	29.98**	32.53**	43.16**	20.36**	13.98*	12.55*	14.96*
3	8A x S-16/03	-17.24**	-20.00**	0.00	-7.69	20.63**	10.22	8.78	17.50*	7.56	1.26	1.26	3.42
4	8A x S-16/04	-17.24**	-20.00**	0.00	-7.69	26.55**	22.14*	7.21	15.80	21.24**	20.38**	6.28	8.55
5	8A x S-16/05	-17.24**	-20.00**	0.00	-7.69	16.59*	4.68	7.42	16.04	16.10**	11.30	7.11	9.40
6	8A x S-16/06	3.45	0.00	25.00**	15.38	22.13**	11.48	10.26	19.10*	11.21*	7.52	1.67	3.85
7	8A x S-16/07	-17.24**	-20.00**	0.00	-7.69	21.15**	13.88	5.68	14.15	3.77	-2.50	-2.09	0.00
8	8A x S-16/08	-21.43**	-21.43**	-8.33	-15.38	35.42**	19.39*	27.73**	37.97**	8.97	-0.78	6.69	8.97
9	8A x S-16/09	-21.43**	-21.43**	-8.33	-15.38	32.10**	16.56*	24.45**	34.43**	9.41	1.63	4.60	6.84
10	8A x S-16/10	35.71**	35.71**	58.33**	46.15**	19.85*	13.03	4.15	12.50	1.13	-3.45	-6.28	-4.27
11	8A x S-16/11	-17.24**	-20.00**	0.00	-7.69	21.46**	5.98	16.16*	25.47**	0.46	-2.24	-8.79	-6.84
12	8A x S-16/12	-14.29*	-14.29	0.00	-7.69	-3.58	-10.34	-14.85	-8.02	-4.98	-9.09	-12.13*	-10.26
13	**DHLB-14A**x S-16/01	6.67	6.67	33.33**	23.08*	16.27*	3.31	2.18	10.38	6.79	4.89	-1.26	0.85
14	14A x S-16/02	-17.24**	-20.00**	0.00	-7.69	30.65**	14.56	16.81*	26.18**	8.61	4.24	2.93	5.13
15	14A x S-16/03	6.67	6.67	33.33**	23.08**	42.29**	26.55**	24.89**	34.91**	7.89	2.93	2.93	5.13
16	14A x S-16/04	-16.67**	-16.67*	4.17	-3.85	25.99**	18.16*	3.71	12.03	12.47*	10.14	0.00	2.14
17	14A x S-16/05	-20.00**	-20**	0.00	-7.69	21.41**	6.17	8.95	17.69*	23.49**	20.00**	15.48**	17.95**
18	14A x S-16/06	-26.67**	-26.67**	-8.33	-15.38	24.97**	11.04	9.83	18.63*	4.74	2.65	-2.93	-0.85
19	14A x S-16/07	-20.00**	-20.00**	0.00	-7.69	19.18*	8.94	1.09	9.20	-0.22	-5.00	-4.60	-2.56
20	14A x S-16/08	31.03**	26.67**	58.33*	46.15**	13.54	-2.45	4.37	12.74	0.00	-7.78	-0.84	1.28
21	14A x S-16/09	-3.45	-6.67	16.67	7.69	5.35	-9.41	-3.28	4.48	4.54	-1.63	1.26	3.42
22	14A x S-16/10	-10.34	-13.33	8.33	0.00	4.13	-4.50	-12.01	-4.95	-2.45	-5.60	-8.37	-6.41
23	14A x S-16/11	-20.00**	-20.00**	0.00	-7.69	25.06**	6.37	16.59*	25.94**	10.45*	8.97	1.67	3.85
24	14A x S-16/12	-10.34	-13.33	8.33	0.00	50.44**	36.09**	29.26**	39.62**	4.46	1.30	-2.09	0.00

Table 4. cont…..

