Journal of Applied and Natural Science 9 (1): 262– 273 (2017)
JANS

Genetic variability, heritability and genetic advance for various quantitative and qualitative traits in Chilli (*Capsicum annuum L.*)

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Received:January 16, 2016; Revised received: November 17, 2016; Accepted: January 26, 2017

Abstract: Genetic variability, heritability and genetic advance for different quantitative and qualitative characters were studied in 64 genotypes of chilli. The study indicated the existence of considerable amount of genetic variability for all the traits under study. Analysis of variance revealed significant differences among genotypes for almost all the traits studied. The maximum range was recorded for fruit yield per plant (150-900 g) followed by vitamin-C content at red ripe stage (35.50 -207.17 mg/100g), vitamin-C content at green stage (24.93-195.83 mg/100g), capsanthin content (39.58-180.35ASTA units, number of fruits per plant (21.32-100.27) and plant height (50.20-105.00cm). The highest phenotypic and genotypic coefficients of variability were observed for average fruit weight followed by seed yield per plant, average seed weight per fruit, number of fruits per plant, fruit yield per plant and fruit diameter. In general the phenotypic coefficients of variation (PCV) were slight higher than genotypic coefficients of variation GCV), which indicates the minor role of environment in the expression of traits under observation. The estimates of heritability in broad sense was high for all the characters. The present investigation indicates a great scope of in the improvement of these traits as these characters in general possessed high estimates of heritability coupled with high genetic advancement except for days to first fruit set, days to first green fruit harvest, days to first ripe fruit harvest and dry matter content (high heritability but moderate genetic gain) indicating the preponderance of additive gene action for control of these traits.

Key words : Genetic variability, Heritability, Genetic advance, Chilli, *Capsicum annuum* L.

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most important vegetable-cum-spice crops valued for its aroma, taste, flavour and pungency. Chilli contributes about 33% of the total spice export from India and share about 16% of the world spice trade (Kadwey *et al.,* 2016) In addition to the importance as food, peppers have received attention for their potential as nutraceuticals. This is due to their high level of phytochemicals with documented human health benefits. These include carotenoids, flavonoids, ascorbic acid, phenolic compounds and the pungent capsainoids (Crossby, 2005). A wide range of variability reportedly exists in this crop. Cultivation under diverse environmental conditions is thought to have contributed to this vast variability. There is a vast potential for utilizing such variability in crop improvement programmes. Effective identification of potentially useful germplasm forms the first and foremost step in a crop improvement programme. High yielding genotypes with good adaptation and desirable attributes could be directly utilized for undertaking a massive hybridization programme. Variability in plants is the first step in understanding how to improve or produce new plants. Heritability is the degree of genetic control associated to some important traits (Nechif *et al.,* 2011). Variability is a key factor, which determines the amount of progress expected from selection. The potential for improvement in crops is proportional to the magnitude of genetic variability present in the germplasm. The characterization and variability pattern of the available germplasm resources holds a promise in respect of important economic characters. The progress of breeding in such a population is primarily conditioned by the magnitude, nature and inter-relationship of genetic variation for various plant characters that help in partitioning the overall variability into heritable and non-heritable components. Heritability has been widely used in determining the degree to which a character may be transmitted from parents to offsprings. It enables the breeder to decide the extent of selection pressure to be applied under a particular environment, which separates

ISSN : 0974-9411 (Print), 2231-5209 (Online)

out the environmental influence from the total variability. The estimation of heritability has a greater role to play in determining the effectiveness of selection of a character provided it is considered in conjunction with the predicated genetic advance as suggested by Panse and Sukhatme (1957) and Johnson *et al.* (1955). Further more the progress in selection is also directly proportional to the amount of genetic gain. Therefore, the effect of selection is realized more quickly in those characters which have high heritability as well as high genetic gain.Thus genetic parameters like genotypic coefficient of variation, heritability and genetic advance are the tools in the hands of a plant breeder for ensuring efficient selection. Therefore, the current study was undertaken with the aim of estimating genetic variability, heritability and genetic advance in 64 genotypes of chilli (*C. annuum* L.) in Kashmir.

MATERIALS AND METHODS

The present investigation was undertaken at vegetable Experimental farm of Division of Vegetable Science, SKUAST-Kashmir, Shalimar during *Kharif* 2013.

Experimental site and Climate: The experimental field is located at the main campus, Shalimar, Srinagar which is 15 km away from Srinagar city on the foot hills of Mahadev. The altitude of the location is 1685 meter above mean sea level and situated 34° N of latitude and 74.89° E of longitude. The climate is temperate characterized by mild summers. June and July are the hottest months while January and February are the coldest. The maximum rain fall is received during March to April.

