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INVESTIGATION OF COMBINING ABILITY AND HETEROTIC PATTERN OF CHILLI (*Capsicum annuum* L.) INBRED LINES FOR HYBRID DEVELOPMENT

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ABSTRACT

Knowledge on the combining ability of inbred lines and classification of them into heterotic groups are very important in hybrid breeding. Therefore, forty-five locally developed inbred lines of chilli (*Capsicum annuum* L.) were crossed with two testers. Resulted test crosses were evaluated for yield and some yield related agronomic characters in a Randomized Complete Block Design with two replicates to study the combining ability and heterotic pattern of inbred lines. Highly significant differences were observed among inbred lines and crosses. Variance component due to specific combining ability (SCA) was higher than the general combing ability (GCA)or was the same for all the traits, yield, pod length, pericarp thickness, pant height and canopy width other than the number of pods/plant and pod diameter indicating the predominance of non-additive type of gene action and possibility of exploiting heterosis. The test crosses, MICH PL 44 x MICH 3, MICH PL 43 x MICH 3, MICH PL 51 x Galkiriyagama, and MICH PL 66 x Galkiriyagama with high mean values and significant SCA effect for yield exhibited the possibility of extracting as high yielding hybrids. Thirty-one inbred lines were identified through heterotic grouping for specific combination crossing program targeting the development of high yielding hybrid chilli varieties.

Key words: Chilli, GCA, Hheterotic grouping, Lines x tester, SCA.

INTRODUCTION

Chilli (*Capsicum annuum* L) is a high value crop grown commercially in almost all parts of the world. Asian continent is responsible for approximately 89% of chilli cultivated areas in the world with the main growing areas located in India, China, Korea, Thailand, Vietnam, Sri Lanka and Indonesia (Pinto *et al*., 2016).Chilli is consumed mainly as green and dry chilli in Sri Lanka and it is one of the most important condiments. Chilli production areas in the country have limited to13,029 ha with a production of 62,866 t in 2015 (DOA, 2015). This production is mainly for green chilli. During the same year, 49,928 t dry chilli has been imported with a value of 10,542 million rupees (DOA, 2015). Achieving self-sufficiency in chilli is very important to Sri Lanka as a developing country. Therefore, productivity of chilli cultivation should be increased. Development of high yielding hybrid chilli varieties is one of the key factors that lead to increase the productivity.

The success of any hybrid breeding program depends on the selection of parents and knowledge on gene action for specific characters (Venkatesh *et al*., 2001). Combining ability analysis is a powerful tool to identify good combiners and select appropriate parents in hybrid development program (Kumar *et al*., 2016). According to Patel *et al., (*1998), Ahamed *et al.*, (2003), Tarchoun *et al.*, (2013), Gueddes *et al.,* (2015) and Herath *et al.*, (2016), both general combining ability and specific combining ability were reported in varying magnitude depending on the yield and yield related agronomic characters in chilli. Large numbers of inbred lines are available in hybrid breeding program. It is very difficult to analyse the combining ability of all these lines in a diallel design. Heterotic pattern of inbred lines is utilized to classify inbred lines in to heterotic groups. This method is important to identify potential inbred lines for the development of high yielding hybrids. Heterotic patterns are critical for maximizing the expression of heterosis in hybrids (Menkir *et al*., 2003).

Considering the necessity of developing high yielding chilli hybrids within the country, this study was conducted to study combining ability effects of inbred lines for yield and some yield components, and to identify and select superior hybrid combinations based on crosses of selected lines and testers. Moreover, for heterotic grouping of inbred lines with fresh pod yield for specific combination crossing program to increase yield.

MATERIALS AND METHODS

Location

This experiment was conducted during 2015/16 *Maha* and 2016 *Yala* at the Field Crop Research and Development Institute (FCRDI), Mahailluppallama (08^{0}06'40.54" N and 80^{0}28'14.70E) which is located in theDL1b agro-ecological region of Sri Lanka.

