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MAGNITUDE OF HETEROSIS FOR QUANTITATIVE CHARACTERS IN CHILLI (*CAPSICUM ANNUUM* L.) IN MULTI-LOCATION TRIALS

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Abstract

Heterosis, heterobeltiosis and commercial heterosis for dry chilli yield per plot and yield attributing traits in chilli were evaluated in line × tester design involving six CMS lines and six restorers. The hybrids differed significantly for all the traits studied, as evident from their significant mean square values in all the traits. Mean squares due to crosses × locations were significant for all the characters studied except fruit width. It was found that high magnitude of significant positive heterosis (120.92%) followed by heterobeltiosis (119.18%), commercial heterosis over Indam-5 (73.25%) and commercial heterosis over Tejaswini (34.81%) was recorded by the cross CM5032A × NCR3295 for dry chilli yield per plot. The cross CM1112A × NCR1886 has recorded highest magnitude of significant positive heterosis, heterobeltiosis and commercial heterosis for fruit width and thousand seed weight. The cross CM5076A × NCR3295 was recorded highest magnitude of significant positive commercial heterosis for fruit length and number of fruits per plant. The cross CM5032A × NCR1238 was recorded highest magnitude of significant positive heterobeltiosis for plant height and significant negative commercial heterosis for days to 50% flowering. The CM5076A × NCR1681 was recorded highest magnitude of significant positive commercial heterosis for plant height and significant negative heterobeltiosis for days to 50% flowering. These hybrids could be further evaluated in yield trials over the locations and seasons before recommending for market release.

Key words : Chilli, commercial heterosis, cytoplasmic genetic male sterility, heterosis, heterobeltiosis, restorer.

Introduction

Chilli belongs to the family Solanaceae and has chromosome number of 2n = 24. It is valued for its pungency, which is due to crystalline alkaloid content called capsaicin, present in the placenta of the fruits and colour values of capsanthin. Chilli is most cultivated spice cum vegetable crop from the economic and nutritional point of view in the world. Development of hybrids for having high productivity and desirable qualities is identified as a key factor to increase the production of chilli in the country. Chilli is also a major foreign exchange earner among spices.

Cytoplasmic genetic male sterility is a unique attribute important for breeding programmes of many crops as this trait impairs the production of viable pollen from anthers (Kim *et al*., 2006; Lee *et al*., 2008). CGMS System applied for producing the F_1 chilli hybrids (Min *et al*., 2009) as this approach could help to reduce the production cost by 47% compare to the conventional method (Yang *et al*., 2008).

Exploitation of heterosis has been recognised as a practical tool in providing a means of increasing yield and other commercial characters in chilli. The greater the extent of out crossing and higher ratio of viable seeds produced by crossed chilli fruit facilitates for the development of commercial chilli hybrids. Therefore to meet the quantum jump in yield in short term, heterosis breeding has been undertaken to develop and identify the suitable best performing hybrids.

Materials and Methods

The experiment was conducted at Medchal research station, Hyderabad in *Kharif* 2014 with six CMS lines *viz*., CM1008A, CM1037A, CM1112A, CM1162A, CM5032A and CM5076A and six restorers *viz.,* NCR3295, NCR4293, NCR1681, NCR1886, NCR1748

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and NCR1238 and crossing was performed in line × tester fashion to produce 36 hybrids. During *Kharif* 2015, the 36 hybrids along with their parents and two check hybrids *viz*., Indam-5 and Tejaswini were evaluated in randomised block design replicated thrice at four different locations *viz*., Medchal Research Centre, Hyderabad; Parkal Research Centre, Warangal; Cherla Research Centre at Badhrachalam and Mandapadu Research Centre at Guntur. The experiments were planted with four rows per plot in three replications in randomised block design. Observations were recorded for nine quantitative characters. Data obtained were subjected to Line × tester analysis (Kempthrone, 1957) to estimate the general and specific combining ability effects and their respective variances. The result of pooled analysis over locations is presented in table 1. The mean over three replications and for all the hybrids for each of the trait was calculated over mid parent, better parent and standard check and used in the estimation of heterosis as per the standard procedure given by Turner (1953).

Results and Discussion

The mean sum of squares of nine quantitative characters obtained over pooled analysis of variance for four locations *viz*., Hyderabad, Warangal, Guntur and Badhrachalam are presented in table 1. The pooled analysis of variance revealed significant differences due to locations for all the characters, indicating the sufficient diversity among the environment (table 1). The differences among the parents, parents vs crosses and crosses were observed to be significant for all the characters studied of parents vs crosses, indicating the existence of wider genetic differences among the parents and crosses. Partitioning of crosses in to lines, testers and lines × testers revealed that variance due to lines were significant for all the characters except fruit width, average seed count per fruit and leaf curl virus tolerance in lines, where as for testers, plant height, fruit length, fruit width, average seed count per fruit, thousand seed weight were found significant, indicates wide variability existing among the genotypes.

The interaction due to lines × testers were significant for all the traits studied, the results were in accordance with the earlier studies of Hasanuzzaman *et al*. (2012), Suryakumari *et al*. (2014) and Kranthi Rekha *et al*. (2016). Interaction effects of parents vs crosses × locations, parents × locations and crosses × locations were significant for all the characters, leaf curl virus tolerance and fruit width in all above interactions in case of (parents vs crosses) × locations and leaf curl virus tolerance in case of parents vs locations and locations × crosses. Further partitioning of crosses × locations indicated that the interaction of lines × locations showed significant differences for days to 50% flowering, plant height, plant width, fruit length, number of fruits per plant. Interaction effects of lines × testers × locations were significant for all the characters studied. This indicates presence of wide variability in genotypes studied and there is a good scope for identifying promising parents and hybrid combinations and improving the yield through its components. These results are in conformity with Khalil and Hatem (2014) and Kranthi Rekha *et al*. (2016).

In respect of *per se* performance of parents, CM5076B and CM5032B among lines and NCR3295 and NCR1886 among the tester were found to be superior for dry chilli yield per plot and for most of the yield attributing characters (table 2). Among the hybrids CM5032A × NCR3295, CM5076A × NCR1238, CM5076A × NCR3295, CM5032A × NCR1886, CM1162A × NCR3295, CM1008A × NCR3295 and CM5076A × NCR1681 had high *per se* performance for dry chilli yield per plot and other important yield contributing traits.

Genetic principles of expression of heterosis superior to better parent Mackey (1976), which may result from one or two of the following occurrences : (i) The accumulated action of favourable dominant or semi-dominant genes dispersed amongst two parents *i.e.*, dominance; (ii) the complementary interaction of additive dominant on recessive genes at different loci *i.e.*, non-allelic interaction or epistasis; (iii) favourable interaction between two alleles at the same locus *i.e.*, intra locus or inter allelic interactions referred to as over dominance. It will be possible to recover homozygous lines as good as heterotic hybrids, if either both of the first two situations are the cause of heterosis, although it depends on the linkage relationship of the genes involved and the ability to identify the recombination's. Kaladee (1988) reported that the over dominance or heterosis of hybrids was due to the heterozygosity in self pollinated crops.

