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Research Article

GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR QUANTITATIVE AND QUALITATIVE TRAITS IN CHILLI (*Capsicum annuum* L.)

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Abstract- Thirty three chilli germplasm were evaluated in a randomized block design with two replication to estimate genetic variability, heritability and genetic advance of twelve quantitative and four qualitative traits. The overall values of GCV lower than the PCV for all the traits. High magnitude of PCV and GCV were recorded for carotene content and followed by red pod yield/plant, dry pod yield/plant and capsaicin. High values of GCV are an indication of high genetic variability among the germplasm. The heritability estimates in broad sense were found to be high for all the characters except number of secondary branches per plant, capsaicin, days to first flowering, pod girth and thousand seed weight. High heritability estimates indicated the presence of large number of fixable additive factors and hence these traits can be improved by selection. The traits like carotene content, red pod yield per plant, dry pod yield per plant and mean pod weight with high phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance as percent of mean, indicating that these characters are under additive gene effects and more reliable for effective selection.

Keywords- Chilli variability, Heritability and genetic advances, Qualitative and quantitative traits.

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Introduction

Chilli (*Capsicum annuum* L.) is one of the important vegetable cum spice crop. The origin of chilli is Mexico, with secondary centres in Guatemala and Bulgaria. Chilli is grown for its dry and green pods of commerce. It is valued for its pungency which is due to crystalline acrid volatile alkaloid capsaicin, present high in the placenta of pods. Chilli is a good source of vitamin C, vitamin A and E, small quantity of proteins, fats, carbohydrates and traces of minerals. It is also a good source of oleoresin, which having varied uses in processed food and beverage industries. The natural colour extract of chillies is also finding its increased value in place of artificial colour in the food items.

The genus Capsicum is often cross pollinated crop and natural cross pollination may go up to 50 per cent depending upon extent of style exertion, time of dehiscence of anthers, wind direction and insect population. Germplasm serves as a valuable source of base population and provides scope for building up of genetic variability. The study of variability, heritability and genetic advance of different traits in the genetic stock will facilitate evaluation and identification of suitable genotypes. Phenotypic and genotypic coefficients of variation are useful in detecting amounts of variability present in the germplasm. Heritability and genetic advance helps in determining the influence of environment in expression of characters and the extent to which improvement is possible after selection [1]. Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregating generation and needs to be accompanied by a substantial amount of genetic advance [2]. As the variability is an outcome of genetic divergence, the relationship between geographic distribution and genetic diversity provides an aid for identification of suitable genotypes for a valuable hybridization programme to improve the yield and quality in chilli.

Materials and Methods

The present investigation was carried out at the Western Block, Department of Vegetable Crops, Horticultural College and Research Institute, Periyakulam, which is situated at 10-13° N latitude and 77-59° E longitude and at an altitude of 289 M above mean sea level. The experiment was conducted during August, 2013 to April, 2014. The experiment was conducted in a randomized block design with two replication. Seeds collected from the NBPGR, Regional station, Rajendranagar, Hyderabad were sown in the nursery and 45-day old seedlings were transplanted in ridges and furrow, at a spacing of 45 X 45 cm. Three ridges were maintained for each genotype and each replication. Standard horticultural practices (TNAU crop production guide) and plant protection measures were adapted uniformly to all the genotypes.

Five randomly selected plants in each replication were tagged for recoding observations and the mean values were used for statistical analysis. Observations on pod and seed characters were recorded in ten pods selected at random from each plant and mean worked out. The observation were recorded twelve quantitative and four qualitative traits, *viz*., plant height, number of primary branches per plant, number of secondary branches per plant, days to first flowering, number of pods per plant, pod length, pod girth, mean pod weight, red pod yield per plant, dry pod yield per plant, number of seed per pod, thousand seed weight, ascorbic acid, capsaicin, capsanthin and carotene content.

Data from mean of individual genotypes were subjected to method of analysis of variance. This was done as suggested [3]. The phenotypic and genotypic coefficients of variation were estimated using the formula suggested [4] and expressed in percentage. Heritability in broad sense (h^2) was calculated according [5] and expressed in percentage. Genetic advance was worked out based on the formula suggested [2]. The range of genetic advance as per cent of mean was classified as suggested [2].