Parent material and seed production of F1 hybrids

Forty-five inbred lines and two testers were selected for this study. These inbred lines were developed at the Field Crop Research and Development Institute through generation advancement of exotic chilli germplasm. Selection of inbred lines for the study was done on the basis of phenotypic evaluation during 2015 *Yala* (Herath *et al.*, 2016). Commercially grown chilli varieties, Galkiriyagama selection and MICH 3 were used as testers due to their wider genetic background and significant divergence from tested inbred lines. Thirty day old seedlings of these inbred lines and tester lines were planted in clay pots during 2015/16 *Maha*. Eight pots from each parent were maintained inside the net house. Plants were grown under good management conditions according to the recommendation of Department of Agriculture (DOA). At flowering, each inbred line was crossed to two testers (line x tester). Pollinated flowers were covered using oil paper bags. Ripened pods were harvested and seeds were extracted separately.

Field experiment

Seeds of the crosses between inbred lines and testers, seeds of inbred lines and tester lines were sown in nursery trays and after thirty days they were transplanted in the field during 2016 *Yala*. After preparing the land, and before planting the chilli plants, well decomposed cattle manure was incorporated before planting at the rate of 500g/per planting hole. Each plot (6.0 m x 1.8 m) consisted of 50 plants at a spacing of 60 cm x 60 cm and 1 plant per hill. Randomized complete block design with two replicates was adopted. Chemical fertilizer application was done according to the recommendation of DOA. Insecticides and fungicides were applied as required. Weed control was done manually.

Data recording

Agronomic characters, yield, number of pods/plant, pod length, pod diameter, pericarp thickness, plant height and canopy width were assessed based on the descriptors published by the DOA (DOA, 1995). Harvesting was started 70 days after field planting and continued at 10 day intervals. Number of pods and fresh green chilli yield of crosses, inbred line and testers were recorded at each harvesting. Pod diameter, pericarp thickness and pod length were recorded on randomly selected 10 pods from 10 plants from each replicate of each treatment. Height and canopy width of 10 randomly selected plants from each crosses, inbred line and testers were measured.

Data analysis

Combining ability variances and effect for yield and yield related agronomic characters were calculated under the line x tester analysis according to Jawahar and Sharma (2006) as follows.

σ^2_{gca} = Cov (HS) (when inbreeding coefficient, f = 0)

Where, σ^2_{gca} = General Combining Ability variance, Cov (HS) = Covariance of half-sib relatives

σ^2_{sca} = Cov (FS) – 2 Cov (HS)

Where, σ^2_{sca} = Specific Combining Ability variance, Cov (FS) = Covariance of full-sib relatives, Cov (HS) = Covariance of half-sib relatives

$\sigma^2_A = \sigma^2_{gca} / [\frac{(1+F)}{4}]$

Where, σ^2_A = additive genetic variance, σ^2_{gca} = General Combining Ability variance, F = inbreeding coefficient

$\sigma^2_D = \sigma^2_{sca} / [(1+F)^2)/2]$

Where, σ^2_D = dominant genetic variance, σ^2_{sca} = Specific Combining Ability variance, F = inbreeding coefficient

g_i=FH_i - MC

Where g_i = gca effect of i^{th} line, FH_i = line mean, MC = hybrid mean

g_j= MM_j - MC

Where g_j = gca effect of j^{th} tester, MM_j = tester mean, MC = hybrid mean

g_{ij}= MH_{ij}- MC - g_i- g_j

Where g_{ij} = sca effect of ij^{th} cross,MH_{ij} = cross mean, MC = hybrid mean ,g_i = gca effect of i^{th} line, g_j = gca effect of j^{th} tester

Significant differences of each GCA values and SCA values were tested using the t test. Determination of heterotic group was done according to Menkir *et al*., (2003) depending on mean performance and SCA effect. If inbred line x tester hybrid mean is greater than each of two testers means, group was named as "both" and if smaller than each of two tester means, then group was named as "neither". If inbred line x tester hybrid mean is greater than tester 1 or 2, it was grouped with the greater tester name. Mean separation was done using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Genetic variability among parents and hybrids

Analysis of variance revealed significant difference among inbred lines for all the studied traits indicating sufficient genetic variability in the breeding material used in the study (Table 1). Highly significant mean squares due to hybrids for all the traits revealed the varying performance of cross combinations for all the studied traits and, it implied that selection is possible to identify most desirable crosses. The mean sum of squares due to parents was further partitioned in to lines, testers and line vs testers. Lines exhibited significant difference for all the traits indicating the diversity among inbred lines. Testers showed non-significant differences for number of pods/plant, plant height and canopy width. Partitioning sum of squares due to hybrids in to lines in hybrids, testers in hybrids and line x testers in hybrids revealed highly significant difference among line x tester interaction for all the traits other than number of pods/plant. It indicated the presence of non- additive genetic variance. Significant difference among parent vs hybrids for all the traits other than canopy width exhibited that hybrids differ considerably from parents for all the traits other than canopy width and heterosis is reflected in the hybrids which could be exploited for the development of high yielding hybrid varieties.

