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ASSESSMENT OF GENETIC VARIABILITY IN RECOMBINANT INBRED LINES OF CHILLI (*CAPSICUM ANNUUM* L.)

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ABSTRACT

Study on genetic variability was conducted with 68 recombinant inbred lines ofchilli (*Capsicum annuum* L.) in Randomized Complete Block Design with two replicate.Eight quantitative characters,yield, number of pod/plant, pod length, pod diameter, pericarp thickness, plant height, canopy width and days to 50% flowering were taken into consideration. The analysis of variance and mean performance revealed significant variability among the inbred lines for the characters studied. Among the recombinant inbred lines, > 17t/ha of yield was recorded in MICH PL 35, MICH PL 37 and MICH PL 38 in both *yala* and *maha* season indicating the possibility of further testing to isolate as open pollinated chilli varieties. Mean performance of the inbred lines on tested characters was different depending on the season. Phenotypic variance showed higher value than genotypic variance indicating greater influence of environment for the quantitative characters. High genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) were observed for the characters, yield, number of pods/plant, pod length, pod diameter and pericarp thickness indicating the high variability of these characters that offer good scope for selection of parents for the development of chilli hybrids. Moderate GCV and PCV values were observed in plant height and canopy width. The lowest GCV and PCV were observed for days to 50% flowering. High heritability, high genetic advance and high GCV were exhibited for pod characters indicating the presence of fixable additive genetic effect.

Keywords: chilli,GCV,inbred lines, PCV, heritability

INTRODUCTION

Chill (*Capsicum annuum* L.) is the most widely cultivated spices of peppers in the world (Misra *et al*.,2011).In Sri Lanka, it is an economically important condiment and cultivated mainly for green chilli and dry chilli. In 2014, 13978 ha of chilli was cultivated with the production of 71,767 t. In the same year, 46,422 t of dry chilli was imported with the value of 7578 million rupees (DOA. 2014). Even though green chilli production is sufficient to fulfill local demand, dry chilli production is not sufficient. Performance of available open pollinated chilli varieties has not sufficient to increase the productivity of chilli cultivation in Sri Lanka. Local farmers prefer to cultivate imported chilli hybrid varieties with the purpose of achieving higher yield. But, these hybrid varieties do not perform well under local farming condition. Therefore, development of superior hybrid chilli varieties and open pollinated chilli varieties adapted to local condition are very important to increase the productivity of chilli cultivation in the country.

Recombinant inbred lines are developed mainly for the heterosis breeding. Genetic variability among inbred lines are very important to select better parents to develop superior chilli hybrids. Open pollinated chilli varieties can be developed using the inbred lines through hybridization and selection.

The assessment of nature and magnitude of variabilityin the available germplasm is one of the important pre-requisites for selecting effective breeding methods since the geneticimprovement of any crop depends on the magnitude of geneticvariability and the extent of heritability of economically important traits (Ukkund *et al*.,2007). Coefficients of variation assess the magnitude of variability present in a population.Estimates of heritability and genetic advances are important preliminary steps in any breeding program as itprovides information needed in designing the most effective breeding program. (Jalal and Ahmad, 2012)

As an initial step of developing new high yielding open pollinated and hybrid chilli varieties, this study was conducted to assessthe genetic variability of recombinant inbred lines considering the mean performance,genotypic and phenotypic variance, coefficients of variation, heritability and genetic advance.

MATERIAL AND METHODS

Location

This study was conducted during *Yala* 2015 and *Maha* 2015/16 at the Field Crop Research and Development Institute (FCRDI), Mahailluppallama (08006'40.54" N and 80028'14.70E), DL1b agro-ecological region in Sri Lanka.

Recombinant inbred lines used in the study

Sixty-eightrecombinant inbred lines developed at the FCRDI were used in this study.Source materials to develop inbred lines were 20 F1 commercial chilli hybrids. These F1 hybrids were subjected generation advancement through continuous self-pollination and selection of plants for better agronomic traits and for 8 generations from *maha* 2011/2012 to *maha* 2014/15.Seeds were extracted from selected 68 plants of F 8 progenies separately.