Experimental material: Sixty four diverse genotypes of chilli were evaluated for various yield and yield attributing traits at the Experimental field of the Division of Vegetable science SKUAST-K Shalimar Srinagar, during *Kharif* 2013. The name of the genotypes along with their mean performance are given in the Table 3.

Experimental Design and layout: The experimental was planted in simple square lattice Design with four replications. The experimental field consisted of 8 blocks in each replication, such that there were 82 i.e. 64 treatments (genotypes) in each replication. The plot size was kept 2.4 x 1.8 m (4.32 m^2), each plot consisted of 3 rows of each genotype in each replication at spacing of 45 x 45 cm. Observations were based on 5 randomly selected plants in each replication.The experimental fields were well prepared and standard cultural, manural and plant protection practices were followed to ensure a healthy crop growth.

The analysis of variance were carried out as suggested by Panse and Sukhatme (1957) and were used for calculating other genetic parameters.

The magnitude of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) existing in a trait was worked out by the formula given by Burton (1952) . Heritability(b.s) was calculated as per the formula given by Burton and Devane (1953) and Johnson *et al*. (1955). Genetic advance explains the degree of gain obtained in a character under a particular selection pressure. It also indicates the presence of additive genes in the trait and further suggest reliable crop improvement through selection of such traits. It was estimated by using the formula given by Lush (1949) and Johnson *et al*. (1955).

The equations are given as under:

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

Where,

$\hat{\sigma}^2 p$ = Phenotypic variance, and

$\overline{x}$ = grand mean of the trait studied

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

$\hat{\sigma}^2 g$ = Genotypic variance, and

$\overline{x}$ = grand mean of the trait studied

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

Where,

H2 = Estimate of heritability in broad sense,

$\sigma^2 g$ = Genotypic variance, and

$\sigma^2 p$ = Phenotypic variance

$$GA = \frac{s^2 g}{s^2 g} \times (s^2 p)^{0.5} \times K$$

Where,

GA = Genetic advance of the trait,

$\sigma^2 g$ = genotypic variance of the trait,

$\sigma^2 p$ = phenotypic variance of the trait, and

K = selection differential; (K= 2.06 at 5 per cent selection intensity)

RESULTS AND DISCUSSION

The analysis of variance revealed that all the twenty characters exhibited significant differences among the genotypes. The extent of variability present in 64 genotypes of chilli was measured in terms of range, mean, phenotypic variance, genotypic variance, genotypic coefficient of variation, phenotypic coefficient of variation, heritability in broad sense and genetic advance (Tables 1-4). The maximum range was recorded for vitamin-C content at red ripe stage

Table 1. Estimates of mean, range, phenotypic variance, genotypic variance, phenotypic and genotypic coefficients of variation, heritability (bs) and genetic advance (as % of mean) for fifteen growth characters in chilli (*Capsicum annuum* L.).

S. No.	Parameters	Mean	Range	Phenotypic variance (PV)	Genotypic variance (GV)	Phenotypic co-efficient of vari-ation (PCV)	Genotypic coefficient of variation (GCV)	Heritability (bs)	Genetic advance (as % of mean)
1.	Days to first flower	33.94	24.62-42.20	13.41	13.38	10.79	10.78	0.99	22.18
2.	Days to first fruit set	39.11	30.05-49.87	14.30	14.20	9.67	9.63	0.99	19.78
3.	Days to first green fruit harvest	57.05	44.80-69.70	34.41	32.45	10.28	10.00	0.94	19.97
4.	Days to first ripe fruit harvest	82.43	66.58-95.50	47.24	45.59	8.33	8.19	0.96	16.57
5.	Plant height (cm)	71.64	50.20-105.00	216.61	205.09	20.54	20.00	0.98	41.82
6.	Plant spread (cm)	41.28	21.32-68.20	122.48	122.43	26.81	26.80	0.99	55.20
7.	Number of branches per plant	3.47	1.85-6.20	1.097	1.04	30.11	29.36	0.95	58.96
8.	Fruit length (cm)	10.81	6.65-16.30	5.092	4.80	20.85	20.00	0.99	42.87
9.	Fruit diameter (cm)	1.68	0.83-4.48	0.407	0.406	37.98	37.92	0.99	77.99
10.	Average fruit weight (g)	10.10	2.45-28.88	39.53	39.51	62.25	62.23	0.99	128.16
11.	Number of fruits per plant	46.94	21.32-100.27	385.16	384.89	41.81	41.79	0.99	86.06
12.	Fruit yield per plant (kg)	0.42	0.150-0.90	0.03	0.03	40.75	40.61	0.99	83.35
13.	Average seed weight per fruit (g)	0.74	0.20-2.12	0.11	0.11	44.85	44.79	0.98	92.13
14	Seed yield per plant (g)	33.16	5.73-73.93	252.86	252.73	47.94	47.93	0.99	98.72
15.	100 seed weight (g)	0.59	0.30-1.36	0.038	0.037	32.46	31.96	0.96	64.81

Table 2. Estimates of mean, range, phenotypic variance, genotypic variance, phenotypic and genotypic coefficients of variation for five quality characters in Chilli (*capsicum annuum* L.).