The heterosis range for nine quantitative traits is presented in table 3. High magnitude of significant positive average heterosis (120.92%) followed by heterobeltiosis (119.18%), commercial heterosis over Indam-5 (73.25%) and commercial heterosis over Tejaswini (34.81%) was recorded by the cross CM5032A × NCR3295 for dry chilli yield per plot. Heterosis for dry chilli yield was also reported by Chaudhary *et al*. (2013), Suryakumari *et al*. (2014) and Kranthi Rekha *et al.* (2016). For thousand seed weight, High magnitude of significant positive average heterosis (14.95%) followed by heterobeltiosis

Table 1 : Pooled analysis of variance for L x T analysis of yield and yield attributing traits of four locations in chilli.

Source of variation	DF	DFF	PH	PW	FL	FW	NFPP	ASC	TSW	DCY
Locations	3	51**	682.88**	153.9**	3**	0*	95878.3**	548.8**	0.2**	7164640.5**
Rep *Loc.	6	3.5	18.6	2.1	0	0	151.6	18.1	0	27411.7
Treatments	47	93.1**	5553.4**	631.6**	35.5**	0.1**	28062.8**	2824.2**	1.1**	9566663**
Parents	11	117.4**	7580.7**	1135.7**	47.4**	0.2**	7660**	3155.2**	1**	1146086.9**
Parent vs Crosses	1	634.4**	10449.9**	384**	1**	0.1**	578850.6**	31664.1**	3.3**	270711232**
Crosses	35	70**	4776.4**	480.2**	32.8**	0.1**	18738.3**	1896.2**	1.1**	4751856.5**
Line effect	5	143.5*	8272.9**	1749.9**	39.6**	0.1	91403.2**	821.4	1.1*	4492672.5
Tester effect	5	90.3	20855.7**	167.5	170.7**	0.3**	8290.7	6822.7**	4.7**	6970184.5
Line * Tester effect	25	51.3**	861.2**	288.8**	3.9**	0.1**	6294.8**	1125.8**	0.4**	4360028 **
Loc * Parents	33	10.2**	56.5**	14.5**	0.4**	0 **	390.2**	80.1**	0*	216205.9 **
Loc * Parent vs Cross	3	50.6**	865.8**	34**	2.9**	0	24256.6**	126.4**	0.1**	4386790**
Loc * Crosses	105	14.9**	113**	44.8**	0.4**	0**	6042.8**	161.9**	0.1**	452063.7**
Loc * Line effect	15	34.8**	196.8*	78.4*	0.7*	0	28930.5**	255	0.1	589123.6
Loc * Tester effect	15	11.6	111.2	39.6	0.4	0	2296.3	80.7	0.1	373848.6
Loc * L * T effect	75	11.6**	96.6**	39.1**	0.4**	0**	2214.6**	159.5**	0.1**	440294.8**
Error	376	5.2	11.8	4.8	0	0	134.8	17.4	0	63301.6

*: Significant at 5% level; **: significant at 1% level.

Note: DF- Degrees of freedom, DFF-days to 50% flowering, PH- Plant height, PW- Plant width, FL-Fruit length, FW- Fruit width, NFPP-Number of fruit per plant, ASC-Average seed count per fruit , TSW –Thousand seed weight, DCY- Dry chilli yield per plot.

Table 2 : Pooled mean performance of parents and hybrids for quantitative traits across four locations in chilli.

S. no.	Code	DFF	PH	PW	FL	FW	NFPP	ASC	TSW	DCY
	Lines									
1	CM1008B	34.2	71.5	37.2	8.8	1.3	118.2	73.4	4.0	2219.8
2	CM1037B	35.0	98.2	39.5	7.7	1.4	121.7	69.9	4.3	2226.5
3	CM1112B	35.6	69.1	41.4	8.6	1.2	130.8	80.3	4.3	2219.3
4	CM1162B	36.2	105.2	51.0	9.9	1.4	146.5	96.8	4.2	2316.8
5	CM5032B	33.3	76.0	68.0	9.8	1.4	121.0	109.8	4.9	2303.6
6	CM5076B	36.3	121.0	51.3	12.3	1.3	153.8	107.2	4.6	2890.7
	Mean	**210.4**	**541.0**	**288.5**	**57.3**	**7.9**	**792.1**	**537.3**	**26.4**	**14176.6**
	Testers									
1	NCR3295	32.5	119.6	64.6	11.3	1.3	199.5	115.7	4.8	2340.4
2	NCR4293	36.1	105.9	44.2	7.9	1.2	121.6	87.0	4.2	1713.1
3	NCR1681	41.8	142.0	39.8	4.4	1.1	111.6	74.5	4.0	2204.2
4	NCR1886	40.9	78.0	51.9	8.1	1.1	115.6	84.3	4.3	2249.8
5	NCR1748	40.7	63.5	47.4	8.5	1.4	109.0	102.5	4.4	1880.3
6	NCR1238	39.5	75.7	43.8	8.5	1.1	124.8	73.2	4.3	1768.1
	Mean	**38.6**	**97.5**	**48.6**	**8.1**	**1.2**	**130.3**	**89.5**	**4.3**	**2026.0**
	Crosses									
1	CM1008AxNCR3295	39.9	123.4	51.3	11.4	1.3	192.6	126.4	4.7	4192.2
2	CM1008AxNCR4293	38.6	107.9	44.1	10.0	1.2	166.5	110.7	4.5	3492.8
3	CM1008AxNCR1681	40.2	116.0	43.6	6.9	1.2	173.2	125.0	4.0	3507.3
4	CM1008AxNCR1886	40.4	83.3	47.1	8.3	1.2	155.9	97.0	4.6	2905.0
5	CM1008AxNCR1748	37.7	81.2	59.5	9.1	1.4	187.3	111.3	4.5	3589.6
6	CM1008AxNCR1238	37.2	78.1	46.5	8.1	1.2	149.5	81.8	4.6	2771.8
7	CM1037AxNCR3295	37.9	114.0	42.0	9.7	1.2	160.1	120.4	4.5	3652.9

Table 2 continued....

Table 2 continued...