	Hybrids/crosses	No. of effective tillers /plant				Ear head length (cm)				Ear head girth (cm)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
25	**DHLB-15A** x S-16/01	-13.33*	-13.33	8.33	0.00	-0.49	-9.49	-10.48	-3.30	6.91	3.11	-2.93	-0.85
26	15A x S-16/02	-10.34	-13.33	8.33	0.00	15.04*	3.21	5.24	13.68	11.01*	4.66	3.35	5.56
27	15A x S-16/03	-13.33*	-13.33	8.33	0.00	20.78**	9.96	8.52	17.22*	8.48	1.67	1.67	3.85
28	15A x S-16/04	-6.67	-6.67	16.67	7.69	43.34**	37.81**	20.96*	30.66**	17.03**	16.75*	2.09	4.27
29	15A x S-16/05	-13.33*	-13.33	8.33	0.00	35.55**	21.28**	24.45**	34.43**	-8.43	-12.61*	-15.9**	-14.10*
30	15A x S-16/06	-26.67**	-26.67**	-8.33	-15.38	21.12**	10.15	8.95	17.69*	8.05	3.98	-1.67	0.43
31	15A x S-16/07	13.33*	13.33	41.67**	30.77**	17.09*	9.65	1.75	9.91	1.11	-5.42	-5.02	-2.99
32	15A x S-16/08	-24.14**	-26.67**	-8.33	-15.38	14.52*	0.61	7.64	16.27	6.87	-3.11	4.18	6.41
33	15A x S-16/09	-17.24**	-20.00**	0.00	-7.69	17.67*	3.48	10.48	19.34*	14.73**	6.10	9.21	11.54*
34	15A x S-16/10	-3.45	-6.67	16.67	7.69	18.28*	11.14	2.40	10.61	1.59	-3.45	-6.28	-4.27
35	15A x S-16/11	-13.33*	-13.33	8.33	0.00	45.93**	26.89**	39.08**	50.24**	20.37**	16.59**	8.79	11.11
36	15A x S-16/12	24.14**	20.00**	50.00**.	38.46**	40.94**	30.57*	24.02**	33.96**	5.45	0.43	-2.93	-0.85
37	**DHLB-16A**x S-16/01	-17.24**	-20.00**	0.00	-7.69	34.17**	18.32**	17.03*	26.42**	9.58	9.33	2.93	5.13
38	16A x S-16/02	-14.29*	-14.29	0.00	-7.69	27.68**	11.13	13.32	22.41*	9.57	6.78	5.44	7.69
39	16A x S-16/03	-17.24**	-20.00**	0.00	-7.69	22.06**	7.74	6.33	14.86	9.29	5.86	5.86	8.12
40	16A x S-16/04	24.14**	20.00**	50.00**	38.46**	1.60	-5.47	-17.03*	-10.38	-4.17	-7.59	-13.39*	-11.54*
41	16A x S-16/05	-17.24**	-20.00**	0.00	-7.69	19.12*	3.40	6.11	14.62	-0.88	-2.17	-5.86	-3.85
42	16A x S-16/06	10.34	6.67	33.33**	23.08**	22.90**	8.39	7.21	15.80	16.44**	15.93**	9.62	11.97*
43	16A x S-16/07	-17.24**	-20.00**	0.00	-7.69	21.66**	10.35	2.40	10.61	1.72	-1.67	-1.26	0.85
44	16A x S-16/08	-21.43**	-21.43**	-8.33	-15.38	17.46*	0.20	7.21	15.80	9.77*	2.72	10.46	12.82*
45	16A x S-16/09	-21.43**	-21.43**	-8.33	-15.38	18.56*	1.23	8.08	16.75	8.94	4.07	7.11	9.40
46	16A x S-16/10	-21.43**	-21.43**	-8.33	-15.38	36.72**	24.41**	14.63	23.82**	12.81*	10.86	7.62	9.91
47	16A x S-16/11	-17.24**	-20.00**	0.00	-7.69	1.42	-14.34	-6.11	1.42	4.70	4.46	-2.09	0.00
48	16A x S-16/12	-14.29*	-14.29	0.00	-7.69	22.41**	9.89	4.37	12.74	4.62	3.03	-0.42	1.71
CD at 5 %		0.18	0.21	0.21	0.21	3.12	3.60	3.60	3.60	1.13	1.31	1.31	1.31
CD at 1 %		0.24	0.28	0.28	0.28	4.16	4.80	4.80	4.80	1.52	1.75	1.75	1.75

*, ** denotes level of significance at 5% and 1 %, respectively and SC-I-Aadishakti, SC-II-Pratap.

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Table 4. cont…..