S. No.	Parameters	Mean	Range	Phenotypic variance (PV	Genotypic variance (GV)	Phenotypic coefficient of variation (PCV)	Genotypic coefficient of variation (GCV)	Heritability (bs)	Genetic advance as % of mean
1.	Dry matter content (%)	78.39	65.10-87.92	36.78	36.68	7.74	7.73	0.99	15.89
2.	Vitamin-C content at green stage (mg/100g)	84.58	24.93-195.83	951.93	949.63	36.47	36.43	0.99	74.95
3.	Vitamin-C content at ripe stage (mg/100g)	94.22	35.50-207.17	945.47	939.32	32.64	32.53	0.95	66.79
4.	Capsaicin content (mg/g)	0.51	0.29-0.87	0.011	0.011	20.422	20.314	0.98	41.62
5.	Capsanthin content (ASTA units)	86.20	39.58-180.35	936.84	936.39	35.51	35.49	0.99	73.10

(mg/100g), followed by vitamin-C content at green stage (mg/100g),capsanthin content (ASTA units) and plant height height (cm) while the lowest range was observed for Capsaicin content (mg/g) followed by fruit yield plant^{-1} (kg), 100 seed weight, average seed weight per fruit and number of branches plant^{-1}. On the basis of mean performance of the genotypes SH-P-5 recorded the highest total fruit yield of 446.90 q ha^{-1} followed by SH-P-29 (390 q ha^{-1}), SH-SC-9 (380 q ha^{-1}) and SH-SC-25 (360.49 q ha^{-1}) while SH-SC-23 produced lowest yield of 74 q ha^{-1} followed by SH-SC-27 (93.80 q ha^{-1}) and SH-SC-10 (97.28 q ha^{-1}). In general the phenotypic and genotypic coefficients of variation were almost similar with slight higher phenotypic coefficients of variation,which indicates the role of environment in the expression of traits under observation. This was in agreement with the study of Bandale *et al.* (2006) and Chattopadhyay *et al.*(2011)for various yield and quality characters like green fruit yield plant^{-1},red ripe fruit yield plant^{-1}, number of fruits per plant, number of seeds plant^{-1}, fruit length, fruit girth, ascorbic acid content and capsaicin content in chilli. The average fruit weight (62.25 and 62.23%), number of fruits plant^{-1} (41.81 and 41.79%), Fruit yield plant^{-1} (40.75 and 40.61%), average seed weight per fruit (44.85 and 44.79%) Seed yield plant^{-1} (47.94 and 47.93%) 100 seed weight (32.46 and 31.96%), number of branches plant^{-1} (30.11 and 29.36%) fruit diameter (37.98 and 37.92%), vitamin-C content at green stage (36.47 and 36.43%), vitamin-C content at red ripe stage (32.64 and 32.53%), capsaicin content (20.42 and 20.31%) and capsanthin content (35.51 and 35.49%) recorded high phenotypic and genotypic coefficients of variation, indicating that genotypes had broad genetic base for these characters. The same was observed by Khurana *et al.* (2003); Verma *et al.* (2004) for number of fruits plant^{-1}in chilli, Chattopadhyay (2011) for average fruit weight and number of fruits plant^{-1}in chilli, Manju and Sreelathakumary (2002) for vitamin-C content and capsaicin content in chilli, Varadarajan *et al.* (1996) for capsanthin content in chilli. while plant height (20.54 and 20.00%), fruit length (20.85 and 20.00%), plant spread (26.81 and 26.80%) exhibited moderate phenotypic and genotypic coefficients of variation suggesting the existence of moderate variability in the genetic stock studied. The same was observed by Ahmed *et al.* (1990) in a study on genetic variability in Kashmir chilli for fruit length. Moreover Pandita *et al.* (1991) and Khurana *et al.* (2003) while studying variability and heritability in chilli (*Capsicum fruitescens* L.) and genetic diversity for growth, yield and quality traits in chilli (*Capsicum annuum* L.) respectively revealed moderate variability for plant height. Thus these characters were highly amenable for improvement through selection. Characters which possessed moderate to high coefficients of variation suggested that there is better potential for improvement through selection. A

Table 3. Mean performance of Chilli genotypes with respect to different growth parameters.