8	CM1037AxNCR4293	41.2	93.1	43.1	7.5	1.2	192.4	116.7	4.7	3969.0
9	CM1037AxNCR1681	40.8	131.8	37.4	5.8	1.2	145.4	118.1	4.1	3972.8
10	CM1037AxNCR1886	40.0	86.7	50.7	7.7	1.1	206.1	115.6	4.6	4209.8
11	CM1037AxNCR1748	42.8	88.7	45.4	7.8	1.3	166.3	111.2	4.6	2843.3
12	CM1037AxNCR1238	41.1	80.0	43.2	8.1	1.2	167.7	90.4	4.5	3576.6
13	CM1112AxNCR3295	37.9	108.2	49.4	9.9	1.2	217.1	110.6	4.8	3862.8
14	CM1112AxNCR4293	38.3	97.4	48.2	7.8	1.1	190.3	118.1	4.8	3430.0
15	CM1112AxNCR1681	37.8	107.7	45.7	5.4	0.8	203.0	112.0	3.9	4813.7
16	CM1112AxNCR1886	38.3	88.2	48.5	8.5	1.3	180.5	85.5	4.9	3657.1
17	CM1112AxNCR1748	37.3	76.5	50.2	7.9	1.3	200.3	100.5	4.9	3968.3
18	CM1112AxNCR1238	37.4	83.2	45.1	8.4	1.2	176.0	91.4	4.6	3458.0
19	CM1162AxNCR3295	39.3	121.9	48.2	11.4	1.3	211.4	118.5	4.9	4266.8
20	CM1162AxNCR4293	39.6	102.7	44.3	10.2	1.2	193.5	99.8	4.8	3710.1
21	CM1162AxNCR1681	40.8	134.6	49.4	5.8	1.1	194.9	117.0	4.1	3054.3
22	CM1162AxNCR1886	42.8	82.3	49.5	8.8	1.2	188.2	91.1	4.6	3610.7
23	CM1162AxNCR1748	41.9	86.1	58.6	9.5	1.4	201.4	111.6	4.9	3727.4
24	CM1162AxNCR1238	42.0	80.8	44.8	8.4	1.2	165.0	84.3	4.8	3930.0
25	CM5032AxNCR3295	36.2	115.3	53.5	11.3	1.3	271.5	101.9	4.8	5129.8
26	CM5032AxNCR4293	39.3	128.8	57.9	9.8	1.2	199.0	111.8	4.3	3476.7
27	CM5032AxNCR1681	43.1	110.3	65.5	6.2	1.2	220.8	90.6	4.0	3204.2
28	CM5032AxNCR1886	39.8	95.7	58.9	7.8	1.3	288.6	111.7	4.5	4822.6
29	CM5032AxNCR1748	43.8	87.0	53.6	9.5	1.3	227.2	126.9	4.6	3003.8
30	CM5032AxNCR1238	34.1	96.8	51.2	9.3	1.2	215.8	89.8	4.1	3120.8
31	CM5076AxNCR3295	35.3	135.4	59.0	11.8	1.2	293.5	116.8	4.6	5030.2
32	CM5076AxNCR4293	41.6	129.2	58.5	9.9	1.2	247.3	113.0	4.5	4264.5
33	CM5076AxNCR1681	35.9	152.8	53.9	6.6	1.1	257.3	105.1	4.1	4084.4
34	CM5076AxNCR1886	35.4	120.3	50.8	10.6	1.2	219.9	109.8	4.0	3254.3
35	CM5076AxNCR1748	40.8	110.8	49.3	10.1	1.3	242.0	100.4	4.9	3368.6
36	CM5076AxNCR1238	36.8	95.3	60.4	9.6	1.2	290.7	97.3	4.5	5061.4
	Mean	**1412.8**	**3731.3**	**1808.1**	**314.7**	**43.8**	**7357.7**	**3839.5**	**163.1**	**135993.2**
	Checks									
1	Indam-5	39.75	69.07	52.45	9.2	1.37	169.85	100.35	4.47	2960.92
2	Tejaswini	41.42	130.28	40.43	7.9	0.81	189.5	76.03	4.97	3805.17
	Grand Mean	**38.72**	**101.13**	**49.62**	**8.76**	**1.22**	**185.82**	**101.81**	**4.5**	**3381.83**
	S.E	0.8	1.82	1.05	0.11	0.01	11.05	2.04	0.06	123.12
	C.D.5%	2.24	5.04	2.92	0.31	0.04	30.7	5.66	0.16	342.02

Note: DF- degree of freedom, DFF-days to 50% flowering, PH- Plant height, PW- Plant width, FL-Fruit length, FW- Fruit width, NFPP-Number of fruit per plant, ASC-Average seed count per fruit , TSW –Thousand seed weight, DCY-Dry chilli yield per plot.

(13.85%), commercial heterosis over Indam-5 (10.24%) was recorded by the cross CM1112AxNCR1886. Heterosis for thousand seed weight was also reported by Suryakumari *et al.* (2014) and Kranthi Rekha *et al.* (2016). High magnitude of significant positive average heterosis (69.15%) followed by heterobeltiosis (67.87%) was recorded by CM1008A × NCR1681 and commercial heterosis over Indam-5 (26.47%) and commercial heterosis over Tejaswini (66.92%) was recorded by the cross CM5032A × NCR1748 for average seed count per fruit. Heterosis for average seed count per fruit was also reported by Suryakumari *et al.* (2014) and Kranthi Rekha *et al*. (2016).

For number of fruits per plant, high magnitude of significant positive average heterosis (143.96%) followed by heterobeltiosis (138.5%) was recorded by CM5032A × NCR1886 and commercial heterosis over Indam-5 (72.80%) and commercial heterosis over Tejaswini (54.88%) was recorded by the cross CM5076A × NCR3295. Heterosis for number of fruits per plant was

Table 3a : Heterosis, heterobeltiosis and commercial heterosis for days to 50% flowering, plant height and plant width in chilli.