Field experiment

Seeds of recombinant inbred lines were sown in nursery beds and, after thirty days they were transplanted in the field during *Yala* 2015. Seedlings of inbred lines were planted in Randomized complete block design with two replicates in plot size of 6.0 m x 1.8 m consisted of five rows of plants at the spacing of 60 cm x 60 cm and 2 plants per hill. Each plot contained 100 plants. Chemical fertilizer application was done according to the recommendation of DOA. Sufficient amount of water was supplied throughout the cropping period.Insecticides and fungicides were applied to protect the crop from pests and diseases. Same procedure was followed during Maha 2015/16.

Data recording

Five plans were randomly selected per treatment and observations were recorded on plant height, canopy width, pod length, pod diameter, pericarp thickness.Number of days which was taken to start the flowering of 50% plant from each treatment was taken as days to 50% flowering.These agronomic characters were assessed based on the descriptors published by DOA (DOA, 1995). Harvesting was started 75 days after field planting and continued at 10 day intervals. Number of pods and fresh green chilli yield of each treatment were recorded at each harvesting.

Climatic data on rainfall, temperature and photoperiod were collected from the agrometeorological station, Mahailuppallama.

Data analysis

The data for each tested agronomic character over two replicates and two season were submitted for statistics using SAS to ascertain existence of variability among genotypes. Mean separation was done by Duncan Multiple Range Test. Genotypic variance (σ2g) and phenotypic variance (σ2p) were obtained from analysis of variance table according to Comstock and Robinson (1952) as follows.

$$\sigma^2 g = \frac{MS1 - MS2}{r \times s}$$

$$\sigma^2 p = \frac{MS1}{r \times s}$$

Where, r = replication, s = season MS1= Mean square for cultivar, MS2= Mean square for cultivar × season.

Phenotypic Coefficient of Variation (PCV),Genotypic Coefficient of Variation (GCV), broad sense heritability(h2)and genetic advance (GA) were calculated according to Singh and Chaudh

$$GCV\ \% = \frac{\sqrt{\sigma^2 g}}{x} \times 100$$

$$PCV\ \% = \frac{\sqrt{\sigma^2 p}}{x} \times 100$$

Where, $\sigma^2 g$ = genotypic variance, $\sigma^2 p$ = phenotypic variance and x = sample mean.

$$h_2 = \frac{\sigma^2 g}{\sigma^2 p}$$

Where, $\sigma^2 g$ = genotypic variance, $\sigma^2 p$ = phenotypic variance

$$GA = k.\sqrt{\sigma^2 p}.h_2$$

$$GA\ \text{as}\ \%\ \text{of means (GAM)} = \frac{GA}{x} \times 100$$

Where, k = constant = 2.06 at 5% selection intensity, $\sigma^2 p$ = phenotypic variance, h_2= Heritability, x = sample mean

RESULTS AND DISCUSSION

Climatic data

According to figure 1, dry weather condition prevailed in June, July and August during Yala 2015. But, at the time of crop establishment inter- monsoon rain was received. Larger fluctuation on temperature was not observed during yala 2015.According to figure 2, heavy North East monsoon rain prevailed in November, December and January. Sudden fluctuation of sunshine ours was observed during both *Yala* 2015 and *Maha* 2015/16.

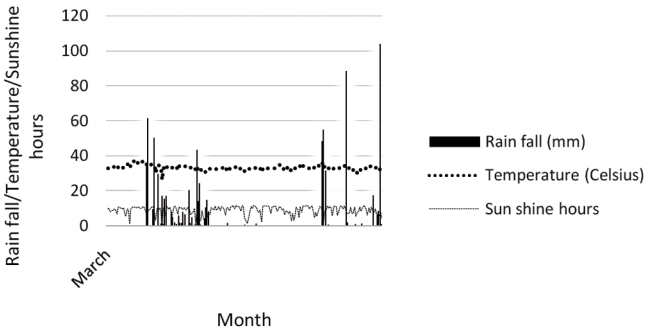

Figure 1. Changes on rainfall, temperature and sunshine hours during *yala* 2015.