S. No.	Genotypes	Days to first flower	Days to first fruit set	Days to first green fruit harvest	Days to first ripe fruit harvest	Plant height (cm)	Plant spread (cm)	Number of branches per plant	Fruit length (cm)
1.	SH-P-17	34.45	40.90	61.30	81.49	65.80	41.60	6.20	11.32
2.	SH-SC-2	29.32	36.10	53.75	76.71	90.81	42.27	4.60	14.24
3.	SH-SC-106	34.57	39.16	51.50	73.74	52.17	36.47	3.92	9.82
4	SH-SC-1114	32.17	36.02	51.90	74.48	69.87	68.20	3.30	8.83
5.	SH-SC-82	35.69	39.53	59.15	85.10	92.52	50.07	2.15	10.68
6.	SH-SC-1003-3	31.47	37.02	62.30	85.75	63.82	32.25	4.42	10.8
7.	SH-SC-910	34.35	37.90	64.55	89.35	102.95	48.54	2.95	7.53
8.	SH-SC-1002-1	29.32	34.80	48.05	71.82	56.65	36.20	3.30	6.73
9.	SH-SC-1	36.26	39.77	65.40	89.35	54.85	38.50	1.95	10.44
10.	SH-SC-6	33.56	37.15	55.80	80.69	51.05	22.75	2.47	11.96
11.	SH-SC-25	33.66	38.40	61.20	85.00	72.70	27.12	3.17	11.17
12.	SH-P-5	34.72	39.87	63.75	88.15	72.40	21.32	1.87	16.30
13.	SH-SC-3	30.65	34.80	55.45	83.57	54.55	32.02	4.40	12.28
14.	SH-SC-22	31.69	35.82	57.30	81.55	62.60	38.52	3.42	10.35
15.	SH-SC-115-1	28.81	35.20	53.85	79.97	73.45	59.35	3.82	10.22
16.	SH-SC-27	35.76	41.70	61.60	87.10	103.90	28.62	3.17	10.91
17.	SH-SC-863-2	32.68	38.65	50.10	75.87	73.35	52.65	4.57	13.43
18.	SH-SC-277	33.85	38.85	50.95	76.72	72.10	49.45	2.95	11.36
19.	SH-P-20	34.82	39.44	51.95	75.30	93.00	48.69	3.00	9.52
20.	SH-SC-4	31.67	36.80	47.30	72.00	75.50	45.57	5.52	8.67
21.	SH-SC-5	28.50	36.17	45.10	66.58	81.75	45.61	1.85	15.63
22.	SH-SC-10	32.66	36.50	50.60	75.72	35.30	52.12	3.90	6.65
23.	SH-SC-7	35.42	40.67	57.15	82.12	63.35	41.42	5.75	8.45
24.	SH-SC-1008	35.45	38.35	55.30	88.62	74.00	43.25	5.53	10.39
25.	SH-SC-30	28.61	34.82	47.15	70.45	82.32	41.12	3.42	9.68
26.	SH-SC-7-104-2	34.70	38.97	51.80	72.72	59.90	33.63	4.15	7.67
27.	SH-SC-277-1	35.22	39.	54.75	82.12	92.00	45.61	2.85	9.45
28.	SH-SC-965-5	31.52	35.96	51.95	75.75	103.00	59.50	3.75	13.72
29.	SH-SC-9	36.47	39.78	59.40	88.57	73.80	38.67	2.77	9.64
30.	SH-P-101	30.51	34.90	50.75	77.50	82.95	27.07	4.15	13.39
31.	SH-SC-24	28.72	34.90	53.40	79.35	64.37	40.15	2.82	9.84
32.	SH-SC-108	24.62	30.05	44.80	67.85	73.60	38.37	3.15	9.84
33.	SH-SC-101	31.37	36.62	55.65	81.92	67.30	35.38	2.95	7.83

Contd.

