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Genetic Variability Studies in Byadagi Chilli (*Capsicum annuum* L.)

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ABSTRACT

Chilli (Capsicum annuum L.) is one of the most important vegetable cum spice crop for small and marginal farmers in Asia, Africa and South America. Chilli is valued for its pungency which is due to crystalline acrid volatile alkaloid capsaicin, present in the placenta of fruits Experiment comprising 70 chilli accessions was conducted on genetic variability studies for twenty six quantitative and qualitative characters of Byadagi chilli. The phenotypic variances for all the twenty six studied characters were found to be higher than the genotypic variance. Very high GCV and PCV was observed for ascorbic acid content and high GCV and PCV was observed for average fruit weight, leaf area index at 45 Days after transplanting, fruit diameter, fruit length diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant. Very high heritability coupled with very high GAM were observed for the characters fruit diameter, average fruit weight, number of fruits per plant, early green fruit yield per plant, total green fruit yield per plant, dry red chilli yield per plant, total green fruit yield per hectare, total dry fruit yield per hectare and ascorbic acid content. The study indicated that the additive component is predominant. Thus, there is ample scope for improving these characters through direct selection.

Key words: *byadagi chilli, Fruit weight, Genetic advance, Genetic variability, Heritability.*

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most important vegetable cum spice crop for small and marginal farmers in Asia, Africa and South America[1]. Among the 5 cultivated species of the genus Capsicum, *C. annuum* is the most widely cultivated in India for its pungent (chilli syn. hot pepper) and non-pungent (sweet pepper syn. capsicum, bell pepper) fruits. Pepper (chilli and sweet) market types prevalent in India can broadly be grouped into the following 4 categories: (i) fresh market (green, red, multi-color whole fruits), (ii) fresh processing (sauce, paste, canning, pickling), (iii) dried spice (whole fruits and powder), and (iv) industrial extracts (paprika oleoresin, capsaicinoids and carotenoids).

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Besides conventional nutritional food uses, a number of versatile food (paprika oleoresin) and non-food (defense, spiritual, ethnobotanical) uses of chillies are known[2,3]. Chilli is valued for its pungency which is due to crystalline acrid volatile alkaloid capsaicin, present in the placenta of fruits. Capsaicin has diverse prophylactic and therapeutic uses in allopathic and ayurvedic medicine[4]. Apart from rich source of vitamin C, it has vitamins A and E, small quantity of proteins, fats, carbohydrates and traces of minerals[5]. Chilli is also a good source of oleoresin, which is the total flavor extract of the dried ground and is a concentrated homogenous free flowing product[6]. Among the exported spices from India, export of dry chilli and its derived products stand first in terms of quantity and second in terms of total value after mints (menthol, menthol crystal and mint oils)[7].

To improve yield and other characters, information on genetic variability is a great importance and is a prerequisite for the effective screening of superior accessions[8]. The progress in breeding for the economic characters that are mostly environmentally influenced is determined by the magnitude and nature of their genetic variability. Byadagi is a local paprika type mainly grown in Karnataka which has got a geographical indication tag. It is long and has a thin skin, and when it's dried has a crinkly appearance. It is known for its color and pungency and is consumed across India. It has the highest color value of 1, 50,000- 2, 50,000 CU[5]. It is low pungent and characterized by wrinkles on the pods and sweet flavor. It is best grown in tropical and subtropical region with annual of 500 to 800 mm with temperature ranging between 20 to 38˚C. Hence, it is essential to partition the overall variability into its heritable and non-heritable components with the help of genetic parameters like genetic co-efficient of variation, heritability and genetic advance over mean. The present study was, therefore, undertaken to determine the genetic variability for various characters to estimate the scope of advance for selection in Byadagi chilli.

MATERIAL AND METHODS

Experimental location: The field experiment was conducted at Regional Horticulture Research and Extension Centre, Kumbapur, Dharwad district (Karnataka), during *Kharif* season 2014-15 which is located at Northern Dry Zone (Zone-3) of Karnataka.

Experimental material: The experimental material comprised of 70 accessions of Byadagi chilli were maintained at RHREC (Regional Horticulture Research and Extension Centre), Kumbapur, Dharwad district (Karnataka), India. The accession numbers of the accessions with codes are given in Table 1.