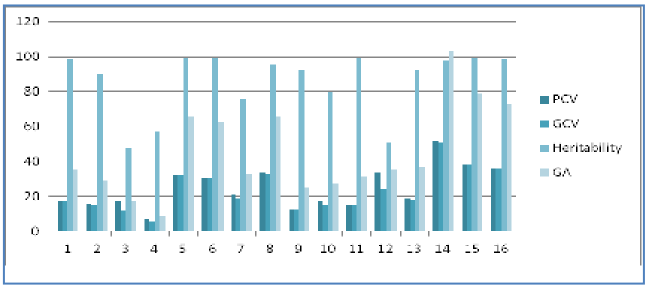
Result and Discussion

Variability parameter

Estimation of variability in a population is an effective tool for the breeder to design selection procedures more accurately and identify superior genotypes. The magnitudes of phenotypic and genotypic coefficient of variations were assessed to know the real worth of the source material. The extent of variability with respect to twelve quantitative and four qualitative characters in thirty three germplasm measured in term of mean performance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance as percent of mean are given in [Table-2] and show in [Fig-1]. Analysis of variance [Table-1] revealed significant differences among germplasm for all the traits studies indicating presence of significant variability in materials which can be exploited through selection. Similar results were noticed [6-9]. The rang of variation was high for red pod yield per plant (101.86-488.26 g) followed by number of pod per plant (47.40-207.70), ascorbic acid content (75.24-131.20 mg/100g), number of seeds per pod (56.10-99.60), plant height (37.29-100.30 cm), days to first flowering (57.10-77.20 days), dry pod yield per plant (20.72-93.99 g), capsanthin content (35.62-66.09) and number of secondary branches per plant (11.90-24.50). Relatively low range of variability was recorded in respect to number of primary braches per plant (4.50-8.70), pod length (2.90-10.41 cm), thousand seed weight (2.87-4.96g), carotene content (1.28-6.08 mg/100g), pod girth (1.59-4.00cm), capsaicin content (0.32-1.26%) and mean pod weight (0.25-0.92 gm) and these finding are in accordance with [10-13].

Coefficient of variation

The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters [Table-2] and the difference between PCV and GCV was narrow indicating the little influence of environment on the expression of these characters and considerable amount of variation was observed for all the characters. These results are supported by earlier observations of [9,14,15]. The estimates of PCV and GCV were recorded high for carotene content (51.39 and 50.73 %), red pod yield per plant (38.549 and 38.527 %), dry pod yield per plant (36.03 and 35.73 %), capsaicin (33.71 and 24.06 %), mean pod weight (33.44 and 32.66 %), number of pods per plant (31.99 and 31.930 %) and pod length (30.41 and 30.29 %) indicating higher magnitude of variability for these characters. Similar results were also reported [8] for average dry fruit weight, [16] and [17] for fruit yield per plant, [18] for yield per plant, [19] for number of fruits per plant and [20] for capsaicin.



1)Plant height, 2) Number of primary branches per plant, 3) Number of secondary branches per plant, 4) Days to first flowering, 5) Number of pods per plant, 6)Pod length, 7)Pod girth, 8)Mean pod weight, 8)Number of seeds per pod, 9) Thousand seed weight, 10)Red pod yield per plant, 11) Dry pod yield per plant, 12) Ascorbic acid content, 13) Capsaicin content, 15) Capsanthin content, 16) Carotene content.

Fig-1 Variability parameters for different characters in chilli germplasm

Table-1 *Analysis of variance for quantitative and qualitative characters in chilli germplasm*

S. No	Characters	Replication	Genotypes	Error
1.	Plant height (cm)	90.0009	362.762	2.693
2.	Number of primary branches per plant	0.0009	1.9501	0.1081
3.	Number of primary braches per plant	8.4386	13.2438	4.6189
4.	Days to first flowering	38.1193	35.3076	2538.2109
5.	Number of pods per plant	13.0341	2538.2109	5.1376
6.	Pod length (cm)	0.1266	5.5097	0.0203
7.	Pod girth (cm)	0.0649	0.4980	0.0696
8.	Mean pod weight (gm)	0.0046	0.0488	0.0011
9.	Number of seeds per pod	34.661	239.6563	9.0731
10.	Thousand seed weight (gm)	0.3867	0.7582	0.0857
11.	Red pod yield per plant (gm)	2481.678	424.748	1.7523
12.	Dry pod yield per plant (gm)	0.2485	0.2485	0.0219
13.	Ascorbic acid content (mg/100g)	16.0005	168.1899	6.4673
14.	Capsaicin content (%)	1.1974	5.5381	0.0707
15.	Capsanthin content (ASTA)	16.8561	16021.7656	9.1842
16.	Carotene content (mg/100g)	44.1297	946.0684	8.0077

The estimates of PCV and GCV were moderate for pod girth (21.41 and 18.60), capsanthin (19.11 and 18.39), plant height (17.27 and 17.142), number of secondary branches per plant (17.21 and 11.96), thousand seed weight (16.83 and 15.02), number of primary branches per plant (15.81 and 14.95), ascorbic acid (15.21 and 15.15) and number of seeds per pod (12.92 and 12.44). Similar observations were earlier reported by [21] for fruit girth, [17] for ascorbic acid, [22] for plant height and [20] for carotene.