	Hybrids/crosses	Grain yield /Plant (g)				Fodder yield /plant (g)				1000 grain weight (g)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
1	**DHLB-8A** x S-16/01	150.21**	128.78**	25.35	61.07**	120.73**	105.28**	6.04	47.01**	3.98	1.21	-2.35	-4.60
2	8A x S-16/02	105.37**	100.27**	15.46	48.36**	83.72**	75.35**	-0.35	38.16**	31.90**	20.57**	32.97**	29.91**
3	8A x S-16/03	102.72**	79.96**	-1.40	26.70	92.18**	73.42**	-10.42	24.20	25.92**	10.56*	0.98	-1.34
4	8A x S-16/04	155.05**	109.1**	14.56	47.21**	117.36**	77.68**	-8.22	27.25	20.95**	6.06	-3.12	-5.35
5	8A x S-16/05	127.24**	124.73**	23.13	58.22**	92.73**	91.30**	0.31	39.07**	28.13**	26.93**	15.94**	13.27**
6	8A x S-16/06	77.96**	76.47**	-3.31	24.24	72.00**	71.51**	-10.90	23.52	11.41*	7.49	5.61	3.18
7	8A x S-16/07	88.85**	75.69**	-3.74	23.69	82.19**	67.72**	-13.37	20.11	12.49**	11.24*	3.92	1.53
8	8A x S-16/08	94.24**	93.05**	7.09	37.60*	88.31**	87.32**	-3.24	34.15*	24.96**	19.81**	9.43	6.91
9	8A x S-16/09	93.41**	84.46**	11.37	43.11*	94.88**	85.85**	5.80	46.68**	-14.08*	-14.69**	-20.96**	-22.78**
10	8A x S-16/10	105.97**	105.97**	12.85	45.01**	78.04**	76.07**	-7.00	28.94*	1.27	-1.13	-5.21	-7.39
11	8A x S-16/11	82.26**	77.83**	-2.57	25.19	85.02**	79.19**	-7.44	28.33	-0.63	-4.68	-5.21	-7.39
12	8A x S-16/12	64.32**	55.56*	-4.60	22.59	55.01**	45.20*	-14.13	19.05	33.04**	31.15**	19.79**	17.03**
13	**DHLB-14A**x S-16/01	104.89**	95.33**	-2.18	25.69	100.61**	96.89**	-9.17	25.94	13.60**	8.07	4.27	1.87
14	14A x S-16/02	83.70**	71.63**	-1.05	27.15	71.61**	55.46**	-11.66	22.48	13.34**	1.42	11.86*	9.28
15	14A x S-16/03	138.96**	120.84**	10.59	42.11*	135.97**	124.30**	3.48	43.46**	30.99**	17.43**	2.27	-0.08
16	14A x S-16/04	147.76**	110.58**	5.45	35.50*	115.54**	84.38**	-14.94	17.93	20.51**	7.90	-6.04	-8.20
17	14A x S-16/05	96.99**	90.55**	2.10	31.20	87.92**	76.63**	-7.39	28.40	5.25	3.76	-7.01	-9.14
18	14A x S-16/06	159.22**	150.09**	34.74**	73.13**	108.45**	96.79**	2.23	41.73**	25.02**	17.92**	15.85**	13.19**
19	14A x S-16/07	97.52**	91.76**	-3.97	23.39	91.43**	85.86**	-14.26	18.88	5.15	1.59	-5.09	-7.28
20	14A x S-16/08	71.08**	62.76**	-9.72	16.01	66.82**	58.69**	-18.89	12.46	4.90	2.92	-10.37*	-12.43**
21	14A x S-16/09	95.24**	78.59**	7.83	38.55*	85.34**	67.77**	-4.49	32.41*	21.13**	17.49**	8.86	6.36
22	14A x S-16/10	-4.60	-8.71	-49.98**	-35.73*	40.41*	31.52**	-30.53**	-3.68	-6.27	-10.57*	-14.25**	-16.23**
23	14A x S-16/11	92.95**	89.17**	-1.40	26.70	87.73**	83.33**	-11.27	23.02	2.77	-3.62	-4.15	-6.36
24	14A x S-16/12	59.25**	44.63*	-11.29	13.99	52.89**	36.08*	-19.53	11.57	19.57**	18.46**	5.12	2.70

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Table 4. cont…..