Nursery raising and cultivation practices: The germplasms were sown in raised seed beds and 30 days old seedlings were transplanted at the spacing of 75 cm x 45 cm in randomized block design (RBD) with two replications consisting of one row of 24 plants for each entry. The crop was raised as per the recommended package of practices[9].

Observations were recorded: Five random competitive plants per treatment/accessions were selected, tagged and observations for twenty six (quantitative and qualitative) characters were recorded *viz*., plant height at 45 and 90 DAT (cm), plant spread from east to west at 45 and 90 DAT (cm), plant spread from north to south at 45 and 90 DAT (cm), number of primary branches per plant at 45 and 90 DAT, stem girth at 45 and 90 DAT (cm), leaf area index at 45 and 90 DAT, days to first flowering, days to 50 per cent flowering, fruit length (cm), fruit diameter (cm), fruit length diameter ratio, average fruit weight (g), number of fruits per plant, early green fruit yield per plant (g), total green fruit yield per plant (g), per cent dry matter in fruit and ascorbic acid content (mg/ 100 g).

Statistical Analysis: Average values of each parameter or characters were used for analysis. The mean values were subjected to statistical analysis (ANOVA) as suggested Panse and Sukatme[10]. Phenotypic and genotypic co-efficient of variation[11], heritability[12], genetic advance and genetic advance over mean[13] were calculated.

RESULTS AND DISCUSSION

The analysis of variances showed that, the variances due to treatments (accessions) was significant (at P= 0.05) for all the traits studied (Table 1), indicating thereby the presence of genetic variability in the experimental material. The estimates of mean, range, genotypic variance (GV), phenotypic variance (PV), genotypic co-efficient of variance (GCV), phenotypic co-efficient of variance (PCV), heritability (h^2), genetic advance (GA), and genetic advance over mean (GAM) for different characters are presented in Table 2. Among 26 traits studied, high range of variation was observed for all the characters. It was maximum in case of ascorbic acid content (42.68-259.18 mg/100g) and minimum for the leaf area index at 45 DAT (0.04 – 0.14). The characters showing wide range of variation provide an ample scope for selecting desired types. In case of co-efficient of variation, the phenotypic and genotypic co-efficient of variation were very high for ascorbic acid (40.63 and 40.32, respectively). High GCV and PCV were observed for average fruit weight, leaf area index at 45 DAT, fruit diameter, fruit length diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant, these results are in confirmation with Krishna *et al.*[14]. These characters having higher range of variation have better scope of improvement through selection. In general, difference between the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were found to be narrow for all the characters studied. The results suggest that these traits are least affected by environmental factors and thus selection on phenotypic basis would be rewarding.

However, genotypic co-efficient of variation alone is not sufficient to estimate the heritable variation present in population. But, heritability along with genetic advance and genetic advance over mean provides a more reliable estimate for predicting the selection advance. Very high heritability coupled with very high genetic advance over mean were observed for the characters *viz,* ascorbic acid content (98.25 % and 82.41 %, respectively) followed by average fruit weight, total dry fruit yield per hectare, fruit diameter, number of fruits per plant, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant, dry red chilli yield per plant and fruit length diameter ratio. For ascorbic acid very high heritability coupled with very high GAM, these results are in agreement with Rani *et al.*[15] and Chattopadhyay *et al.*[16]. Kashinath[17] reported very high heritability and GAM for average fruit weight. Nageshwar Rao[18] reported very high heritability and very high GAM for number of fruits per plant. Total green fruits yield per plant are in agreement with Ajith and Manju[19]. In the present investigation very high heritability along with high GAM was observed in fruit length, similar results are reported by Venkateshwar Rao[20] and Nageshwar Rao[18]. Very high heritability with high GAM was observed for plant spread from east to west at 45 and 90 DAT these results are in line with Sarkar *et al.*[21]. Therefore, additive component is predominant here. Thus, there is ample scope for improving these characters through direct selection.