Table 3. *Contd.*

34.	SH-SC-505	35.77	40.40	61.30	87.35	84.95	48.72	6.10	10.84
35.	SH-SC-23	34.68	40.71	52.00	76.17	87.65	38.57	1.95	7.55
36.	SH-P-29	35.52	39.67	55.75	84.85	59.75	64.42	2.90	12.61
37.	SH-P-12	33.53	39.35	49.45	76.62	105.00	29.66	2.95	13.56
38.	SH-SC-8	34.37	39.40	52.35	77.07	78.75	32.67	3.95	8.84
39.	SH-SC-814	33.68	38.97	62.95	89.90	77.35	66.67	4.05	11.87
40.	SH-SC-502	34.62	39.67	57.85	82.70	71.20	44.72	4.20	9.81
41.	SH-SC-1003-2	38.75	44.92	64.70	90.65	67.35	41.22	2.95	11.83
42.	SH-SC-578-1	36.47	40.20	60.35	85.75	66.55	38.57	2.75	8.94
43.	SH-SC-885	28.48	34.37	57.55	83.27	67.60	32.51	3.95	13.83
44.	SH-SC-254-1	35.61	39.92	61.40	88.09	71.20	22.66	1.95	9.53
45.	SH-P-50	34.52	38.85	59.15	87.54	79.25	49.75	4.15	9.50
46.	SH-SC-14	39.67	44.91	62.70	90.80	56.95	48.88	2.72	9.05
47	SH-SC-29	32.55	38.00	54.55	76.30	84.25	32.70	3.10	13.35
48	SH-SC-11	31.66	36.90	57.20	86.28	83.75	44.67	4.12	12.40
49	SH-SC-13	36.42	39.90	62.90	90.19	59.20	30.78	4.15	12.79
50	SH-SC-16	29.78	36.67	58.40	81.96	61.87	37.45	4.70	7.75
51	SH-SC-505	33.57	38.62	60.25	89.82	93.62	31.43	3.95	8.79
51	Kashmir Long-1	33.50	39.70	60.05	85.60	35.57	48.65	3.12	11.9
52	SH-SC-15	40.02	43.72	60.20	85.35	50.20	46.69	2.27	13.77
53	SH-SC-28	39.47	45.72	63.75	91.62	56.35	33.21	2.95	15.29
54	SH-SC-115	28.92	34.02	53.85	72.67	57.57	26.22	2.82	9.77
55	SH-SC-26	37.43	41.70	54.9	83.10	66.80	31.77	3.27	10.35
56	SH-SC-12	39.33	44.90	58.00	82.40	84.97	58.75	2.55	15.75
57	SH-SC-17	33.86	40.67	58.45	85.27	63.80	56.20	2.10	10.52
58	SH-SC-1001	40.63	48.71	67.25	93.13	62.27	61.57	4.42	8.81
59	SH-SC-105	41.82	49.12	69.20	94.66	74.75	30.50	4.22	10.48
60	SH-SC-19	42.20	49.87	69.70	95.50	52.80	38.55	2.47	11.80
61	SH-SC-21	39.53	45.27	60.30	86.45	64.21	48.20	2.40	7.99
62	SH-SC-18	32.55	39.15	64.00	90.72	58.00	27.67	3.75	8.99
63	SH-SC-20	27.67	33.95	55.8	81.11	66.30	35.55	3.35	12.81
64	SH-SC-29	32.55	38.00	54.55	76.30	84.25	32.70	3.10	13.35

Table 4. Mean performance of Chilli genotypes with respect to more growth parameters.