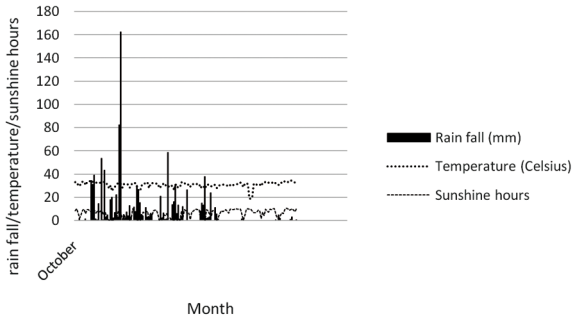

Figure 2. Changes on rainfall, temperature and sunshine hours during *maha* 2015/16.

Analysis of variance over two seasons for the tested quantitative characters

The results from analysis of variance over two seasons for the tested quantitative characters are presented in Table 1. Significant difference among the recombinant inbred lines was observed for all the tested characters other than number of pods/plant. There was a significant effect on season for the tested agronomic characters other than plant height. Interaction between season and treatment was significant for pod length, pod diameter, plant height, canopy width and days to 50 % flowering.

Table 4. Analysis of variance for yield and yield related agronomic characters of inbred lines

Source	df	Yield	Number of pods/ plant	Pod length	Pod diameter	Pericarp thickness	Plant height	Canopy width	Days to 50% flowering
Season	1	8776.8*	304984.0*	88.8*	14.7*	19.1*	58.1	25302.3*	14764.7*
Block	1	241.3	41111.5*	1.6	1.2	0.03	1148.8*	111.5	31.1
Treatment	67	58.2*	1457.6	9.1*	25.0*	0.3*	252.4*	247.5*	30.0*
Season * Treatment	67	25.9	1201.4	2.7*	3.1*	0.1	125.3*	93.8*	24.5*
CV %		45.3	50.3	10.8	8.3	18.8	11.2	14.6	5.1

* = null hypothesisis rejected at œ = 0.0001.

Mean performance of recombinant inbred lines

Mean performance of the tested agronomic characters during *yala* 2015 and *maha* 2015/16 are shown in Table 2 and 3. Mean, maximum and minimum values on agronomic characters confirmed the variability associate with the inbred lines. None of the inbred lines performed well for all the tested character during both season indicating the high environmental effect on the expression of tested agronomic characters. Performance of the inbred lines on tested character was vary depending on the season. Among the recombinant inbred lines, highest yield was recorded in MICH PL 35, MICH PL 37 and MICH PL 38 exhibiting the stability over seasons.These inbred lines can be exploited for further testing to release as open pollinated varieties. Also, there is a possibility of using

this high yielding genotypes as parents in a cross to improve the yield potential. Inbred line, MICH PL 27 exhibited the highest number of pods/plant (215) during *yala* 2015. Inbred lines, MICH PL 27, MICH PL 52, MICH PL 49, MICH PL 47and MICH PL 63 also produced higher number of pods/plant during the same season. But, the performance of these inbred lines on number of pods/ plant was comparatively low with rainy weather condition during *maha* season other than MICH PL 47. In case of pod length, MICH PL 35, MICH PL 31, MICH PL 36, MICH PL 55 and MICH PL 19 were the promising inbred lines during *yala* 2015. Among these inbred lines, MICH PL 35 performed well during *maha* season also in case of pod length. Tallest plants were observed in MICH PL 54, MICH PL 66, MICH PL 38, MICH PL 47 and MICH PL 55 respectively during *yala* season. But, performance of these inbred lines on plant height was reducedduring *maha* season other than MICH PL 38. For canopy width, MICH PL 41 was promising following the MICH PL 35, MICH PL 38, MICH PL 37 and MICH PL 30 during Yala season and MICH PL 37 was promising following the MICH PL 38, MICH PL 41, MICH PL 15 and MICH PL 9 during *maha* season. Only the Pericarp thickness was maximum in MICH PL 1 in both season indicating greater possibility for long distance transportation. Inbred lines, MICH PL 60, MICH PL 65, MICH PL 46, MICH PL 45 and MICH PL 16showed less pericarp thickness which is suitable for dry chilli production during *yala* season. During *maha* season MICH PL 7, MICH PL 60, MICH PL 45, MICH PL 67 and MICH PL 53 showed less pericarp thickness. Early maturity character was showed in MICH PL 5, MICH PL 35, MICH PL 17, MICH PL 49 and MICH PL 28 during *yala* season. MICH PL 17, MICH PL 48, MICH PL 19, MICH PL 22 and MICH PL 1 exhibited early maturity character during *maha* season. There is a possibility of using this inbred lines as parents to develop early maturity hybrids depending on the season. Wide variations in mean performance of yield and yield related agronomic characters were also observed by Mishra *et al*, 2004 and Herathet *al*, 2015.Profound effect of environmental factors on quantitative traits of chilli was observed by Chaim and Paran (2000).Larger reduction on mean performance of yield was observed during *maha* season for all the inbred lines.