	Cross	DFF				Plant height				Plant width			
		MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini
1	CM1008AxNCR3295	**19.75****	**16.83****	0.42	-3.62	29.13**	3.14**	78.6**	-5.32**	0.74	-20.62**	-2.29	26.75**
2	CM1008AxNCR4293	9.85**	6.93**	-2.94	-6.84**	21.7**	1.9	56.25**	-17.17**	8.32**	-0.23	-16.02**	8.94**
3	CM1008AxNCR1681	5.82**	-3.79	1.05	-3.02	8.67**	-18.33**	67.95**	-10.96**	13.2 **	9.46**	-16.9**	7.79 **
4	CM1008AxNCR1886	7.66**	-1.22	1.68	-2.41	11.52**	6.84 **	20.66**	-36.04**	5.76 **	-9.25**	-10.17**	16.53 **
5	CM1008AxNCR1748	0.67	-7.38**	-5.24 *	-9.05**	20.36**	13.65 **	17.57**	-37.67**	**40.78 ****	**25.65****	13.47**	47.2 **
6	CM1008AxNCR1238	0.9	-5.91*	-6.5 **	-10.26**	6.13**	3.15	13.06**	-40.07**	14.95 **	6.32**	-11.31**	15.05 **
7	CM1037AxNCR3295	12.35**	8.33**	-4.61	-8.45**	4.63**	-4.72 **	64.99**	-12.54**	-19.39**	-35.03**	-20.02**	3.75
8	CM1037AxNCR4293	15.83**	14.09**	3.56	-0.6	-8.78**	-12.09 **	34.8**	-28.54**	2.95	-2.45	-17.89**	6.51**
9	CM1037AxNCR1681	6.41**	-2.2	2.73	-1.41	9.72**	-7.2 **	90.83**	1.16	-5.71**	-6.07**	-28.69**	-7.5**
10	CM1037AxNCR1886	5.38*	-2.24	0.63	-3.42	-1.62	-11.74 **	25.51**	-33.47**	10.94**	-2.31	-3.3	25.43**
11	CM1037AxNCR1748	13**	5.12*	7.55 **	3.22	9.75**	-9.66 **	28.47**	-31.89**	4.58*	-4.08*	-13.38**	12.37**
12	CM1037AxNCR1238	10.29**	4.01	3.35	-0.8	-8.02**	-18.56 **	15.81**	-38.61**	3.72*	-1.3	-17.67**	6.8**
13	CM1112AxNCR3295	11.38**	6.56*	-4.61	-8.45**	14.61**	-9.57 **	56.59**	-16.99**	-6.76**	-23.46**	-5.78**	22.22**
14	CM1112AxNCR4293	6.74**	6 *	-3.77	-7.65**	11.29**	-8.03 **	41.02**	-25.24**	12.72**	9.25**	-8.04**	19.29**
15	CM1112AxNCR1681	-2.37	-9.58**	-5.03 *	-8.85**	2.02	-24.16 **	55.96**	-17.32 **	12.57 **	10.38 **	-12.81 **	13.11 **
16	CM1112AxNCR1886	0	-6.52**	-3.77	-7.65**	19.87**	13.06 **	27.68**	-32.31 **	3.98 *	-6.52 **	-7.47 **	20.03 **
17	CM1112AxNCR1748	-2.08	-8.2**	-6.08 *	-9.86**	15.4**	10.68**	10.79**	-41.27 **	12.95 **	5.88 **	-4.39 *	24.03 **
18	CM1112AxNCR1238	-0.33	-5.27*	-5.87 *	-9.66**	14.82**	9.84**	20.39**	-36.18 **	5.89 **	3.09	-14.01 **	11.54 **
19	CM1162AxNCR3295	14.32**	8.53**	-1.26	-5.23*	8.44**	1.91	76.47**	-6.45 **	-16.7 **	-25.43 **	-8.2 **	19.08 **
20	CM1162AxNCR4293	9.57**	9.45**	-0.42	-4.43	-2.73*	-3.05*	48.65**	-21.2 **	-7.02 **	-13.29 **	-15.63 **	9.44 **
21	CM1162AxNCR1681	4.6*	-2.4	2.52	-1.61	8.84**	-5.27**	94.81**	3.27**	8.75 **	-3.2	-5.82 **	22.18 **
22	CM1162AxNCR1886	11.14**	4.68*	7.76**	3.42	-10.19**	-21.8**	19.11**	-36.86**	-3.93 **	-4.75 **	-5.72 **	22.3**
23	CM1162AxNCR1748	9.11**	3.07	5.45*	1.21	2.12	-18.12**	24.71**	-33.89**	19.14 **	14.86 **	11.76 **	44.97**
24	CM1162AxNCR1238	11.01**	6.33**	5.66*	1.41	-10.71**	-23.23**	16.94**	-38.01**	-5.54 **	-12.28 **	-14.65 **	10.72**
25	CM5032AxNCR3295	10.01**	8.77**	-9.01**	-12.68**	17.93**	-3.57**	66.99**	-11.47**	-19.29**	-21.32**	2	32.32**
26	CM5032AxNCR4293	13.22**	8.78**	-1.26	-5.23*	**41.65****	21.66**	86.53**	-1.11	3.28*	-14.83**	10.42**	43.24**
27	CM5032AxNCR1681	14.89**	3.19	8.39**	4.02	1.21	-22.32**	59.75**	-15.31**	21.5**	-3.68**	**24.88****	**62****
28	CM5032AxNCR1886	7.42**	-2.65	0.21	-3.82	24.24**	22.65**	38.51**	-26.57**	-1.74	-13.36**	12.33**	45.71**
29	CM5032AxNCR1748	18.38**	7.58**	10.06**	5.63*	24.75**	14.47**	25.97**	-33.22**	-7.11**	-21.2**	2.16	32.52**
30	CM5032AxNCR1238	-6.3**	-13.71**	**-14.26****	**-17.71****	27.55**	**27.3****	40.08**	-25.74**	-8.43**	-24.75**	-2.45	26.55**
31	CM5076AxNCR3295	2.55	-2.76	-11.32**	-14.89**	12.57**	11.91**	96.07**	3.94**	1.81	-8.62**	12.49**	45.92**
32	CM5076AxNCR4293	14.98**	14.71**	4.61	0.4	13.85**	6.75**	87.02**	-0.86	22.53**	13.96**	11.53**	44.68**
33	CM5076AxNCR1681	-7.91**	**-13.97****	-9.64**	-13.28**	16.14**	7.55**	**121.16****	**17.24****	18.3**	5.03**	2.8	33.35**
34	CM5076AxNCR1886	**-8.21****	-13.44**	-10.9**	-14.49**	20.94**	-0.55	74.23**	-7.64**	-1.53	-2.09	-3.08	25.72**
35	CM5076AxNCR1748	5.96**	0.2	2.52	-1.61	20.16**	-8.4**	60.47**	-14.93**	-0.2	-4.06*	-6.1**	21.81**
36	CM5076AxNCR1238	-2.97	-6.96**	-7.55**	-11.27**	-3.07*	-21.21**	38.03**	-26.83**	27.08**	17.69**	15.19**	49.42**

*: Significant at 5% level, **: significant at 1% level.

Table 3b : Heterosis, heterobeltiosis and commercial heterosis for fruit length, fruit width and number of fruits per plant in chilli.