S. No.	Genotypes	Fruit diameter (cm)	Average fruit weight (g)	Number of fruits plant^{-1}	Fruit yield plant^{-1} (kg)	Average seed weight fruit^{-1} (g)	Seed yield plant^{-1} (g)	100 seed weight (g)
1.	SH-P-17	3.14	24.05	25.71	0.57	0.85	23.04	0.51
2.	SH-SC-2	1.54	12.57	45.02	0.54	0.30	13.02	0.60
3.	SH-SC-106	1.44	7.90	64.87	0.46	0.50	32.83	0.82
4	SH-SC-1114	0.83	2.45	99.07	0.26	0.51	48.69	0.71
5.	SH-SC-82	1.64	8.69	30.87	0.28	0.90	28.21	0.50
6.	SH-SC-1003-3	1.45	8.16	52.87	0.43	0.80	42.15	0.40
7.	SH-SC-910	1.45	5.96	36.05	0.23	0.60	22.12	0.50
8.	SH-SC-1002-1	1.24	5.07	46.62	0.24	0.80	37.97	0.30
9.	SH-SC-1	2.25	12.55	51.10	0.62	1.24	59.63	0.91
10.	SH-SC-6	1.65	10.91	53.92	0.56	1.07	58.76	0.86
11.	SH-SC-25	2.74	8.54	87.44	0.72	0.58	51.68	0.53
12.	SH-P-5	1.43	27.60	35.65	0.90	1.18	41.67	1.02
13.	SH-SC-3	1.75	7.85	71.10	0.54	0.70	48.87	0.50
14.	SH-SC-22	1.30	8.99	56.59	0.52	0.79	45.90	0.40
15.	SH-SC-115-1	1.34	6.88	51.56	0.36	0.80	40.56	0.63
16.	SH-SC-27	1.35	7.46	26.44	0.19	0.20	5.73	0.72
17.	SH-SC-863-2	1.49	7.75	61.22	0.47	0.80	47.77	0.42
18.	SH-SC-277	2.96	6.67	56.42	0.36	0.60	34.10	0.75
19.	SH-P-20	1.19	26.97	24.35	0.655	1.79	42.96	1.01
20.	SH-SC-4	1.59	5.94	23.89	0.20	0.70	16.37	0.65
21.	SH-SC-5	1.82	9.75	35.79	0.37	0.50	17.94	0.73
22.	SH-SC-10	1.40	6.74	31.26	0.19	0.80	24.15	0.43
23.	SH-SC-7	1.59	5.4	36.49	0.20	0.90	34.05	0.41
24.	SH-SC-1008	1.40	8.70	44.82	0.42	0.30	13.21	0.48
25.	SH-SC-30	1.49	5.85	42.87	0.39	0.50	22.01	0.60
26.	SH-SC-7-104-2	1.27	5.37	52.52	0.28	0.79	42.91	0.50
27.	SH-SC-277-1	1.29	4.96	71.27	0.34	0.80	55.85	0.39
28.	SH-SC-965-5	1.69	9.32	49.32	0.45	0.51	23.95	0.62
29.	SH-SC-9	2.69	10.88	73.59	0.77	0.90	65.10	0.46
30.	SH-P-101	1.76	26.81	21.32	0.57	1.30	26.96	1.02
31.	SH-SC-24	1.43	9.17	51.62	0.47	0.77	40.96	0.49
32.	SH-SC-108	1.69	6.75	74.29	0.49	1.02	73.93	0.80

Contd.

Table 4. *Contd.*

33.	SH-SC-101	1.04	7.44	46.44	0.52	0.39	18.85	0.60
34.	SH-SC-31	1.66	5.22	91.32	0.48	0.30	27.97	0.65
35.	SH-SC-23	4.48	6.28	24.22	0.15	0.98	20.85	0.50
36.	SH-P-29	3.46	28.88	26.85	0.79	2.12	58.98	1.36
37.	SH-P-12	1.36	27.97	24.82	0.64	1.31	31.57	0.85
38.	SH-SC-8	1.68	6.52	25.17	0.16	0.81	20.97	0.40
39.	SH-SC-814	1.84	7.37	52.37	0.38	0.60	31.60	0.70
40.	SH-SC-502	1.63	10.42	42.82	0.44	0.40	32.10	0.57
41.	SH-SC-1003-2	1.11	10.42	32.75	0.34	0.5	16.64	0.6
42.	SH-SC-578-1	1.19	4.62	54.40	0.25	0.70	38.81	0.56
43.	SH-SC-885	1.49	9.11	48.18	0.44	0.40	19.85	0.58
44.	SH-SC-254-1	3.19	8.70	42.37	0.35	0.80	34.86	0.48
45.	SH-P-50	1.76	23.97	27.52	0.67	0.80	22.78	0.53
46.	SH-SC-14	1.52	9.57	24.50	0.23	0.70	15.85	0.52
47.	SH-SC-29	1.03	10.52	62.60	0.63	0.60	36.39	0.72
48.	SH-SC-11	1.34	6.49	34.62	0.23	0.40	13.02	0.61
49.	SH-SC-13	1.17	8.37	31.32	0.26	0.94	29.97	0.50
50.	SH-SC-16	1.23	5.55	100.27	0.54	0.70	72.1	0.58
51.	SH-SC-505	1.29	14.88	33.37	0.48	0.69	23.72	0.52
52.	Kashmir Long-1	1.88	7.35	41.22	0.30	0.50	20.80	0.70
53.	SH-SC-15	2.015	14.47	21.47	0.29	0.96	19.99	0.50
54.	SH-SC-28	1.36	8.22	31.00	0.26	0.69	21.86	0.40
55.	SH-SC-115	1.28	6.67	41.87	0.28	0.30	11.91	0.60
56.	SH-SC-26	1.37	7.60	46.65	0.34	0.70	33.69	0.39
57.	SH-SC-12	1.45	10.57	56.22	0.62	0.80	45.63	0.41
58.	SH-SC-17	1.347	4.25	79.50	0.35	0.40	32.72	0.70
59.	SH-SC-1001	1.59	7.35	41.11	0.29	0.30	12.05	0.60
60.	SH-SC-105	1.47	9.97	45.22	0.47	0.50	22.82	0.70
61.	SH-SC-19	1.23	8.66	24.57	0.23	0.70	17.87	0.40
62.	SH-SC-21	1.35	7.46	70.20	0.58	0.80	55.87	0.50
63.	SH-SC-18	1.34	8.60	67.50	0.58	0.80	54.05	0.43
64.	SH-SC-20	1.89	9.97	25.57	0.26	0.90	23.06	0.30

Table 5. Mean performance of Chilli genotypes with respect to different quality parameters.