Table 2. Variability depend on mean performance of tested agronomic characters during *yala* 2015

Character	Mean	Range		Mean difference between maximum and minimum mean value
		Maximum	Minimum	
Yield (t/ha)	17.0	36.1a (MICH PL 27)	8.1h (MICH PL 55)	28.0
		32.4 ab (MICH PL 37)	8.25 gh (MICH PL 68)	
		31.8 abc (MICH PL 35)	9.6 fgh (MICH PL 7)	
		27.7 abcd (MICH PL 40)	9.8 fgh (MICH PL 43)	
		27.5 abcde (MICH PL 38)	9.8 fgh (MICH PL 59)	
Number of pod/plant	10.2	215 a (MICH PL 27)	22 g (MICH PL 1)	193
		186 ab (MICH PL 52)	47 fg (MICH PL 2)	
		177 abc (MICH PL 49)	59 efg (MICH PL 68)	
		160 abcde (MICH PL 47)	62 defg (MICH PL 8)	
		160 abcde (MICH PL 63)	63 defg (MICH PL 25)	
Pod length (cm)	8.6	14.0 a (MICH PL 35)	4.7 z (MICH PL 49)	9.3
		13.3 ab (MICH PL 31)	4.9 yz (MICH PL 17)	
		12.0 bc (MICH PL 36)	5.6 xyz (MICH PL 29)	
		11.7 bcd (MICH PL 55)	6.2 xyz (MICH PL 64)	
		11.7 bcd (MICH PL 19)	6.4 xyz (MICH PL 5)	
Pod diameter (mm)	11.4	24.6 a (MICH PL 1)	7.0 z (MICH PL 45)	17.6
		19.7 b (MICH PL 8)	7.65 z (MICH PL 68)	
		16.2 c (MICH PL 17)	8.0 yz (MICH PL 33)	
		15.8 cd (MICH PL 14)	8.2 yz (MICH PL 67)	
		15.6 cde (MICH PL 49)	8.3 yz (MICH PL 57)	

Pericarp thickness (mm)	1.7	4.1 a (MICH PL 1)	1.1 h (MICH PL 60)	3.0
		2.95 b (MICH PL 23)	1.2 gh (MICH PL 65)	
		2.3 c (MICH PL 40)	1.2 gh (MICH PL 46)	
		2.1 cd (MICH PL 34)	1.3 fgh (MICH PL 45)	
		2.1 cd (MICH PL 25)	1.3 fgh (MICH PL 16)	
Plant height (cm)	52.4	78.8 a (MICH PL 54)	32.3 z (MICH PL 1)	46.5
		70.9 ab (MICH PL 66)	34.4 z (MICH PL 15)	
		69.3 abc (MICH PL 38)	36.3 z (MICH PL 5)	
		67.2 bcd (MICH PL 47)	39.2 yz (MICH PL 7)	
		67.1 bcd (MICH PL 55)	39.5 xyz (MICH PL 10)	
Canopy width (cm)	54.1	75.0 a (MICH PL 41)	16.5 0 (MICH PL 11)	58.5
		70.4 ab (MICH PL 35)	41.7 no (MICH PL 34)	
		70.0 ab (MICH PL 38)	41.8 no (MICH PL 5)	
		69.5 abcd (MICH PL 37)	41.9 mno (MICH PL 10)	
		64.8 abcde (MICH PL 30)	43.7 lmno (MICH PL 68)	
Days to 50% flowering	64	68 a (MICHPL 35, MICH PL 56)	60 c (MICH PL 17)	8
		66 ab (MICH PL 2)	61 de (MICH PL 48)	
		66 ab (MICH PL 26)	61 de (MICH PL 19)	
		66 abc (MICH PL 57)	61 de (MICH PL 22)	
		66 abc (MICH PL 13)	61 de (MICH PL1)	