Table 1: Analysis of variance (mean sum of squares) for growth, earliness in chilli

SI. No.	Source of variation/ Characters	Replication	Treatments (Accessions)	Error	S. Em±	CD (5%)
	Degrees of freedom	1	69	69		
1	Plant height at 45 DAT (cm)	352.69	131.19*	13.31	2.57	7.27
2	Plant height at 90 DAT (cm)	150.69	109.03*	9.73	2.20	6.22
3	Plant spread from east to west at 45 DAT (cm)	49.44	29.79*	0.69	0.58	1.65
4	Plant spread from east to west at 90 DAT (cm)	247.84	92.18*	3.51	1.32	3.73
5	Plant spread from north to south at 45 DAT (cm)	240.77	95.29*	8.18	2.02	5.70
6	Plant spread from north to south at 90DAT (cm)	154.67	86.97*	8.13	2.01	5.68
7	Number of primary branches per plant at 45 DAT	2.52	1.20*	0.05	0.16	0.47
8	Number of primary branches per plant at 90 DAT	4.82	1.17*	0.15	0.27	0.77
9	Stem girth at 45 DAT (cm)	0.18	0.04*	0.0046	0.04	0.13
10	Stem girth at 90 DAT (cm)	0.23	3.19*	0.0064	0.05	0.16
11	Leaf area index at 45 DAT	0.0008	0.001*	0.0002	0.0094	0.002
12	Leaf area index at 90 DAT	0.0014	0.005*	0.0007	0.0195	0.055

*Significant @ 5 %

DAT: Days after transplanting, S.Em: Standard error of the mean, CD: critical difference, %: percent

Table 2: Analysis of variance (mean sum of squares) for yield, quality and disease incidence in chilli

SI. No.	Source of variation/ Characters	Replication	Treatments (Accessions)	Error	S. Em±	CD (5%)
	Degrees of freedom	1	69	69		
1	Days to first flowering	0.71	29.89*	3.23	1.27	3.58
2	Days to 50 per cent flowering	20.82	74.97*	7.93	1.99	5.61
3	Fruit length (cm)	1.68	5.25*	0.24	0.34	0.97
4	Fruit diameter (cm)	0.06	0.42*	0.0081	0.06	0.18
5	Fruit length diameter ratio	0.00825	6.70*	0.35	0.42	1.18
6	Average fruit weight (g)	6.70	21.72*	0.18	0.30	0.86
7	Number of fruits per plant	9.87	128.51*	2.26	1.06	3.00
8	Early green fruit yield per plant (g)	0.54	573.19*	14.42	2.68	7.57
9	Total green fruit yield per plant (g)	207.00	5126.66*	139.99	8.36	23.60
10	Dry red chilli yield per plant (g)	4074.74	259.76*	10.43	2.28	6.44
11	Total green fruit yield per ha (q)	2.47	201.86*	5.80	1.70	4.80
12	Total dry fruit yield per ha (q)	63.28	15.79*	0.22	0.33	0.93
13	Per cent dry matter in fruit	2.33	5.17*	0.69	0.59	1.66
14	Ascorbic acid (mg/100g)	16.32	4751.4*	36.97	4.29	12.12

*Significant @ 5 %

DAT: Days after transplanting, S.Em: Standard error of the mean, CD: critical difference, %: percent

Table 2: Estimates of mean, range, components of variance, heritability and genetic advance for growth, earliness, yield and quality parameters in chilli