F_1	Cross	Fruit length				Fruit width				Number of fruits per plant			
		MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini
1	CM1008AxNCR3295	12.91 **	0.4	23.73 **	44.09 **	-1.24	-3.35 **	-5.29 **	59.73 **	21.25 **	-3.43	13.39 **	1.64
2	CM1008AxNCR4293	**19.15** **	**13.11** **	8.5 **	26.35 **	-3.82 **	-9.42 **	-11.24 **	49.69 **	38.85 **	36.92 **	-1.96	-12.13 **
3	CM1008AxNCR1681	4.16 **	-22.13 **	-25.31 **	-13.02 **	2.3 *	-9.05 **	-10.87 **	50.31 **	50.72 **	46.5 **	1.98	-8.59 **
4	CM1008AxNCR1886	-1.94 **	-5.87 **	-9.71 **	5.15 **	0.55	-9.36 **	-11.18 **	49.8 **	33.34 **	31.84 **	-8.22 **	-17.74 **
5	CM1008AxNCR1748	4.98 **	3.14 **	-1.07	15.21 **	2.1 *	0.24	**1.94**	**71.93** **	64.86 **	58.4 **	10.26 **	-1.17
6	CM1008AxNCR1238	-6.45 **	-7.97 **	-11.72 **	2.81 **	-1.55	-9.3 **	-11.12 **	49.9 **	23.06 **	19.84 **	-11.97 **	-21.1 **
7	CM1037AxNCR3295	1.43 *	-14.7 **	5.13 **	22.43 **	-7.63 **	-9.96 **	-11.06 **	50 **	-0.32	-19.75 **	-5.76	-15.53 **
8	CM1037AxNCR4293	-4.08 **	-5.28 **	-18.35 **	-4.92 **	-8.88 **	-14.51 **	-15.55 **	42.42 **	58.12 **	58.06 **	13.27 **	1.52
9	CM1037AxNCR1681	-3.59 **	-24.55 **	-36.59 **	-26.16 **	0.17	-11.25 **	-12.33 **	47.85 **	24.63 **	19.46 **	-14.4 **	-23.27 **
10	CM1037AxNCR1886	-2.35 **	-4.66 **	-15.89 **	-2.05 *	-7.63 **	-17.04 **	-18.04 **	38.22 **	73.68 **	69.3 **	21.32 **	8.74 **
11	CM1037AxNCR1748	-4.35 **	-8.75 **	-15.54 **	-1.65	-4.36 **	-5.73 **	-4.13 **	61.68 **	44.14 **	36.59 **	-2.12	-12.27 **
12	CM1037AxNCR1238	-0.61	-5.31 **	-12.12 **	2.34 **	-3.92 **	-11.81 **	-12.88 **	46.93 **	36.05 **	34.38 **	-1.29	-11.52 **
13	CM1112AxNCR3295	-0.94	-12.77 **	7.5 **	25.19 **	0.27	-4.66 **	-10.57 **	50.82 **	31.47 **	8.83 **	27.8 **	14.55 **
14	CM1112AxNCR4293	-5.5 **	-9.33 **	-14.95 **	-0.95	-2.8 *	-3.93 **	-16.83 **	40.27 **	50.82 **	45.54 **	12.05 **	0.43
15	CM1112AxNCR1681	-17.72 **	-38.03 **	-41.87 **	-32.3 **	-26.41 **	-30.03 **	-40.83 **	-0.2	67.48 **	55.21 **	19.5 **	7.11 *
16	CM1112AxNCR1886	1.69 *	-1.33	-7.45 **	7.78 **	**16.49** **	**12.43** **	-4.92 **	60.35 **	46.5 **	37.99 **	6.24 *	-4.78
17	CM1112AxNCR1748	-8.12 **	-8.73 **	-14.38 **	-0.3	1.24	-7.29 **	-5.71 **	59.02 **	67.1 **	53.17 **	17.93 **	5.7 *
18	CM1112AxNCR1238	-2.15 **	-2.67 **	-8.7 **	6.33 **	3.89 **	2.66 *	-13.18 **	46.41 **	37.71 **	34.55 **	3.59	-7.15 *
19	CM1162AxNCR3295	6.85 **	0.1	23.37 **	43.67 **	-4.31 **	-6.38 **	-8.2 **	54.82 **	22.19 **	5.97 *	24.43 **	11.53 **
20	CM1162AxNCR4293	14.78 **	3.33 **	11.27 **	29.58 **	-6.22 **	-11.71 **	-13.43 **	46 **	44.36 **	32.1 **	13.94 **	2.13
21	CM1162AxNCR1681	-18.28 **	-41.12 **	-36.59 **	-26.16 **	-4.71 **	-15.3 **	-16.95 **	40.06 **	51.03 **	33.05 **	14.76 **	2.86
22	CM1162AxNCR1886	-2.52 **	-11.32 **	-4.51 **	11.2 **	-0.1	-9.98 **	-11.73 **	48.87 **	43.62 **	28.46 **	10.8 **	-0.69
23	CM1162AxNCR1748	2.56 **	-4.64 **	2.68 **	19.58 **	0.43	-1.37	0.3	69.16 **	57.7 **	37.5 **	18.59 **	6.3 *
24	CM1162AxNCR1238	-9.28 **	-15.55 **	-9.06 **	5.91 **	-2.66 *	-10.35 **	-12.09 **	48.26 **	21.64 **	12.62 **	-2.87	-12.94 **
25	CM5032AxNCR3295	6.36 **	-0.78	22.28 **	42.41 **	-3.92 **	-8.3 **	-5.35 **	59.63 **	69.45 **	36.12 **	59.85 **	43.27 **
26	CM5032AxNCR4293	10.82 **	0.17	6.88 **	24.47 **	-9.99 **	-17.25 **	-14.58 **	44.06 **	64.04 **	63.63 **	17.16 **	5.01
27	CM5032AxNCR1681	-13.18 **	-37.27 **	-33.06 **	-22.05 **	-2.64 *	-15.36 **	-12.64 **	47.34 **	89.8 **	82.44 **	29.97 **	16.49 **
28	CM5032AxNCR1886	-12.64 **	-20.2 **	-14.86 **	-0.84	-0.2	-12.07 **	-9.23 **	53.07 **	**143.96** **	**138.5** **	69.9 **	52.29 **
29	CM5032AxNCR1748	3.55 **	-3.31 **	3.17 **	20.15 **	-8.03 **	-8.71 **	-5.77 **	58.91 **	97.56 **	87.74 **	33.75 **	19.88 **
30	CM5032AxNCR1238	0.97	-5.6 **	0.72	17.3 **	-5.3 **	-14.77 **	-12.03 **	48.36 **	75.57 **	72.92 **	27.02 **	13.85 **
31	CM5076AxNCR3295	-0.06	-4.13 **	**28.62** **	**49.79** **	-6.02 **	-6.48 **	-12.27 **	47.95 **	66.16 **	47.15 **	**72.8** **	**54.88** **
32	CM5076AxNCR4293	-2.25 **	-19.73 **	7.7 **	25.42 **	0.95	-2.49 *	-9.42 **	52.77 **	79.52 **	60.73 **	45.57 **	30.47 **
33	CM5076AxNCR1681	-20.62 **	-46.26 **	-27.9 **	-16.03 **	-2.37 *	-11.12 **	-17.44 **	39.24 **	93.82 **	67.23 **	51.46 **	35.75 **
34	CM5076AxNCR1886	3.37 **	-14.33 **	14.95 **	33.86 **	2.48 *	-5.36 **	-12.09 **	48.26 **	63.25 **	42.96 **	29.48 **	16.05 **
35	CM5076AxNCR1748	-3.32 **	-18.31 **	9.6 **	27.64 **	-5.59 **	-9.68 **	-8.14 **	54.92 **	84.18 **	57.32 **	42.49 **	27.71 **
36	CM5076AxNCR1238	-8.53 **	-22.63 **	3.8 **	20.89 **	-1.8	-7.26 **	-13.85 **	45.29 **	108.7 **	88.98 **	71.16 **	53.41 **

*: Significant at 5% level, **: significant at 1% level.