Table-2 *Estimation of mean, range, components of variance, heritability and genetic advance for chilli germplasm*

S.No	Characters	Range		Mean	PCV	GCV	Heritability (%)	GA as per cent of mean
		Maximum	Minimum					
1.	Plant height (cm)	100.3	37.29	78.27	17.27	17.142	98.5	35.052
2.	Number of primary branches per plant	8.7	4.5	6.41	15.813	14.959	89.5	29.154
3.	Number of secondary branches per plant	24.5	11.9	17.35	17.217	11.964	48.2	17.125
4.	Days to first flowering	77.2	57.1	64.75	7.321	5.532	57.1	8.611
5.	Number of pods per plant	207.7	47.4	111.45	31.995	31.93	99.6	65.644
6.	Pod length (cm)	10.41	2.9	5.46	30.41	30.298	99.2	62.185
7.	Pod girth (cm)	4	1.59	2.48	21.414	18.602	75.4	33.29
8.	Mean pod weight (gm)	0.92	0.25	0.47	33.446	32.667	95.4	65.73
9.	Number of seeds per pod	99.6	56.1	86.26	12.927	12.447	92.7	24.688
10.	Thousand seed weight (gm)	4.96	2.87	3.85	16.833	15.027	79.6	27.635
11.	Red pod yield per plant (gm)	488.26	101.86	232.24	15.212	15.15	99.1	31.081
12.	Dry pod yield per plant (gm)	93.99	20.72	60.61	33.715	24.067	50.9	35.392
13.	Ascorbic acid content (mg/100g)	131.2	75.24	95.99	19.116	18.394	92.5	36.462
14.	Capsaicin content (%)	1.26	0.32	0.62	51.39	50.738	97.4	103.196
15.	Capsanthin content (ASTA)	66.09	35.62	48.88	38.549	38.527	99.8	79.32
16.	Carotene content (mg/100g)	6.08	1.28	3.25	36.033	35.73	98.3	72.983

Heritability

Heritability estimates along with genetic advance would be helpful in predicted the gain under selection than heritability estimates alone. Burton [4] suggested that genotypic coefficient of variation together with heritability estimates would give the best picture of the extent of genetic advance expected by selection. In the present investigation, high heritability coupled with high genetic advance observed for characters like carotene content, red pod yield per plant, dry pod yield per plant, mean pod weight, mean pod weight, number of pods per plant, pod length, capsanthin content, capsaicin content, plant height, pod girth, ascorbic acid content, number of primary branches per plant, thousand seed weight and number of seeds per fruit revealed the role of additive gene action in the expression of these characters. Thus, these characters could be considered as the reliable indices for selection. Similar results of high heritability and high genetic advance by [23-26] in chilli lend credence to the present findings.

High heritability estimates with moderate genetic advance observed in the present study for number of secondary branches per plant implied equal importance of additive and non-additive gene action. The high heritability might be due to unfavorable influence of environment rather than genetic constitution and offers little scope for selection. These results are in agreement with the earlier finding of [25] and [27]. High heritability estimates with low genetic advance observed for days to first flowering revealed that these characters could not be depended upon for selection. On the basis of the present study, it could be concluded that simultaneous selection based on multiple characters having high estimates of heritability and genetic advance could be exercised for improvement through selection.

Conclusion

The present study clearly indicate that greater variability exist all the character among the selected genotypes. The GCV estimates were high for carotene content, red pod yield per plant, dry pod yield per plant, mean pod weight, number of pods plant, pod length and capsaicin content. The heritability estimates were high for all the characters except number of secondary branches per plant and days to first flowering. The genetic advance as per cent of mean was high for carotene content, red pod yield per plant, dry pod yield per plant, mean pod weight, number of pods per plant and pod length. High heritability estimates coupled with high genetic advance as per cent of mean were observed for the characters like red pod yield per plant, number of pods per plant, pod length, ascorbic acid content, plant height, dry pod yield per plant, carotene content, mean pod weight, number of seeds per pod, capsanthin content, number of primary branches per plant.

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Author contributions

Pandiyaraj P – Conception and design of the work, data collection, data analysis and interpretation, drafting the article, critical revision of the article, final approval of the version to be published and acted as corresponding author.
Saraladevi, D – Critical revision of the article
Juliet Hepziba – Critical revision of the article
Arindam Das - Critical revision of the article

Abbreviations

PCV – Phenotypic coefficient of variation
GCV – Genotypic coefficient of variation
GA – Genetic advance

Ethical approval: This article does not contain any studies with human participants or animal performed by any of the authors.

Conflict of Interest: None declared

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