	Hybrids/crosses	Grain yield /Plant (g)				Fodder yield /plant (g)				1000 grain weight (g)			
		M.P.(%)	B.P.(%)	SH (%) SC-I	SH (%) SC-II	M.P.(%)	B.P.(%)	SH (%) SC-I	SH (%) SC-II	M.P.(%)	B.P.(%)	SH (%) SC-I	SH (%) SC-II
25	**DHLB-15A** x S-16/01	64.43*	56.78	-28.82*	-8.53	74.58**	61.27*	-28.36**	-0.67	30.18**	10.74*	6.83	4.38
26	15A x S-16/02	121.95**	90.24**	9.68	40.93*	92.05**	59.64**	-9.28	25.78	6.09	-14.41**	-5.61	-7.78
27	15A x S-16/03	141.52**	137.81**	1.03	29.82	115.03**	104.88**	-14.83	18.09	20.43**	19.21**	-17.68*	-19.57**
28	15A x S-16/04	95.96**	81.37*	-25.31	-4.03	92.34**	79.94**	-32.25**	-6.07	50.17**	48.86**	2.50	0.14
29	15A x S-16/05	50.48*	33.07	-28.70*	-8.38	52.08*	30.64	-31.50**	-5.03	33.13**	16.81**	4.69	2.29
30	15A x S-16/06	56.58*	38.13	-25.58	-4.38	48.31*	27.90	-33.56**	-7.89	28.41**	8.42	6.52	4.07
31	15A x S-16/07	42.87	33.82	-36.90**	-18.91	51.77*	41.65	-38.46**	-14.67	17.91**	1.65	-5.04	-7.22
32	15A x S-16/08	94.36**	69.32**	-6.07	20.69	87.43**	62.75**	-16.82	15.33	62.49**	46.83**	23.06**	20.23**
33	15A x S-16/09	121.09**	85.94**	12.27	44.26*	97.68**	64.21**	-6.52	29.60*	27.02**	9.89	1.81	-0.53
34	15A x S-16/10	50.82*	32.09	-27.63*	-7.01	45.03*	24.20	-34.39**	-9.04	29.33**	10.30*	5.75	3.32
35	15A x S-16/11	122.45*	99.10**	3.78	33.35*	96.35**	74.54**	-15.52	17.12	22.13**	2.61	2.04	-0.31
36	15A x S-16/12	59.28**	33.11	-18.36	4.90	56.63**	28.17	-24.20*	5.09	31.44**	15.82**	2.78	0.42
37	**DHLB-16A**x S-16/01	109.54**	95.19**	2.69	31.95	102.89**	93.71**	-5.38	31.18*	28.87**	27.21**	22.73**	19.91**
38	16A x S-16/02	59.21**	52.25*	-12.23	12.78	66.49**	54.80**	-12.03	21.96	30.47**	20.83**	33.26**	30.19**
39	16A x S-16/03	113.76**	93.19**	1.64	30.60	108.77**	93.22**	-5.62	30.85*	56.11**	35.40**	27.26**	24.34**
40	16A x S-16/04	116.57**	80.42**	-5.08	21.97	112.61**	77.68**	-13.21	20.32	29.17**	11.90*	5.18	2.76
41	16A x S-16/05	123.69**	121.66**	18.77	52.61**	118.46**	110.98**	10.63	53.37**	8.72	6.19	-0.19	-2.48
42	16A x S-16/06	46.90*	45.18	-21.79	0.50	52.45**	47.90*	-23.17*	6.52	20.97**	18.36**	16.28**	13.6**
43	16A x S-16/07	153.16**	140.04**	26.29*	62.27**	154.67**	140.60**	17.52	62.94**	-11.08*	-11.35*	-16.68**	-18.59**
44	16A x S-16/08	153.29**	146.75**	36.88**	75.88**	143.50**	138.10**	21.7*	68.72**	46.20**	38.28**	29.98**	26.99**
45	16A x S-16/09	99.41**	86.58**	12.66	44.76**	94.77**	80.94**	3.00	42.81**	0.93	0.21	-5.81	-7.97
46	16A x S-16/10	105.58**	101.49**	10.40	41.86*	80.33**	73.54**	-8.33	27.09	25.07**	23.84**	18.73**	16.00**
47	16A x S-16/11	96.32**	95.41**	2.80	32.10	88.79**	87.93**	-8.21	27.27	9.84*	6.83	6.23	3.79
48	16A x S-16/12	109.23**	94.35**	19.20	53.16**	94.85**	77.89**	5.20	45.85**	8.90	5.86	-0.50	-2.79
CD at 5 %		11.50	13.28	13.28	13.28	12.79	14.76	14.76	14.76	1.15	1.33	1.33	1.33
CD at 1 %		15.34	17.72	17.72	17.72	17.06	19.70	19.70	19.70	1.54	1.78	1.78	1.78

*, ** denotes level of significance at 5% and 1 %, respectively and SC-I-Aadishakti, SC-II-Pratap.

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Table 4. cont…..

	Hybrids/crosses	Number of grains/cm²				Fe Content (ppm)				Zn Content (ppm)			
		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)		M.P.(%)	B.P.(%)	SH (%)	
				SC-I	SC-II			SC-I	SC-II			SC-I	SC-II
1	**DHLB-8A** x S-16/01	8.02	5.50	-7.96	-9.35	6.29	-7.32	5.56	52.00**	-11.69**	-17.07	0.00	3.03
2	8A x S-16/02	10.39	4.29	-13.27*	-14.57*	-8.97**	-25.26**	-1.39	42.00**	-2.56	-7.32*	11.76**	15.15**
3	8A x S-16/03	19.47**	11.04	-7.65	-9.05	-5.88	-21.74**	0.00	44.00**	0.00	-4.88	14.71**	18.18**
4	8A x S-16/04	11.40	4.91	-12.76*	-14.07*	21.85**	2.22	27.78**	84.00**.	-7.69**	-12.20**	5.88	9.09*
5	8A x S-16/05	22.33**	15.95*	-3.57	-5.03	-0.72	-11.54**	-4.17	38.00**	-2.56	-7.32*	11.76**	15.15**
6	8A x S-16/06	22.36**	20.86**	0.51	-1.01	-2.63	-18.68**	2.78	48.00**	-2.56	-7.32*	11.76**	15.15**
7	8A x S-16/07	14.11*	14.11	-5.10	-6.53	-3.76	-11.11*	-11.11*	28.00**	-10.53**	-17.07**	0.00	3.03
8	8A x S-16/08	35.9**	32.15**	9.90	8.24	7.81	2.99	-4.17	38.00**	3.90	-2.44	17.65**	21.21**
9	8A x S-16/09	14.96*	10.11	0.00	-1.51	3.70	-8.20	-22.22**	12.00	-7.25*	-21.95**	-5.88	-3.03
10	8A x S-16/10	24.03**	12.81*	14.54*	12.81*	-5.97	-13.7**	-12.5**	26.00**	-13.16**	-19.51**	-2.94	0.00
11	8A x S-16/11	15.66*	13.61	-2.04	-3.52	-20.00**	-29.11**	-22.22**	12.00	0.00	-12.2**	5.88	9.09*
12	8A x S-16/12	26.01**	23.41**	7.04	5.43	-20.29**	-28.57**	-23.61**	10.00	-5.26	-12.2**	5.88	9.09*
13	**DHLB-14A**x S-16/01	7.61	3.80	-2.55	-4.02	-10.07**	-18.29**	-6.94	34.00**	-1.41	-2.78	2.94	6.06
14	14A x S-16/02	5.17	-5.98	-11.73	-13.07*	-16.05**	-28.42**	-5.56	36.00**	0.00	-2.7	5.88	9.09*
15	14A x S-16/03	-0.62	-12.50	-17.86**	-19.1**	-1.89	-15.22**	8.33	56.00**	2.78	0.00	8.82*	12.12**
16	14A x S-16/04	9.15	-2.72	-8.67	-10.05	-29.94**	-38.89**	-23.61**	10.00	2.78	0.00	8.82*	12.12**
17	14A x S-16/05	23.03**	10.33	3.57	2.01	-20.00**	-25.64**	-19.44**	16.00*	-2.78	-5.41	2.94	6.06
18	14A x S-16/06	9.62	2.17	-4.08	-5.53	-36.71**	-45.05**	-30.56**	0.00	2.78	0.00	8.82*	12.12**
19	14A x S-16/07	10.66	4.35	-2.04	-3.52	-22.30**	-25.00**	-25.00**	8.00	-2.86	-2.86	0.00	3.03
20	14A x S-16/08	-4.73	-12.50	-17.86**	-19.1**	16.42**	16.42**	8.33	56.00**	1.41	0.00	5.88	9.09*
21	14A x S-16/09	30.06**	27.93**	20.10**	18.29**	5.26	-10.45*	-16.67**	20.00**	-11.11**	-20**	-17.65**	-15.15**
22	14A x S-16/10	0.78	-3.02	-1.53	-3.02	-1.43	-5.48	-4.17	38.00**	2.86	2.86	5.88	9.09*
23	14A x S-16/11	7.65	3.26	-3.06	-4.52	-24.66**	-30.38**	-23.61**	10.00	12.12**	5.71	8.82*	12.12**
24	14A x S-16/12	10.73	6.52	0.00	-1.51	11.11**	3.90	11.11*	60.00**	0.00	0.00	2.94	6.06