Gene action

Presence of both general and specific combining ability variances indicated the importance of both additive and non-additive gene action in controlling the traits. Variance component due to specific combining ability was higher or same in amount than the general combing ability for all the traits other than the number of pods/plant and pod diameter indicating the predominance of non-additive type of gene action and possibility of exploiting heterosis for yield enhancement. This was further confirmed by low magnitude of σ^2 GCA/ σ^2 SCA ratio for all the traits other than the number of pods/plant and pod diameter. These findings are consistent with that of Jindal *et al*. (2015) and Nascimento *et al*. (2014) who also reported the predominance of non-additive gene action for most of the traits in chilli studied by them.

General combining ability (GCA) analysis

According to the tables 3 and 4 both negative and positive GCA effects were observed for the tested agronomic characters. None of the inbred lines was a good general combiner for all the traits. The estimates of general combining ability effects for yield revealed that out of the 45 inbred lines, 6 lines exhibited positive and significant GCA effects and 8 lines showed negative but significant GCA effects. Inbred lines with significant positive GCA are the potential parents that can contribute in subsequent development of chilli hybrid with high yield. Inbred line, MICH PL 44 exhibited the maximum significant GCA effect of 22.3 whereas MICH PL 55 showed the minimum significant GCA effect of -12.4 indicating the existence of best and poorest combiners for yield in the group of inbred lines studied.

Table 1. Analysis of variance for combining ability for yield and its components in inbred lines evaluated in test crosses with two testers.

	df	Yield t/ha	No of pods/plant	Pod length(cm)	Pod diameter (mm)	Pericarp thickness (mm)	Plant height (cm)	Canopy width (cm)
Replication (r)	1	1219.9**	14955.8	2.9	2.3	100.0	634.6	1291.2
Entries (en)	136	127.2**	5517.4**	4.2**	6.8**	0.2**	163.1**	205.4**
Parents (p)	46	105.5**	3730.0**	4.1**	11.1**	0.3**	262.7**	230.2**
Lines (f)	44	108.6**	3559.0**	4.3**	13.6**	0.3**	252.2**	229.4**
Testers (m)	1	63.3	11735.9*	1.0	0.7	0.0	34.8*	77.4**
Line Vs testers (f Vs m)	1	11.1	3248.4	1.1	11.6**	1.4**	953.2**	419.5*
Hybrids (c)	89	124.4**	1831.0	2.8**	3.1**	0.1**	69.5**	155.2**
Lines in hybrids (fh)	44	166.7**	134.0	5.0**	4.3**	0.1**	5.1*	3.1
Testers in hybrids (mh)	1	314.7**	77808.6**	0.0	36.5**	1.6**	1808.8**	3397.9**
Lines x Testers in hybrids(fh x mh)	44	77.8**	1768.4	0.8**	1.1**	0.0**	42.7**	77.2**
Parents vs hybrids (p vs h)	1	1372.0**	332125.1**	124.8**	34.2**	2.1**	1878.8**	5.8
Error	136	37.0	2635.5	0.5	0.5	0.01	7.5	19.4
Total	273	86.3	4116.3	2.3	3.6	0.1	87.3	116.7
σ^2 GCA		3.5	64.5	0.04	0.41	0.01	3.00	3.1
σ^2 SCA		6.5	43.0	0.2	0.3	0.01	16.7	28.9
σ^2A		13.9	258	0.1	1.6	0.1	12.0	12.5
σ^2D		26.1	172	0.7	1.2	0.02	67.1	115.6
σ^2 GCA/ σ^2 SCA		0.5	1.5	0.2	1.3	1	0.2	0.1

Note: *p<0.05, **p<0.01

Table 3. Estimates of GCA effect for yield and related traits.