S. No.	Genotypes	Dry matter content (%)	Vitamin- C content at green stage (mg/100g)	Vitamin-C content at ripe stage (mg/100g)	Capsacin content (mg/g)	Capsanthin content (ASTA units)
1.	SH-P-17	86.65	89.58	96.20	0.29	119.85
2.	SH-SC-2	80.02	65.60	78.65	0.42	84.10
3.	SH-SC-106	78.80	72.86	82.17	0.46	64.40
4.	SH-SC-1114	65.08	97.54	107.87	0.87	50.37
5.	SH-SC-82	83.24	77.86	89.85	0.38	80.41
6.	SH-SC-1003-3	75.83	137.71	145.70	0.53	87.58
7.	SH-SC-910	81.17	53.59	62.58	0.53	61.53
8.	SH-SC-1002-1	77.00	45.81	56.36	0.56	70.07
9.	SH-SC-1	81.26	24.93	35.50	0.39	102.20
10.	SH-SC-6	76.49	76.80	82.92	0.45	99.50
11.	SH-SC-25	85.12	90.87	99.88	0.43	70.80
12.	SH-P-5	86.29	86.85	95.14	0.53	143.53
13.	SH-SC-3	75.29	76.60	83.93	0.49	83.46
14.	SH-SC-22	83.01	94.47	104.65	0.54	97.83
15.	SH-SC-115-1	80.89	104.60	112.94	0.55	74.64
16.	SH-SC-27	70.90	100.15	110.32	0.59	67.22
17.	SH-SC-863-2	73.90	87.77	96.06	0.59	71.85
18.	SH-SC-277	74.75	57.86	67.89	0.35	100.11
19.	SH-P-20	85.87	68.61	77.27	0.54	161.90
20.	SH-SC-4	76.97	47.29	58.74	0.48	87.89
21.	SH-SC-5	85.86	55.20	66.09	0.45	93.79
22.	SH-SC-10	71.03	120.10	123.34	0.49	59.84
23.	S-40	69.88	124.64	134.40	0.45	61.94
24.	SH-SC-1008	80.05	40.78	48.02	0.52	100.62
25.	SH-SC-30	70.99	75.78	83.39	0.50	59.16
26.	SH-SC-7-104-2	70.04	53.93	64.72	0.57	64.68
27.	SH-SC-277-1	69.85	62.49	75.54	0.55	39.58
28.	SH-SC-965-5	83.94	130.86	139.10	0.43	77.50
29.	SH-SC-9	85.86	54.88	63.32	0.37	103.64
30.	SH-P-101	87.92	101.83	108.03	0.44	167.90
31.	SH-SC-24	82.73	95.77	103.33	0.52	98.95
32.	SH-SC-108	76.65	78.45	87.28	0.44	55.47

Contd.

Table 5. *Contd.*

33.	SH-SC-101	73.68	75.52	85.54	0.68	69.15
34.	SH-SC-505	69.96	67.92	75.69	0.45	52.79
35.	SH-SC-23	71.78	139.68	146.64	0.30	71.66
36.	SH-P-29	87.80	114.90	126.1	0.35	180.35
37.	SH-P-12	85.12	67.74	76.38	0.52	130.47
38.	SH-SC-8	70.01	55.00	67.15	0.47	50.44
39.	SH-SC-814	74.74	63.62	75.97	0.44	79.11
40.	SH-SC-502	84.82	69.58	81.39	0.49	90.06
41.	SH-SC-1003-2	83.11	119.43	131.22	0.70	93.77
42.	SH-SC-578-1	68.46	61.99	70.12	0.68	51.64
43.	SH-SC-885	82.92	57.94	66.2	0.51	75.23
44.	SH-SC-254-1	80.86	98.65	107.73	0.35	81.31
45.	SH-P-50	86.74	79.44	87.50	0.44	178.49
46.	SH-SC-14	85.87	96.55	105.31	0.49	86.6
47.	SH-SC-29	81.86	87.13	99.46	0.71	91.20
48.	SH-SC-11	72.89	119.55	126.41	0.54	66.95
49.	SH-SC-13	81.77	132.75	141.35	0.65	89.17
50.	SH-SC-16	68.86	81.46	90.85	0.40	49.84
51.	SH-SC-505	83.80	77.57	84.13	0.53	98.03
52.	Kashmir Long-1	76.73	173.40	190.66	0.39	87.96
53.	SH-SC-15	83.86	50.012	68.95	0.41	118.27
54.	SH-SC-28	78.70	74.82	95.78	0.5	100.1
55.	SH-SC-115	71.00	63.94	76.12	0.61	51.82
56.	SH-SC-26	75.37	77.81	85.61	0.59	67.61
57.	SH-SC-12	82.11	75.96	85.08	0.51	88.04
58.	SH-SC-17	69.73	70.03	77.95	0.53	41.06
59.	SH-SC-1001	73.47	52.39	65.30	0.48	60.04
60.	SH-SC-105	80.92	101.02	108.69	0.53	87.18
61.	SH-SC-19	80.90	81.36	89.12	0.61	87.99
62.	SH-SC-21	72.07	80.74	87.49	0.57	82.78
63.	SH-SC-18	79.93	195.83	207.17	0.59	92.11
64.	SH-SC-20	83.98	97.69	105.32	0.51	103.39