Table 3c : Heterosis, heterobeltiosis and commercial heterosis for average seed count per fruit, thousand seed weight and dry chilli yield per plot in chilli.

S. no.	Cross	Average seed count per fruit				Thousand seed weight				Dry chilli yield per plot			
		MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini	MPH	BPH	Indam-5	Tejaswini
1	CM1008AxNCR3295	33.74 **	9.26 **	25.99 **	66.29 **	6.48 **	-2.41	5.59 **	-5.03 **	83.86 **	79.12 **	41.58 **	10.17 **
2	CM1008AxNCR4293	38.05 **	27.26 **	10.26 **	45.53 **	9.38 **	6.9 **	0.93	-9.21 **	77.62 **	57.35 **	17.96 **	-8.21 **
3	CM1008AxNCR1681	**69.15 ****	**67.87 ****	24.6 **	64.45 **	1.25	0.21	-9.68 **	-18.76 **	58.56 **	58 **	18.45 **	-7.83 **
4	CM1008AxNCR1886	23.1 **	15.13 **	-3.32	27.6 **	10.06 **	7.25 **	1.86	-8.38 **	29.99 **	29.12 **	-1.89	-23.66 **
5	CM1008AxNCR1748	26.59 **	8.58 **	10.93 **	46.41 **	7.14 **	3.05 *	0.56	-9.55 **	75.1 **	61.71 **	21.23 **	-5.67 *
6	CM1008AxNCR1238	11.59 **	11.45 **	-18.54 **	7.52 **	11.53 **	8.38 **	3.54 *	-6.87 **	39.01 **	24.87 **	-6.39	-27.16 **
7	CM1037AxNCR3295	29.71 **	4 **	19.93 **	58.29 **	-1	-6.54 **	1.12	-9.05 **	59.97 **	56.08 **	23.37 **	-4
8	CM1037AxNCR4293	48.83 **	34.2 **	16.28 **	53.46 **	10.26 **	9.3 **	5.03 **	-5.53 **	101.49 **	78.26 **	34.05 **	4.31
9	CM1037AxNCR1681	63.58 **	58.49 **	17.64 **	55.26 **	0	-4.07 **	-7.82 **	-17.09 **	79.33 **	78.43 **	34.18 **	4.41
10	CM1037AxNCR1886	50.06 **	37.22 **	15.23 **	52.08 **	7.02 **	6.4 **	2.23	-8.04 **	88.09 **	87.12 **	42.18 **	10.63 **
11	CM1037AxNCR1748	29.01 **	8.45 **	10.8 **	46.23 **	6.15 **	5.34 **	2.79 *	-7.54 **	38.47 **	27.7 **	-3.97	-25.28 **
12	CM1037AxNCR1238	26.35 **	23.49 **	-9.97 **	18.83 **	5.73 **	5.43 **	1.3	-8.88 **	79.07 **	60.64 **	20.79 **	-6.01 *
13	CM1112AxNCR3295	12.79 **	-4.46 **	10.16 **	45.4 **	5.18 **	-0.34	7.82 **	-3.02 *	69.43 **	65.05 **	30.46 **	1.51
14	CM1112AxNCR4293	41.15 **	35.77 **	17.64 **	55.26 **	11.98 **	10.58 **	7.08 **	-3.69 **	74.45 **	54.56 **	15.84 **	-9.86 **
15	CM1112AxNCR1681	44.66 **	39.41 **	11.58 **	47.26 **	-5.43 **	-9.62 **	-12.48 **	-21.27 **	117.64 **	116.91 **	62.57 **	26.5 **
16	CM1112AxNCR1886	3.92 *	1.48	-14.78 **	12.47 **	**14.95****	**13.85****	**10.24****	**-0.84**	63.66 **	62.55 **	23.51 **	-3.89
17	CM1112AxNCR1748	9.94 **	-1.97	0.15	32.18 **	13.41 **	12.98 **	10.24 **	-0.84	93.6 **	78.81 **	34.02 **	4.29
18	CM1112AxNCR1238	19.08 **	13.78 **	-8.94 **	20.19 **	7.84 **	7.12 **	3.72 **	-6.7 **	73.45 **	55.82 **	16.79 **	-9.12 **
19	CM1162AxNCR3295	11.55 **	2.41	18.09 **	55.85 **	9.16 **	1.55	9.87 **	-1.17	83.23 **	82.31 **	44.11 **	12.13 **
20	CM1162AxNCR4293	8.6 **	3.1	-0.6	31.19 **	14.4 **	13.61 **	7.26 **	-3.52 **	84.13 **	60.14 **	25.3 **	-2.5
21	CM1162AxNCR1681	36.62 **	20.9 **	16.56 **	53.84 **	0.82	-1.8	-8.57 **	-17.76 **	35.12 **	31.83 **	3.15	-19.73 **
22	CM1162AxNCR1886	0.62	-5.87 **	-9.25 **	19.77 **	9.7 **	8.63 **	3.17 *	-7.2 **	58.13 **	55.84 **	21.94 **	-5.11
23	CM1162AxNCR1748	12.01 **	8.86 **	11.21 **	46.78 **	14.26 **	11.64 **	8.94 **	-2.01	77.62 **	60.88 **	25.89 **	-2.04
24	CM1162AxNCR1238	-0.81	-12.9 **	-16.03 **	10.83 **	14.71 **	13.26 **	8.19 **	-2.68 *	92.42 **	69.63 **	32.73 **	3.28
25	CM5032AxNCR3295	-9.63 **	-11.93 **	1.56	34.04 **	-0.94	-1.69	8.01 **	-2.85 *	**120.92****	**119.18****	**73.25****	**34.81****
26	CM5032AxNCR4293	13.58 **	1.75	11.36 **	46.98 **	-5.01 **	-11.69 **	-2.98 *	-12.73 **	73.11 **	50.92 **	17.42 **	-8.63 **
27	CM5032AxNCR1681	-1.71	-17.53 **	-9.73 **	19.14 **	-9.4 **	-18.31 **	-10.24 **	-19.26 **	42.16 **	39.09 **	8.22 *	-15.79 **
28	CM5032AxNCR1886	15.06**	1.67	11.28 **	46.87 **	-1.27	-7.97 **	1.12	-9.05 **	111.82 **	109.35 **	62.87 **	26.74 **
29	CM5032AxNCR1748	19.54**	15.55 **	**26.47****	**66.92****	-1.62	-7.12 **	2.05	-8.21 **	43.59 **	30.39 **	1.45	-21.06 **
30	CM5032AxNCR1238	-1.91	-18.29 **	-10.56 **	18.04**	-10.24 **	-16.1 **	-7.82 **	-17.09 **	53.29 **	35.47 **	5.4	-17.99 **
31	CM5076AxNCR3295	4.84**	0.97	16.43 **	53.66**	-3.17 **	-5.51 **	2.23	-8.04 **	92.32 **	74.01 **	69.89 **	32.19 **
32	CM5076AxNCR4293	16.42**	5.44 **	12.61 **	48.62**	2.08	-2.17	0.74	-9.38 **	85.26 **	47.53 **	44.03 **	12.07 **
33	CM5076AxNCR1681	15.7**	-1.94	4.72 **	38.21**	-4.97 **	-11.75 **	-9.12 **	-18.26 **	60.34 **	41.3 **	37.94 **	7.34 *
34	CM5076AxNCR1886	14.7**	2.44	9.4 **	44.39**	-10.07 **	-13.56 **	-10.99 **	-19.93 **	26.61 **	12.58 **	9.91 **	-14.48 **
35	CM5076AxNCR1748	-4.22**	-6.3 **	0.07	32.07**	8.64 **	5.79 **	8.94 **	-2.01	41.21 **	16.53 **	13.77 **	-11.47 **
36	CM5076AxNCR1238	7.86**	-9.25**	-3.09	27.9**	1.13	-2.53	0.37	-9.72 **	117.29 **	75.1 **	70.94 **	33.01 **