	Yield t/ha	No of pods/ plant	Pod length (cm)	Pod diameter (mm)	Pericarp thickness (mm)	Plant height (cm)	Canopy width (cm)
Lines							
MICH PL 1	-1.9	-111.7**	-1.1**	3.1**	0.5**	-4.9**	-19.1**
MICH PL 5	-1.4	-3.9	0.0	-1.1**	-0.3**	-2.6*	-11.5**
MICH PL 7	5.2*	2.2	-0.8**	0.2	0.1	-3.9**	-6.4**
MICH PL 8	10.6**	-19.6	0.8*	-0.3	-0.1	5.2**	-2.6
MICH PL 9	3.2	8.1	-0.2	-1.5**	-0.1*	-8.0**	-6.5**
MICH PL 11	4.4	41.0*	1.5**	0.5	0.0	1.6	-3.2**
MICH PL 13	4.3	22.5	-0.6	-1.1**	-0.2**	-1.9	-7.3**
MICH PL 14	-6.7*	16.9	-0.1	-0.6*	0.0	-12.1**	-14.4**
MICH PL 16	-1.4	43.5*	0.1	-0.6*	0.0	-0.3	-9.2**
MICH PL 17	-3.3	-3.4	0.3	-0.1	-0.1*	2.3*	-8.5**
MICH PL 20	0.0	-27.0	-1.7**	1.6**	0.1*	-12.1**	-9.0**
MICH PL 21	2.6	8.9	1.0**	-0.6*	0.1	-8.9**	-6.1**
MICH PL 24	3.2	7.0	1.7**	0.1	0.0	-4.3**	0.5
MICH PL 27	-3.9	-41.2*	0.2	-0.3	0.0	-11.2**	-14.6**
MICH PL 28	-9.1**	-20.8	-0.6	-2.0**	-0.1*	-8.1**	-4.9*
MICH PL 30	3.1	-12.7	-0.4	0.6*	0.1*	3.4**	-0.7
MICH PL 34	-2.5	32.0	-0.7*	-0.8*	-0.2**	0.2	2.6
MICH PL 35	-3.4	-10.6	2.4**	-0.7*	0.0	0.9	4.5*
MICH PL 36	4.1	-26.6	-0.9**	1.2**	0.1	-6.5**	-5.8**
MICH PL 37	-2.9	-22.4	0.4	-0.3	0.1*	4.1**	8.8**
MICH PL 38	3.1	13.1	2.7**	0.5	0.1	3.2*	5.3**
MICH PL 39	12.9**	0.3	-0.8*	0.2	0.0	-2.1	3.1
MICH PL 40	-9.6**	41.1*	0.8*	2.5**	0.5**	1.2	6.0**
MICH PL 41	2.3	-11.0	-0.9**	1.4**	0.1*	3.2**	5.2**
MICH PL 43	11.2**	27.1	0.7*	0.2	-0.1*	1.7	2.5
MICH PL 44	22.3**	-13.1	2.9**	-0.1	-0.1	-0.3	8.6**
MICH PL 46	-1.2	-62.9**	1.0**	1.6**	0.0	1.9	0.5
MICH PL 48	0.2	7.9	-0.1	-0.2	0.0	-6.9**	-0.6
MICH PL 49	-11.3**	21.3	-1.2**	-0.2	0.0	16.1**	31.6**
MICH PL 51	5.3*	-4.6	0.6*	0.0	-0.1*	7.9**	8.9**

Note: *p<0.05, **p<0.01

Table 4. Estimates of GCA effect for yield and related traits.

	Yield t/ha	No of pods/ plant	Pod length (cm)	Pod diameter (mm)	Pericarp thickness (mm)	Plant height (cm)	Canopy width (cm)
MICH PL 52	-2.6	52.4*	-1.8**	0.7*	0.0	3.1*	0.8
MICH PL 53	2.2	-16.1	-1.1**	0.6*	-0.1	2.0	-3.8*
MICH PL 54	-1.3	5.7	-0.4	-1.8**	-0.1*	3.7**	2.3
MICH PL 55	-12.4**	25.7	-0.9**	-0.3	0.0	-0.4	-4.4*
MICH PL 56	-1.9	26.3	-1.1**	0.1	0.0	11.5**	22.5**
MICH PL 58	-1.3	14.2	-1.3**	1.5**	0.1	-3.3**	3.4
MICH PL 59	3.8	-12.7	-1.3**	0.4	-0.1*	-2.0	-0.8
MICH PL 62	-4.0	15.0	-0.7*	-0.8*	0.0	5.8**	9.1**
MICH PL 66	-3.5	45.3**	0.3	0.2	-0.1	5.2**	-0.1
MICH PL 67	-6.4*	-38.7	0.0	-0.8**	-0.1**	2.6*	4.3*
MICH PL 73	-8.2**	-4.4	-0.1	-1.1**	-0.1	-2.4*	0.7
MICH PL 75	-5.6*	15.7	1.9**	-1.3**	0.0	1.4	-2.0
MICH PL 78	2.3	-1.7	0.0	-0.2	0.1	1.5	2.3
MICH PL 79	1.1	-40.0*	0.0	0.4	0.0	3.8**	0.5
MICH PL 81	-1.6	11.8	-0.3	-0.4	0.0	8.8**	4.9*
Mean	13.5	141	7.7	10.9	1.3	56.9	61.7
Standard Error	3.0	25.4	0.3	0.3	0.1	1.4	2.2
Testers							
Galkiriyagama	1.3*	5.7*	0.0	-0.5**	-0.1**	1.1*	-0.9*
MICH 3	-1.3*	-5.7*	0.0	0.5**	0.1**	-1.1*	0.9
Mean	11.5	170	7.2	9.1	0.7	42.8	55.3
Standard Error	0.45	3.8	0.05	0.05	0.0	0.2	0.3