Within the column, the means followed by the same letters are not significantly different at p=0.05

Table 3. Variability depend on mean performance of tested agronomic characters during *maha* 2015/16

Character	Mean	Range		Mean difference between maximum and minimum mean value
		Maximum	Minimum	
Yield (t/ha)	5.7	18.2 a (MICH PL 37, MICH PL 35)	1.5 l (MICH PL 14)	16.6
		17.6 ab (MICH PL 38)	2.1 kl (MICH PL 56)	
		14.4 bc (MICH PL 9)	2.2 kl (MICH PL 11)	
		11.2bcd (MICH PL 6)	2.9 jkl (MICH PL 63)	
		11.0 cde (MICH PL 47)	9.8 jkl (MICH PL 58)	
Number of pod/plant	35	76 a (MICH PL 47)	10 fg (MICH PL 56)	66
		68 ab (MICH PL 35)	12 ef (MICH PL 14)	
		65 abc (MICH PL 46)	15 ef (MICH PL 11)	
		64 abc (MICH PL 38)	25 ef (MICH PL 25)	
		63 abcd (MICH PL 37)	20 ef (MICH PL 34)	
Pod length (cm)	7.5	12.6 a (MICH PL 35, MICH PL 37)	4.3 x (MICH PL 17)	8.3
		10.9 ab (MICH PL 9)	5.0 wx (MICH PL 17)	
		10.7 ab (MICH PL 8)	5.1 vwx (MICH PL 1)	
		10.2 bc (MICH PL 61)	5.2 uvwx (MICH PL 57)	
		10.1 bcd (MICH PL 36)	5.4 xyz (MICH PL 56)	
Pod diameter (mm)	10.9	22.9 a (MICH PL 1)	6.8 u (MICH PL 7)	16.1
		17.3 b (MICH PL 8)	7.3 tu (MICH PL 60)	
		14.7 c (MICH PL 22)	7.3 tu (MICH PL 45)	
		13.8 cd (MICH PL 37)	7.9 stu (MICH PL 67)	
		13.6 cd (MICH PL 65)	8.2 rstu (MICH PL 53)	

Pericarp thickness (mm)	1.1	2.1 a (MICH PL 1)	0.5 f (MICH PL 7)	1.6
		1.5 b (MICH PL 12)	0.7 ef (MICH PL 68, MICH PL 66, MICH PL 20)	
		1.5 b (MICH PL 23)	0.75 def (MICH PL 67)	
		1.5 b (MICH PL 25)		
		1.4 bc (MICH PL 34)		
Plant height (cm)	51.5	74.8 a (MICH PL 38)	30.2 s (MICH PL 46)	44.6
		70.0 ab (MICH PL 67)	33.0 rs (MICH PL 11)	
		68.5 abc (MICH PL 35)	34.2 qrs (MICH PL 29)	
		67.5 abcd (MICH PL 6)	35.5 pqrs (MICH PL 53)	
		67.0 abcd (MICH PL 37)	36.3 pqrs (MICH PL 10)	
Canopy width (cm)	34.8	60.8 a (MICH PL 37)	15.6 s (MICH PL 46)	45.2
		57.1 ab (MICH PL 38)	20.7 rs (MICH PL 54)	
		54.9 abc (MICH PL 41)	20.8 rs (MICH PL 11)	
		53.1 abcd (MICH PL 15)	20.9 rs (MICH PL 33)	
		50.9 abcde (MICH PL 9)	21.8 qrs (MICH PL 14)	
Days to 50% flowering	49	72 a (MICHPL 14)	40 m (MICH PL 5)	32
		58 b (MICH PL 59)	42 lm (MICH PL 35)	
		57 bc (MICH PL 47,	43 klm (MICH PL 17)	
		MICH PL 32, MICH	43 jklm (MICH PL 49)	
		PL 54	44 ilklm (MICH PL 28)	