*: Significant at 5% level, **: significant at 1% level.

Table 4 : Range, heterosis and best heterotic crosses for nine quantitative characters in chilli.

S.no.	Characters	Range of heterosis (%)				No. of hybrids (based on commercial heterosis-1 and CH-2)				Best heterotic crosses			
		MPH	BPH	CH-1:	CH-2	CH-1:	CH-1:	CH-2:	CH-2:	MPH	BPH	CH-1:	CH-2:
				Indam-5	Tejaswini	+VE	-VE	+VE	-VE			Indam-5	Tejaswini
1.	Days to 50% flowering	-8.21 to 19.75	-13.97 to 16.83	-14.26 to 8.39	-17.71 to 5.63	6	11	1	18	CM5076Ax NCR1886	CM5076Ax NCR1681	CM5032Ax NCR1238	CM5032Ax NCR1238
2.	Plant height	-10.71 to 41.65	-24.16 to 27.30	-10.79 to 21.16	-41.2 to 17.24	36	0	3	30	CM5032Ax NCR4293	CM5032Ax NCR1238	CM5076Ax NCR1681	CM5076Ax NCR1681
3.	Plant width (cm)	-19.39 to 40.78	-35.03 to 25.65	-28.69 to 24.88	-7.50 to 62.0	8	21	34	1	CM1008Ax NCR1748	CM1008Ax NCR1748	CM5032Ax NCR1681	CM5032Ax NCR1681
4.	Fruit length (cm)	-20.62 to 19.15	-46.26 to 13.11	-41.87 to 28.62	-32.3 to 49.79	15	19	24	8	CM1008Ax NCR4293	CM1008Ax NCR4293	CM5076Ax NCR3295	CM5076Ax NCR3295
5.	Fruit width (cm)	-26.41 to 16.49	-30.03 to 12.43	-40.83 to 1.94	-0.20 to 71.93	0	34	35	0	CM1112Ax NCR1886	CM1112Ax NCR1886	CM1008Ax NCR1748	CM1008Ax NCR1748
6.	Number of fruits per plant	-0.32 to 143.96	-19.75 to 138.5	-14.4 to 72.80	-23.2 to 54.88	26	3	16	10	CM5032Ax NCR1886	CM5032Ax NCR1886	CM5076Ax NCR3295	CM5076Ax NCR3295
7.	Average seed count per fruit	-9.63 to 69.15	-18.29 to 67.87	-18.54 to 26.47	-7.52 to 66.92	22	8	36	0	CM1008Ax NCR1681	CM1008Ax NCR1681	CM5032Ax NCR1748	CM5032Ax NCR1748
8.	Thousand seed weight (g)	-10.24 to 14.95	-18.31 to 13.85	-12.48 to 10.24	-21.27 to -0.84	16	9	0	32	CM1112Ax NCR1886	CM1112Ax NCR1886	CM1112Ax NCR1886	CM1112Ax NCR1886
9.	Dry chilli yield per plot	-26.6 to 120.92	-12.5 to 119.18	-6.39 to 73.25	-27.1 to 34.81	31	0	9	16	CM5032Ax NCR3295	CM5032Ax NCR3295	CM5032Ax NCR3295	CM5032Ax NCR3295

Note: MPH - Mid parent heterosis, BPH- Heterobeltiosis, CH-1- Commercial Heterosis over Ind-5, CH-2- Commercial Heterosis over Tejaswini.

also reported by Sharma *et al*. (2013), Suryakumari *et al*. (2014) and Kranthi Rekha *et al.* (2016). High magnitude of significant positive average heterosis (16.49%) followed by heterobeltiosis (12.43%) was recorded by CM1112A × NCR1886 and commercial heterosis over Indam-5 (1.94%) and commercial heterosis over Tejaswini (71.93%) was recorded by the cross CM1008AxNCR1748 for fruit width. Heterosis for fruit width was also reported by Khalil and Hatem (2014), Suryakumari *et al.* (2014) and Kranthi Rekha *et al.* (2016).

For fruit length, high magnitude of significant positive average heterosis (19.15%) followed by heterobeltiosis (13.11%) was recorded by CM1008A × NCR4293 and commercial heterosis over Indam-5 (28.62%) and commercial heterosis over Tejaswini (49.79%) was recorded by the cross CM5076A × NCR3295. Heterosis for fruit length was also reported by Sharma *et al*. (2013), Suryakumari *et al.* (2014) and Kranthi Rekha *et al.* (2016). High magnitude of significant positive average heterosis (40.78%) followed by heterobeltiosis (25.65%) was recorded by CM1008A × NCR1748 and commercial heterosis over Indam-5 (24.88%) and commercial heterosis over Tejaswini (62.0%) was recorded by the cross CM5032A × NCR1681 for plant width. Heterosis for plant width was also reported by Khalil and Hatem (2014), Suryakumari *et al.* (2014) and Kranthi Rekha *et al*. (2016).