wide range of variability along with high estimates of phenotypic and genotypic coefficients of variation further indicates that these attributes would respond to selection.

Heritability (b.s.) was high for all the characters and ranged from 94 to 99 per cent indicating that the characters are less influenced by environmental effects and the characters are effectively transmitted to the progeny, suggesting major role of genetic constitution in the expression of a character and thus selection based on phenotypic expression could be relied upon. Similar results were observed by Verma et *al.* (2004) in chilli. High heritability were observed for number of fruits plant^{-1}, fruit length, fruit diameter, fruit weight and fruit yield plant^{-1}. This is confirmity with the reports of Gopalakrishnan *et al*. (1984); Jabeen *et al*. (1998) and Munshi and Behera (2000), who observed high values of heritability for fruit weight, fruit size and Fruit yield plant^{-1} in chilli respectively. High heritability accompanied with moderate genetic advance were observed in days to first fruit set, days to first green fruit harvest, days to first ripe fruit harvest and dry matter content which indicated that these traits might be governed considerably by additive gene action (Panse, 1957). The characters *viz.,* plant height, number of branches plant^{-1}, fruit length, days to first flower, fruit diameter, number of fruits plant^{-1}, average fruit weight, average seed weight per fruit, 100 seed weight, seed yield plant^{-1}, plant spread, vitamin-C content (both at green and ripe stage), capsaicin content and capsanthin content showed the high estimates of heritability coupled with high genetic advance as per cent of mean (GAM), indicating the preponderance of additive gene action for control of these traits. This suggests that real progress in improvement through selection could be made for yield. These results are in conformity with several workers *viz.* Smitha and Basavaraja (2006) for days to first flower in chilli; Jabeen *et al*. (1998) for number of fruits plant^{-1}, fruit weight, fruit length, fruit diameter and fruit yield plant^{-1} in chilli, Shah *et al.* (1986); Ghai and Thakur (1987); Pandita *et al*. (1991) and Munshi and Behera (2000); Manju and Sreelathkumary (2002) for vitamin-C and capsaicin content in chilli; Chattopadhhyay *et al*. (2011) for vitamin-C in chilli.

In general when high heritability is accompanied with high GAM (Genetic advance as per cent of mean), it indicates additive gene effects and selection for such traits may be effective. Low heritability with high GAM is governed by additive gene effects in which low heritability is exhibited due to high environmental effects and the selection may be effective in such cases. Low heritability coupled with low GAM indicates that character is highly influenced by environmental effects and selection for such traits would be ineffective

Fruit yield plant^{-1} is an important character, which decides the commercial viability of the hybrid/variety. Thus the trait deserves the highest priority in any breeding programme. High heritability along with high genetic advance as per cent of mean for this trait suggested the possibility of selecting high yielding cultivars from the present collection. Similar studies were conducted in chilli by Singh *et al*. (2005); Verma *et al*. (2004); Mallikarjun *et al*. (2003) and Jabeen *et al*.(1998) on heritability and genetic advance in chilli and they also revealed high heritability and high genetic advance for fruit yield plant^{-1} in chilli.

Conclusion

The present investigation revealed a great scope in the improvement of different yield and quality traits of chilli, *Capsicum annuum L.*as these characters in general possessed high estimates of heritability coupled with high genetic advancement except for days to first fruit set, days to first green fruit harvest, days to first ripe fruit harvest and dry matter content (high heritability but moderate genetic gain) indicating the preponderance of additive gene action for control of these traits. Thus we can go for the selection of such traits for improving the yield in the present set of chilli genotypes.

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