Table 4. cont…..

	Hybrids/crosses	Number of grains/cm² M.P.(%)	B.P.(%)	SH (%) SC-I	SC-II	Fe Content (ppm) M.P.(%)	B.P.(%)	SH (%) SC-I	SC-II	Zn Content (ppm) M.P.(%)	B.P.(%)	SH (%) SC-I	SC-II
25	**DHLB-15A** x S-16/01	5.11	2.34	-10.71	-12.06	-16.47**	-19.32**	-1.39	42.00**	-5.41	-7.89*	2.94	6.06
26	15A x S-16/02	28.01**	21.3**	0.26	-1.26	-20.22**	-23.16**	1.39	46.00**	-12.00**	-13.16**	-2.94	0.00
27	15A x S-16/03	15.23*	7.41	-11.22	-12.56*	-13.33**	-15.22**	8.33	56.00**	-12.00**	-13.16**	-2.94	0.00
28	15A x S-16/04	9.80	3.70	-14.29*	-15.58*	-30.34**	-31.11**	-13.89**	24.00**	-6.67*	-7.89*	2.94	6.06
29	15A x S-16/05	22.08**	16.05*	-4.08	-5.53	-13.25**	-18.18**	0.00	44.00**	-6.67*	-7.89*	2.94	6.06
30	15A x S-16/06	10.28	9.26	-9.69	-11.06	-25.14**	-26.37**	-6.94	34.00**	-6.67*	-7.89*	2.94	6.06
31	15A x S-16/07	36.06**	35.64**	12.81*	11.11	0.00	-9.09*	11.11*	60.00**	-20.55**	-23.68*	-14.71**	-12.12**
32	15A x S-16/08	37.03**	33.64**	10.46	8.79	-17.42**	-27.27**	-11.11*	28.00**	-10.81**	-13.16*	-2.94	0.00
33	15A x S-16/09	22.94**	17.42*	6.63	5.03	11.11**	-14.77**	4.17	50.00**	-6.06	-18.42**	-8.82*	-6.06
34	15A x S-16/10	-15.57*	-23.42**	-22.24**	-23.42**	8.07*	-1.14	20.83**	74.00**	-9.59**	-13.16**	-2.94	0.00
35	15A x S-16/11	12.39	10.06	-5.10	-6.53	-19.76**	-23.86**	-6.94	34.00**	-10.14**	-18.42**	-8.82*	-6.06
36	15A x S-16/12	18.07**	15.29*	0.00	-1.51	-24.85**	-29.55**	-13.89**	24.00**	-9.59**	-13.16**	-2.94	0.00
37	**DHLB-16A**x S-16/01	0.79	-7.97	-2.81	-4.27	6.85	-4.88	8.33	56.00**	-1.49	-8.33*	-2.94	0.00
38	16A x S-16/02	-19.03**	-31.16**	-27.30**	-28.39**	-10.69**	-25.26**	-1.39	42.00**	5.88	-2.7	5.88	9.09*
39	16A x S-16/03	19.31**	0.00	5.61	4.02	-19.23**	-31.52**	-12.5**	26.00**	2.94	-5.41	2.94	6.06
40	16A x S-16/04	15.33*	-2.22	3.27	1.71	-16.88**	-28.89**	-11.11*	28.00**	0.00	-8.11*	0.00	3.03
41	16A x S-16/05	14.45*	-2.42	3.06	1.51	1.41	-7.69	0.00	44.00**	8.82**	0.00	8.82*	12.12**
42	16A x S-16/06	18.31**	4.59	10.46	8.79	5.81	-9.89**	13.89**	64.00**	2.94	-5.41	2.94	6.06
43	16A x S-16/07	4.86	-6.28	-1.02	-2.51	-4.41	-9.72*	-9.72*	30.00**	9.09**	2.86	5.88	9.09*
44	16A x S-16/08	-3.05	-15.46*	-10.71	-12.06	11.45**	8.96	1.39	46.00**	4.48	-2.78	2.94	6.06
45	16A x S-16/09	5.45	-1.93	3.57	2.01	15.32**	0.00	-11.11*	28.00**	15.25**	9.68*	0.00	3.03
46	16A x S-16/10	-4.43	-6.28	-1.02	-2.51	-5.11	-10.96*	-9.72*	30.00**	6.06	0.00	2.94	6.06
47	16A x S-16/11	-0.53	-9.66	-4.59	-6.03	-18.88**	-26.58**	-19.44**	16.00*	0.00	0.00	-8.82*	-6.06
48	16A x S-16/12	-15.65**	-23.19**	-18.88**	-20.10**	-14.89**	-22.08**	-16.67**	20.00**	0.00	-5.71	-2.94	0.00
CD at 5 %		2.16	2.49	2.49	2.49	5.23	6.03	6.03	6..03	2.06	2.38	2.38	2.38
CD at 1 %		2.88	3.33	3.33	3.33	6.97	8.05	8.05	8.05	2.75	3.18	3.18	3.18