Note: *$p<0.05$, **$p<0.01$

Other inbred lines with significant positive GCA for yield were MICH PL 7, MICH PL 8, MICH PL 39, MICH PL 43 and MICH PL 51. The number of inbred lines, which indicated significant positive GCA among the 45 inbred lines, were 5 for number of pods/plant, 11 each for pod length and pod diameter, 6 for pericarp thickness, 16 for plant height, 12 for canopy width.

Highly significant positive GCA effect was recorded for the inbred lines, MICH PL 8 and MICH PL 43, MICH PL 44 and MICH PL 51 for yield and pod length. Parent lines, MICH PL 37, MICH PL 35, MICH PL 41,MICH PL 49, MICH PL 51, MICH PL 56, MICH PL 62, MICH PL 67 and MICH PL 81exhibited positive significant GCA for plant height and canopy width indicating that they were good for contributing genes to increase plant height and canopy width. Inbred line, MICH PL 43 with significant positive GCA for yield and negative GCA for pericarp thickness can be used as a parent for the development of high yielding hybrid varieties suitable for dry chilli production. There is a scope for improving combining ability for component traits, as high combiners for yield were high combiners or at least average combiners for most of the traits studied. Among the testers, Galkiriyagama was a good general combiner for yield, number of pods/plant and plant height while MICH 3 was a good combiner for pod diameter and pericarp thickness. Different parents having good general combining ability for chillihave also been reported by Doshi and Shukla (2000), Hasanuzzaman *et al*. (2012), Nascimento *et al*. (2014) and Jindal *et al*. (2015).

Specific combining ability analysis

Specific combining ability effect and mean performance of the crosses which showed high significant SCA are listed in Table 5. Significant positive or negative SCA effect among the 90 hybrids indicated the possibility of exploiting hybrid vigour for all the tested characters. The number of crosses, which indicated significant positive SCA among the 90 crosses, were 11 for yield, 3 for number of pods/plant, 7 for pod length, 19 for pod diameter, 12 for pericarp thickness, 22 for plant height, 15 for canopy width. Most of the crosses having significant SCA effect exhibited high mean values. However, no single cross did contribute as good specific combiner for all the tested characters.

Table 5. Crosses showing high significant SCA for yield and related traits.