For plant height, high magnitude of significant positive average heterosis (41.65%) was recorded by CCM5032A × NCR4293 and heterobeltiosis (13.11%) was recorded by CM5032A × NCR1238 and commercial heterosis over Indam-5 (121.16%) and commercial heterosis over Tejaswini (17.24%) was recorded by the cross CM5076A × NCR1681. Heterosis for plant height was also reported by Sharma *et al*. (2013) and Suryakumari *et al*. (2014), Kranthi Rekha *et al*. (2016). Higher significant negative average heterosis (-8.21%) was recorded by CM5076A × NCR1886 and heterobeltiosis (-13.97%) was recorded by CM5076A × NCR1681 and commercial heterosis over Indam-5 (-14.26%) and commercial heterosis over Tejaswini (-17.71%) was recorded by the cross CM5032A × NCR1238 for days to 50% flowering. Heterosis for days to 50% flowering was also reported by Sharma *et al.* (2013), Suryakumari *et al.* (2014) and Kranthi Rekha *et al.* (2016).

The cross CM1112A × NCR1886 has recorded highest magnitude of significant positive heterosis, heterobeltiosis and commercial heterosis for fruit width and thousand seed weight. The cross CM5032A × NCR1238 was recorded highest magnitude of significant positive heterobeltiosis for plant height and significant negative commercial heterosis for days to 50% flowering. The CM5076A × NCR1681 both hybrids recorded highest magnitude of significant positive commercial heterosis for plant height and significant negative heterobeltiosis for days to 50% flowering.

In the pooled analysis, for dry chilli yield per plant, 31 hybrids and 9 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2 respectively (table 4) for thousand seed weight, 16 hybrids exhibited significant and positive commercial heterosis-1. For average seed count per fruit, 22 hybrids and 36 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2, respectively. For number of fruits per plant, 26 hybrids and 16 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2, respectively. For fruit width, 35 hybrids exhibited significant and positive commercial heterosis-2. For fruit length, 15 hybrids and 24 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2, respectively. For plant width, 8 hybrids and 34 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2, respectively. For plant height, 13 hybrids and 36 hybrids exhibited significant and positive commercial heterosis-1 and commercial heterosis-2 respectively. For days to 50% flowering, 15 hybrids and 6 hybrids exhibited significant and negative commercial heterosis-1 and commercial heterosis-2, respectively.

Among the parents, involved in different cross combinations, the lines CM5076B, CM5032B and CM1162B and restorers NCR3295, NCR1886 and NCR1681 yielded the best heterotic hybrids. The existence of genetic variatbility and nature of gene effects impose the selection of breeding methodology. Many hybrids exhibited significant and desirable heterobeltiosis and commercial heterosis for most of the traits studied including the dry chilli yield per plant in different locations, which suggest the potentiality of hybrids and heterosis breeding scope.

A perusal of *per se* performance and heterotic effects of crosses revealed that the hybrids *viz*., CM1112A × NCR1886, CM5032A × NCR3295, CM5076A × NCR3295 and CM5076A × NCR1681 found to be most promising for all the approaches and could be evaluated further in different locations and season for yield trials and stability studies before commercial release.

References

Chaudhary, A., K. Rajesh and S. S. Solankey (2013). Estimation of heterosis for yield and quality components in chilli (*Capsicum annuum* L.). *African Journal of Biotechnology*, **12(47)** : 6605-6610.

Hasanuzzaman, M. M., M. A. Hakim, F. Jannatul, M. M. Islam and L. Rahman (2012). Combining ability and heritability analysis for yield and yield contributing characters in chilli (*Capsicum annuum* L.) land races. *Plant Omic Journal*, **5(4)** : 337-344.

Kaladee, D. (1998). *Improvement of self pollinated crop*. Department of Agronomy, Faculty of Agriculture, Chiang Mai University. 250 p.

Kempthorne, O. (1957). The design and analysis of experiments (p.631). *Robert E Krieger,* Publ. Co. Inc., New York.

Kim, D. S., D. H. Kim, J. H. Yoo and B. D. Kim (2006). Cleaved amplified polymorphic sequence and amplified fragment length polymorphism markets linked to the fertility restorer gene in chilli pepper (*Capsicum annuum* L.). *Molecular Cells*, **21(1)** : 135-140.

Khalil, M. R. and M. K. Hatem (2014). Study on combining ability and heterosis of yield and its components in pepper (*Capsicum annuum* L.). *Alexandria Journal for Agricultural Research*, **59(1)** : 61-71.

Kranthi Rekha, G., L. Naram Naidu, C. Venkata Ramana, K. Umajyothi, M.Paratpararao and K. Sasikala (2016). Heterosis studies for yield and yield attributing characters in chilli (*Capsicum annuum* L.) over environments. *Plant Archives*, **16(1)** : 243-251.

Lee, J., J. B. Yoon and H. G. Park (2008). A CAPS marker associated with the partial restoration of cytoplasmic male sterility in chilli pepper (*Capsicum annuum* L.). *Molecular Breeding*, **21(1)** : 95-104.

Min, W. K., S. Kim, S. K. Sung, B. D. Kim and S. Lee (2009). Allelic discrimination of the restorer-of –fertility gene and its inheritance in peppers (*Capsicum annuum* L.). *Theoretical and Applied Genetics*, **119(7)** : 1289-1299.

Mackey, I. (1976). Genetics and evolutionary principles of heterosis. In : Heterosis of plant breeding (Janossy, A. And Lupton, F G. H,(eds)., Proce.8th congr. *Eucarpia. Elsevier*, P.17-33.

Samia Ben Mansoor Gueddes, Dhouha Saidana, Ali Ben Dhiab and Saleh Rezgui (2015). Estimation of Heterotic and Genetic control of Fruit traits in Tunisian Hot Pepper varieties (*Capsicum annuum* L.) grown in an open field. *International Journal of Current Researh in Biosciences and Plant Biology*, **2(11)** : 68-78.

Sharma, V. K., P. Shailaja and B. B. Sharma (2013). Heterosis studies for earliness, fruit yield and yield attributing traits in bell pepper. *African Journal of Agricultural Research*, **8(29)** : 4088-4098.

Suryakumari, S., D. Srihari, C. Ravishankar, V. Chengareddy and A. Sivashankar (2014). Genetic divergence and combining ability studies for exploitation of heterosis in paprika (*Capsicum annuum* L.). *International Journal of Agricultural Science and Research*, **4(2)** : 59-66.

Turner, J. H. (1953). A study of heterosis in upland cotton, combining ability and inbreeding effects. *Agronomy Journal*, **45** : 487-490.

Yang, C. J., B. J. Chen, J. G. Liu and S. Li (2008). Study on the superiority of hybrid breeding by male sterility in hot pepper. *Journal of China Capsicum*, **1** : 36-38.