*, ** denotes level of significance at 5% and 1 %, respectively and SC-I-Aadishakti, SC-II-Pratap.

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Table 5. The Estimates of General Combining ability effect for different traits in pearl millet.

SI. No.	Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective tillers / plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	Number of Grains/ cm²	Fe Content (ppm)	Zn Content (ppm
(A)Females													
1.	8A	0.73*	1.42*	0.88	-0.047*	0.48	0.12	4.06**	3.76*	-0.02	0.29	0.125	1.43**
2.	14A	0.11	0.42	0.24	0.049*	-0.17	-0.08	-0.77	-0.63	-0.61**	-0.11	-3.62**	0.52*
3.	15A	-1.88**	-2.49**	-7.21**	0.045*	0.60	-0.17	-7.26**	-9.58**	-0.31*	-0.14	3.54**	-1.72**
4.	16A	1.03**	0.63	6.07**	-0.047*	-0.91*	0.13	3.98**	6.46**	0.96**	-0.03	-0.042	-0.22
SE+		0.36	0.68	1.85	0.0215	0.36	0.13	1.34	1.49	0.13	0.25	0.61	0.24
CD at 5 %		0.73	1.38	3.73	0.043	0.73	0.26	2.71	3.01	0.27	0.50	1.23	0.48
CD at 1 %		0.98	1.84	4.97	0.057	0.98	0.35	3.61	4.02	0.36	0.68	1.64	0.65
(B)Males													
1	S-16/01	-1.88**	-1.49	8.04*	0.02	-1.21	0.24	-0.34	0.90	0.46	-0.55	5.04**	-0.47
2	S-16/02	-0.63	-0.49	3.97	-0.105**	1.76**	0.60*	1.55	1.54	1.90**	-1.92**	2.79*	1.02*
3	S-16/03	-1.01	0.01	10.50**	0.02	0.65	0.22	1.55	2.61	-0.18	-0.89*	4.79**	1.27**
4	S-16/04	2.51**	1.63	8.84**	0.107**	-1.27*	-0.27	-1.29	-4.80	-0.68**	-0.96*	0.29	0.77
5	S-16/05	1.98**	1.88	0.47	-0.08*	0.56	-0.09	1.99	2.50	-0.16	0.57	-0.20	1.52**
6	S-16/06	-1.13	-0.99	2.72	0.02	-0.05	0.07	-2.01	-4.22	0.91**	0.49	0.29	1.52**
7	S-16/07	-0.88	-1.11	-7.80*	0.02	-1.50*	-0.51*	-2.31	-1.19	-1.43**	0.85	-2.20*	-1.47**
8	S-16/08	0.36	0.01	-5.38	-0.005	0.56	0.49*	3.65	4.43	1.19**	0.22	3.04**	1.27**
9	S-16/09	2.86**	3.51**	-9.63**	-0.105**	0.14	0.54*	5.69*	7.13**	-1.19**	2.11**	-4.20**	-3.47**
10	S-16/10	-2.51**	-2.99*	-3.70	0.12**	-1.60*	-0.52*	-6.94**	-6.89*	-0.45	0.12	3.04**	-0.47
11	S-16/11	0.48	-0.11	-8.98**	-0.08*	1.63*	-0.13	0.36	-0.09	-0.67**	-0.09	-8.95**	-0.97*
12	S-16/12	-0.13	0.13	0.94	0.07	0.32	-0.64**	-1.89	-1.93	0.31	0.04	-3.7**	-0.47
SE+		0.63	1.19	3.21	0.037	0.63	0.23	2.33	2.59	0.23	0.43	1.06	0.41