Agronomic trait	Crosses with high significant SCA	SCA effect	Mean performance
Yield t/ha	MICH PL 11 x MICH 3	11.3	14.0 ijklmn
	MICH PL 66 x Galkiriyagama	10.1	26.1 bcdef
	MICH PL 14 x MICH 3	9.4	19.5 efghijkl
	MICH PL 51 x Galkiriyagama	8.5	33.2 abcde
	MICH PL 43 x MICH 3	5	34.0 abcd
	MICH PL 44 x MICH 3	6.0	44.2 a
No of pods/plant	MICH PL 43 x MICH 3	40.8	277 a
	MICH PL 11 x MICH 3	37.6	248 abcde
	MICH PL 36 x Galkiriyagama	37.3	231abcde
Pod length(cm)	MICH PL 55 x Galkiriyagama	1	9.2 ijklmnop
	MICH PL 16 x MICH 3	0.8	9.5 defghijk
	MICH PL 41 x Galkiriyagama	0.8	9.0 hijklmn
Pod diameter (mm)	MICH PL 58 x Galkiriyagama	1	12.1 bcdef
	MICH PL 13 x Galkiriyagama	0.9	9.4 lmnopq
	MICH PL 21 x Galkiriyagama	0.9	9.9 ijklmn
	MICH PL 38 x	0.8	9.5 klmnop
	GalkiriyagamaMICH PL 62 x Galkiriyagama	0.8	9.6 jklmnop
Pericarp thickness (mm)	MICH PL 21 x MICH 3	0.2	1.4bcd
	MICH PL 78 x MICH 3	0.2	1.4 bcd
	MICH PL 38 x MICH 3	0.2	1.45 bc
	MICH PL 21 x Galkiriyagama	-0.2	0.9 hijk
	MICH PL 78 x Galkiriyagama	-0.2	0.85 ijk
	MICH PL 38 x Galkiriyagama	-0.2	0.85 ijk
Plant height (cm)	MICH PL 40 x MICH 3	9.5	60.4 cdef
	MICH PL 56 x MICH 3	6.8	60 ab
	MICH PL 81 x MICH 3	6.1	64.6 bc
	MICH PL 62 x Galkiriyagama	5.5	63.2 bcd
Canopy width (cm)	MICH PL 46 x MICH 3	13.8	76.4 bc
	MICH PL 56 x MICH 3	10.3	94.8 a
	MICH PL 14 x MICH 3	10.6	58.2 lmnopqr
	MICH PL 62 x Galkiriyagama	8.2	77.6 b

Note; Within the column, the means followed by the same letters are not significantly different at 0.05

SCA effect is very important to determine the usefulness of a particular cross combination in the exploitation of heterosis. Among the 90 crosses, mean yield of the crosses, MICH PL 44 x MICH 3, MICH PL 43 x MICH 3, MICH PL 51 x Galkiriyagama, MICH PL 66 x Galkiriyagama was 44.2 t/ha, 34.0 t/ha, 33.2 t/ha and 26.1 t/ha, respectively, with the significant SCA effect for yield. It indicates that there is a possibility of selecting hybrids with higher yield. The cross, MICH PL 43 x MICH 3 which showed significant SCA effect for yield also exhibited highest significant SCA effect for number of pods/plant. The crosses, MICH PL 11 x MICH 3 for yield, MICH PL 55 x Galkiriyagama for pod length, MICH PL 58 x Galkiriyagama for pod diameter, MICH PL 21 x MICH 3 for pericarp thickness, MICH PL 40 x MICH 3 for plant height, MICH PL 46 x MICH 3 for canopy width showed highest desirable positive SCA effects. The SCA effect of the crosses was related to GCA effect of its parents which involved one parent with high GCA and the other parent as average or poor combiner. It indicated that both additive and non-additive genetic effects are important in the study of inheritance. Ahmed *et al*. (1997) also observed the same effect.

Heterotic grouping

Yield of hybrids and SCA were considered to determine heterotic groups of inbred lines. According to the heterotic grouping, thirteen inbred lines were in group “both”, 12 inbred lines were in group “T1” and 6 inbred lines were in group “T2”. Therefore, out of 45 inbred lines 31 inbred lines were selected for specific combination crossing program with the objective of increasing yield. During the inbred line development through generation advancement and selection, additive genetic effect is fixed. But, such a selection does not identify heterosis that would significantly increase yield. Therefore, categorizing inbred lines in to heterotic groups is important. Menkir *et al*. (2003) and Librando and Magulama (2008) reported the heterotic grouping of inbred lines in maize.

Table 6. Mean performance (t/ha), GCA and SCA effects, and heterotic grouping.