SI. No.	Characters	Mean ± S.Em	Range	GV	PV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM
1	Plant height at 45 DAT (cm)	42.85±2.57	28.30-64.80	58.94	72.25	17.91	19.83	81.57	14.28	33.33
2	Plant height at 90 DAT (cm)	69.58±2.20	57.99-89.79	49.64	59.38	10.12	11.07	83.60	13.27	19.07
3	Plant spread from east to west at 45 DAT (cm)	31.46±0.58	22.90-44.90	14.55	15.24	12.12	12.40	95.47	7.67	24.40
4	Plant spread from east to west at 90 DAT (cm)	52.94±1.32	37.93-66.44	44.33	47.84	12.57	13.06	92.66	13.20	24.93
5	Plant spread from north to south at 45 DAT (cm)	35.24±2.02	24.00-53.30	43.55	51.73	18.72	20.40	84.18	12.47	35.39
6	Plant spread from north to south at 90DAT (cm)	54.24±2.01	38.29- 68.95	39.42	47.55	11.57	12.71	82.90	11.77	21.70
7	Number of primary branches per plant at 45 DAT	4.35±0.16	2.10-6.10	0.57	0.63	17.40	18.23	91.10	1.49	34.22
8	Number of primary branches per plant at 90 DAT	5.71±0.27	4.50-8.16	0.50	0.66	12.48	14.23	76.98	1.28	22.57
9	Stem girth at 45 DAT (cm)	0.68±0.048	0.45-1.04	0.017	0.022	19.46	21.84	79.40	0.24	35.72
10	Stem girth at 90 DAT (cm)	1.19±0.056	0.82-1.47	0.019	0.026	11.76	13.54	75.43	0.25	21.05
11	Leaf area index at 45 DAT	0.08±0.009	0.04 – 0.14	0.0005	0.0006	27.09	31.80	72.58	0.03	47.56
12	Leaf area index at 90 DAT	0.25±0.019	0.19-0.47	0.0024	0.0031	18.89	21.68	75.94	0.08	33.92
13	Days to first flowering	33.28±1.27	28.00-42.50	13.32	16.56	10.96	12.22	80.46	6.74	20.26

14	Days to 50 per cent flowering	52.21±1.99	42.50-66.50	33.52	41.45	11.08	12.33	80.87	10.72	20.54
15	Fruit length (cm)	11.46±0.34	5.62-14.21	2.50	2.75	13.81	14.46	91.23	3.11	27.18
16	Fruit diameter (cm)	1.70±0.06	1.09-2.87	0.21	0.21	26.82	27.34	96.26	0.92	54.22
17	Fruit length diameter ratio	7.20±0.41	2.62-11.12	3.53	3.88	26.09	27.35	90.99	3.69	51.28
18	Average fruit weight (g)	10.44±0.30	6.70-21.37	10.77	10.95	31.41	31.68	98.29	6.70	64.15
19	Number of fruits per plant	33.14±1.03	21.50-66.00	63.12	65.38	23.96	24.39	96.54	16.08	48.51
20	Early green fruit yield per plant (g)	74.86±2.68	49.18-108.83	279.38	293.81	22.32	22.89	95.08	33.57	44.84
21	Total green fruit yield per plant (g)	226.74±8.36	145.29-326.50	2493.30	2633.33	22.02	22.63	94.68	100.09	44.14
22	Dry red chilli yield per plant (g)	50.98±2.28	32.82-73.48	124.66	135.10	21.89	22.79	92.27	22.09	43.33
23	Total green fruit yield per ha (q)	44.68±1.70	29.14-64.49	98.02	103.83	22.15	22.80	94.40	19.81	44.35
24	Total dry fruit yield per ha (q)	11.77±0.33	6.25-17.13	7.78	8.00	23.70	24.04	97.24	5.66	48.16
25	Per cent dry matter in fruit	10.10±0.59	6.88-14.11	2.23	2.93	14.80	16.95	76.24	2.69	26.63
26	Ascorbic acid (mg/100g)	120.41±4.29	42.68-259.18	2357.21	2394.18	40.32	40.63	98.45	99.24	82.41

DAT- Days after transplanting S.Em: Standard error of the mean, CD: critical difference, %: per cent
h^2- Broad sense heritability PV- Phenotypic variance GV- Genotypic variance GA- Genetic advance
PCV- Phenotypic co-efficient of variation GAM- Genetic advance as per cent of mean GCV- Genotypic co-efficient of variation

CONCLUSION

Increasing industrialization, migration of populations to urban areas, a shortage of agricultural labor, shrinking cultivable land, increasing risks of crop failure due to unpredictable climate, emerging global markets and networks and increasing demand (domestic and export) for more nutritious and safer foods will affect future chilli breeding, production and marketing. On the basis of above findings it may be concluded that the characters, ascorbic acid content, average fruit weight, leaf area index at 45 Days after transplanting, fruit diameter, fruit length: diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant can be improved through direct selection from the existing germplasms. As there is high degree of additive components of variance and high to very high GCV and PCV for these traits.

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