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CD at 5 %	1.27	2.39	6.46	0.074	1.27	0.46	4.69	5.22	0.47	0.88	2.13	0.84
CD at 1 %	1.70	3.19	8.62	0.0998	1.70	0.62	6.26	6.96	0.62	1.17	2.8495	1.12

*, ** denotes level of significance at 5% and 1 %, respectively.

Table 6. The Estimates of Specific Combining ability effect for different traits in pearl millet.

SI. No	Parents	Days to 50% flow-ering	Days to maturity	Plant height (cm)	No. of effective tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	Number of grains/ cm²	Fe Content (ppm)	Zn Content (ppm)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	**DHLB-8A** x S-16/01	5.26**	0.82	-5.46	-0.078	0.25	1.11*	9.33	7.20	-1.40**	-0.67	2.87	-1.68*
2	8A x S-16/02	1.01	1.32	2.71	-0.053	3.08*	0.65	2.35	1.97	2.11**	-0.34	0.12	0.81
3	8A x S-16/03	-2.11	-0.17	-7.82	-0.078	-1.25	-0.32	-6.30	-6.33	-0.28	-0.27	-0.87	1.56
4	8A x S-16/04	-0.63	-4.80*	0.83	-0.166*	0.31	0.78	4.74	2.66	-0.35	-1.20	23.62**	-0.93
5	8A x S-16/05	1.38	1.44	-5.78	0.022	-1.47	0.70	5.85	1.48	1.79**	-0.94	1.12	0.31
6	8A x S-16/06	-0.48	6.32*	11.66	0.222**	-0.20	-0.12	-3.71	0.15	-0.73	-0.05	5.62*	0.31
7	8A x S-16/07	-0.73	-0.55	-5.11	-0.078	0.19	0.01	-3.63	-4.64	1.38**	-1.52	-1.87	-0.68
8	8A x S-16/08	1.51	1.32	3.46	-0.153*	3.18*	0.06	-4.04	-2.99	-0.47	2.04*	-2.12	2.56**
9	8A x S-16/09	-2.98*	-0.17	13.21*	-0.053	2.84*	-0.23	-3.89	0.80	-2.34**	-1.78*	-7.87**	-0.68
10	8A x S-16/10	0.38	-2.17	0.08	0.522**	-0.05	-0.47	9.51*	5.63	-0.87	3.05**	-8.12**	-2.68**
11	8A x S-16/11	-2.61*	-3.55	3.06	0.022	-0.54	-1.15*	-5.72	-1.48	-0.66	0.03	-3.12	0.81
12	8A x S-16/12	0.01	0.19	-10.86	-0.128	-6.33**	-1.04*	-4.49	-4.45	1.85**	1.66	-9.37**	0.31
13	**DHLB-14A**x S-16/01	-3.11*	-5.67*	11.47	0.226**	-0.24	-0.43	0.03	0.67	0.11	0.79	-2.37	0.22
14	14A x S-16/02	0.13	-0.67	-9.14	-0.049	0.13	-0.29	-1.28	-1.75	-0.25	0.36	0.87	-0.27
15	14A x S-16/03	1.01	-0.17	10.76	0.226**	3.09*	0.08	4.69	8.06	0.48	-1.85*	8.87**	0.47

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16	14A x S-16/04	-0.51	-0.30	12.07	-0.211**	0.17	0.23	4.90	2.23	-0.17	0.009	-9.62**	0.97
17	14A x S-16/05	0.01	-0.55	2.85	-0.074	-0.46	1.90**	-0.11	0.35	-0.83	0.86	-6.12**	-1.77**
18	14A x S-16/06	1.13	-2.17	-1.39	-0.274**	0.34	-0.47	20.66**	13.99**	1.29**	-0.54	-14.62**	0.22
19	14A x S-16/07	-1.11	3.44	-2.97	-0.174*	-0.20	-0.08	1.08	-0.88	0.70	-0.50	-8.12**	0.22
20	14A x S-16/08	0.13	0.82	-12.59	0.551**	-1.51	-0.63	-7.83	-9.84	-2.66**	-2.97**	10.62**	-0.52
21	14A x S-16/09	1.63	3.32	-11.14	0.151*	-2.85*	-0.43	-0.87	-2.19	2.42**	2.57**	-0.12	-3.77**
22	14A x S-16/10	-0.98	0.82	-6.87	-0.174*	-3.10*	-0.52	-17.91**	-6.88	-1.55**	0.32	1.62	1.22
23	14A x S-16/11	-2.98*	-2.55	12.50	-0.074	0.21	0.29	-0.28	0.16	0.07	0.24	-0.37	2.72**
24	14A x S-16/12	4.63**	3.69	-5.52	-0.124	4.42**	0.35	-3.09	-3.93	0.38	0.69	19.37**	0.22

Table 6. cont…..