	Mean performance			SCA		
Inbred lines	**Galkiriya gama (T1)**	**MICH 3 (T2)**	**GCA**	**Galkiriya gama (T1)**	**MICH 3 (T2)**	**Group**
MICH PL 1	16.1	18.3	-1.9	-3.5	3.5	Neither
MICH PL 5	16.9	18.1	-1.4	-2.6	2.6	Neither
MICH PL 7	19.0	22.5	5.2	-4.9	4.9	Both
MICH PL 8	24.4	22.5	10.6	0.6	-0.6	Both
MICH PL 9	18.9	20.6	3.2	-3.0	3.0	Both
MICH PL 11	24.6	16.1	4.4	7.2	-7.2	T1
MICH PL 13	18.7	21.9	4.3	-4.5	4.5	Both
MICH PL 14	10.8	18.8	-6.7	-9.4	9.4	T2
MICH PL 16	17.6	17.4	-1.4	-1.1	1.1	Neither
MICH PL 17	18.4	14.7	-3.3	2.4	-2.4	T2
MICH PL 20	17.3	19.0	0.0	-3.0	3.0	T2
MICH PL 21	17.3	21.7	2.6	-5.7	5.7	T2
MICH PL 24	23.0	16.5	3.2	5.2	-5.2	T1
MICH PL 27	17.3	15.1	-3.9	0.9	-0.9	Neither
MICH PL 28	14.2	13.0	-9.1	-0.1	0.1	Neither
MICH PL 30	21.2	18.2	3.1	1.7	-1.7	Both
MICH PL 34	19.0	14.9	-2.5	2.8	-2.8	T1
MICH PL 35	17.4	15.5	-3.4	0.7	-0.7	Neither
MICH PL 36	22.1	18.3	4.1	2.5	-2.5	Both
MICH PL 37	17.9	15.5	-2.9	1.1	-1.1	Neither
MICH PL 38	21.5	18.0	3.1	2.3	-2.3	Both
MICH PL 39	27.0	22.1	12.9	3.6	-3.6	Both
MICH PL 40	14.3	12.4	-9.6	0.5	-0.5	Neither
MICH PL 41	22.4	16.3	2.3	4.8	-4.8	T1
MICH PL 43	21.4	26.1	11.2	-6.0	6.0	Both
MICH PL 44	27.5	31.2	22.3	-5.0	5.0	Both
MICH PL 46	12.6	22.5	-1.2	-11.3	11.3	T2
MICH PL 48	20.7	15.9	0.2	3.5	-3.5	T1
MICH PL 49	13.4	11.7	-11.3	0.4	-0.4	Neither
MICH PL 51	25.7	15.9	5.3	8.5	-8.5	T1
MICH PL 52	16.0	17.8	-2.6	-3.2	3.2	Both
MICH PL 53	20.8	17.7	2.2	1.8	-1.8	Both
MICH PL 54	18.5	16.6	-1.3	0.6	-0.6	T1
MICH PL 55	12.8	11.2	-12.4	0.2	-0.2	Neither
MICH PL 56	20.2	14.3	-1.9	4.5	-4.5	T1
MICH PL 58	19.2	15.8	-1.3	2.1	-2.1	T1
MICH PL 59	19.4	20.7	3.8	-2.6	2.6	Neither

Table 7. Mean performance (t/ha), GCA and SCA effects, and heterotic grouping.

	Mean performance			SCA		
Inbred lines	**Galkiriyagama (T1)**	**MICH 3 (T2)**	**GCA**	**Galkiriyagama (T1)**	**MICH 3 (T2)**	**Group**
MICH PL 62	16.3	16.0	-4.0	-1.1	1.1	Neithe
MICH PL 66	22.1	10.7	-3.5	10.1	-10.1	T1
MICH PL 67	14.4	15.5	-6.4	-2.4	2.4	Neithe
MICH PL 73	15.2	12.9	-8.2	0.9	-0.9	Neithe
MICH PL 75	18.1	12.6	-5.6	4.2	-4.2	T1
MICH PL 78	19.2	19.4	2.3	-1.5	1.5	Both
MICH PL 79	21.6	15.9	1.1	4.4	-4.4	T1
MICH PL 81	14.8	19.9	-1.6	-6.4	6.4	T2
Mean	18.8	17.5				

CONCLUSIONS

There was a significant difference among 45 inbred lines for all the studied traits and superior inbred lines and cross combinations that could be exploited by chilii breeders for effective hybrid breeding program were identified. Both GCA and SCA variances were observed for all the traits. But, variance component due to SCA was higher than or the same in amount with the general combing ability for all the traits other than the number of pods/plant and pod diameter. It indicated the possibility of exploiting heterosis. The crosses, MICH PL 44 x MICH 3, MICH PL 43 x MICH 3, MICH PL 51 x Galkiriyagama and MICH PL 66 x Galkiriyagama with high mean value and significant SCA indicated them as high yielding hybrids for further testing. Thirty-one inbred lines were identified through heterotic grouping for specific combination crossing program, targeting the development of high yielding hybrid chilli varieties.

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