Within the column, the means followed by the same letters are not significantly different at p=0.05

Phenotypic and Genotypic variance,genotypic and phenotypic coefficient of variance, heritability and genetic advance

The extent of genetic variability inrespect of mean, phenotypic andgenotypic variance, phenotypic and genotypic coefficients of variation, heritabilityand genetic advance is given in Table 4.Phenotypic variance showed higher value than genotypic variance indicating greater influence of environment for the tested quantitative characters. High genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) were observed for the characters, yield, number of pods/plant, pod length, pod diameter and pericarp thickness. This indicates the high variability of these characters that offer good scope for selection of parents for the development of chilli hybrids. Higher genotypic and phenotypiccoefficient of variations were observed for fruit length, fruit diameter by Smitha and Basvaraja, 2007. Moderate GCV and PCV values were observed in plant height and canopy width suggesting that these traits have less potential for selection. Therefore, heterosis breeding is the good option to increase plant height and canopy width. The lowest GCV and PCV were observed for days to 50% flowering. Similar result was reported by Manju and Sreelathakumary (2002). High heritability, high genetic advance and high GCV were exhibited for pod characters indicating the presence of fixable additive genetic effect. Therefore, pod characters can be improved through hybridization and selection. High heritability for pod characters indicated that large proportion of phenotypic variance due to genotypic variance. This further confirm the reliability of selection for these traits on the basis of phenotype of chilli. High heritability along with moderate genetic advance for pod characters was observe by Kumar *et al.*, 2012.

Table 4. Genotypic and phenotypic variances, coefficients of variations,heritability and genetic advance for yield and yield related characters

	Genotypic variance (σ2g)	Phenotypic variance (σ2p)	Genotypic coefficient of variance (GCV %)	Phenotypic Coefficient of Variance (PCV %)	Heritability as %	Genetic Advance as % of mean
Yield (t/ha)	6.46	14.56	22.4	33.62	44	30.74
No of pods/ plant	64.04	364.4	11.62	27.72	18	9.98
Pod length (cm)	1.6	2.28	15.64	18.64	70	27.06
Pod diameter (mm)	5.47	6.27	20.98	22.45	87	40.35
Pericarp Thickness (mm)	0.06	0.09	17.37	21.57	65	29.07
Plant height (cm)	31.78	63.12	10.85	15.3	50	15.86
Canopy width (cm)	38.44	11.12	13.94	7.5	34.6	53.41
Days to 50% flowering	1.37	7.5	2.07	4.85	18	1.82

CONCLUSIONS

There was high genetic variability among the recombinant inbred lines. Performance of these inbred lines was vary depend on the season. High magnitude of phenotypic variance than genotypic variance confirmed the greater influence of environment for the tested agronomic characters. There was a significant effect on season (*Yala* and *Maha*) for all the agronomic characters other than plant height.There is greater potential of utilizing the developed inbred lines for the development of superior chilli hybrids and open pollinated varieties.Characters, yield, number of pods/plant, pod length, pod diameter and pericarp thickness that exhibited high genotypic coefficient of variance and phenotypic coefficient of variance offer good scope for selection of parents for the

development of chilli hybrids. Mean performance of agronomic character indicated that inbred lines, MICH PL 35, MICH PL 37 and MICH PL 38 can be exploited for further testing to release directly as open pollinated varieties.Pod characters can be improved through hybridization and selection, because of the presence of fixable high additive genetic effect.

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