1	2	3	4	5	6	7	8	9	10	11	12	13	14
25	**DHLB-15A** x S-16/01	-3.11*	-0.26	-2.36	-0.07	-3.91**	-0.53	-7.15	-4.17	0.16	-0.77	-5.54*	2.47**
26	15A x S-16/02	-0.36	0.24	-1.78	0.055	-3.29*	-0.14	10.71*	8.90	-3.01**	2.74**	-1.29	-1.02
27	15A x S-16/03	0.51	0.24	10.27	-0.07	-1.43	0.02	6.27	3.84	-2.61**	-0.53	1.70	-1.27
28	15A x S-16/04	-1.51	1.61	-3.16	-0.057	3.34*	0.57	-4.39	-1.27	0.71	-1.06	-9.79**	1.22
29	15A x S-16/05	-0.48	-2.13	5.61	0.03	2.31	-1.74**	-9.43*	-8.04	0.49	-0.60	0.70	0.47
30	15A x S-16/06	-0.36	-1.76	1.46	-0.27*	-0.62	-0.22	-3.82	-2.78	-0.32	-1.61	-4.79*	0.47
31	15A x S-16/07	3.38*	0.86	-6.81	0.33**	-0.82	-0.03	-9.32	-9.33	0.40	2.42**	10.70**	-2.52**
32	15A x S-16/08	-0.86	-2.26	-0.73	-0.245**	-1.54	0.06	0.53	0.59	1.71**	2.59**	-10.54**	-1.27
33	15A x S-16/09	1.63	1.24	0.21	-0.045	-0.47	0.61	7.90	5.29	1.12*	-0.04	7.70**	1.47
34	15A x S-16/10	1.01	1.24	-3.71	-0.07	-0.57	-0.17	0.05	-0.72	0.94	-3.71**	12.45**	0.47
35	15A x S-16/11	4.01**	4.86*	0.46	0.03	4.58**	1.23*	8.87	6.05	0.63	-0.13	4.45*	-1.02
36	15A x S-16/12	-3.86**	-3.88	0.53	0.38	2.44	0.35	-0.22	1.64	-0.25	0.72	-5.79**	0.47
37	**DHLB-16A**x S-16/01	0.96	5.11*	-3.65	-0.078	3.90**	-0.15	-2.22	-3.70	1.12*	0.65	5.04*	-1.02
38	16A x S-16/02	-0.78	-0.88	8.22	0.047	0.07	-0.21	-11.78*	-9.12	1.16*	-2.76**	0.292	0.47
39	16A x S-16/03	0.58	0.11	-13.21*	-0.078	-0.41	0.21	-4.66	-5.57	2.41**	2.65**	-9.70**	-0.77
40	16A x S-16/04	2.66*	3.49	-9.75	0.434**	-3.83**	-1.58**	-5.25	-3.62	-0.18	2.26*	-4.20	-1.27
41	16A x S-16/05	-0.91	1.24	-2.67	0.022	-0.37	-0.86	3.69	6.20	-1.45**	0.68	4.29*	0.97

42	16A x S-16/06	-0.28	-2.38	-11.72	0.322**	0.48	0.81	-13.12**	-11.36*	-0.22	2.21*	13.79**	-1.02
43	16A x S-16/07	-1.53	-3.76	14.89*	-0.078	0.83	0.10	11.87*	14.86**	-2.49**	-0.39	-0.70	2.97**
44	16A x S-16/08	-0.78	0.11	9.87	-0.153*	-0.12	0.50	11.34*	12.23*	1.41**	-1.66	2.04	-0.77
45	16A x S-16/09	-0.28	-4.38	-2.27	-0.053	0.48	0.05	-3.14	-3.90	-1.21*	-0.75	0.29	2.97**
46	16A x S-16/10	-0.41	0.11	10.49	-0.278**	3.73**	1.17*	8.34	1.97	1.49**	0.33	-5.95**	0.97
47	16A x S-16/11	1.58	1.24	-16.02*	0.022	-4.24**	-0.37	-2.87	-4.73	-0.04	-0.14	-0.95	-2.52**
48	16A x S-16/12	-0.78	-0.01	15.84*	-0.128	-0.53	0.33	7.81	6.74	-1.98**	-3.08**	-4.20	-1.02
SE+		1.26	2.38	6.42	0.0744	1.26	0.46	4.66	5.19	0.46	0.87	2.12	0.83
CD at 5 %		2.55	4.79	12.92	0.1496	2.54	0.93	9.39	10.44	0.94	1.76	4.27	1.68
CD at 1 %		3.40	6.39	17.24	0.1996	3.40	1.24	12.53	13.93	1.25	2.35	5.69	2.25

*, ** denotes level of significance at 5% and 1 %, respectively.