Doi: HTTPS://DOI.ORG/10.23910/2/2022.0494

Studies on Genetic Variability and Character Association in Chilli Genotypes (*Capsicum annuum* L.)

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Article History

Article ID: IJEP0494
Received on 06th October, 2022
Received in revised form on 09th October, 2022
Accepted in final form on 18th November, 2022

Abstract

The present investigation was carried out at Experimental Farm of Regional Horticultural Research and Training Station Dhaulakuan, District Sirmour (HP), Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, during Kharif season, 2018 to ascertain extent of variability, heritability and genetic advance as percentage of mean for yield and other horticultural traits of 21 chilli genotypes. The experiment was laid out in RCBD with three replications at spacing of 45cm × 45cm. Analysis of variance indicated significant differences among the genotypes for all the traits studied**.** RACH-132 exhibited the maximum number of fruits per plant (97.27), fruit weight at edible maturity (4.08 g), green fruit yield plant^{-1} (280.10 g), red fruit yield plant^{-1} (275.89 g) and fruit diameter (1.23 cm) while, number of seeds and thousand seed weight was maximum in RACH-121 (100.40, 5.12 g). DKC-8 (0.49%) recorded the maximum capsaicin content. The estimates of phenotypic and genotypic coefficients of variation (PCV and GCV) were moderate to high for all characters studied except days to first red maturity. High heritability coupled with high genetic gain was found for characters like green fruit yield plant^{-1}, red fruit yield plant^{-1} and capsaicin content which indicates that these characters were under the strong influence of additive gene action and hence simple selection based on phenotypic performance of these traits would be effective.

Keywords: *Capsicum annuum* L., variability, heritability, genetic advance

1. Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable as well as spice crop mostly grown in tropical and subtropical regions of the world. The genus *Capsicum,* belonging to Solanaceae family, is dicotyledonous flowering plant, often cross pollinated crop where 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 (Pandiyaraj et al., 2017). The genus represents a diverse plant group of about 25 wild and five cultivated species *viz*. *Capsicum annuum* L., *Capsicum frutescens* L.*, Capsicum chinense* Jacquin*, Capsicum pubescence* Ruiz & Pavon, *Capsicum pendulum* Willdenow among which *Capsicum annuum* L. is the most widely cultivated species which includes both hot peppers (pungent fruits) and sweet peppers (non pungent fruits). The major chilli producing countries accounting for more than 85% of the world production are India, China, Korea, Japan, Spain, Nigeria, Pakistan, Indonesia, Mexico etc. In India, chilli is grown in area of 366000 ha with the production of 3737000 mt and productivity of 10.21 mt ha^{-1} (Anonymouus, 2019). In India, chillies are valued for use as a vegetable (green chilli), spice (dry chilli), condiment, sauce and pickle under different climates (Hazra et al., 2011). The chilli crop exhibits wide range of genetic and morphological diversity in terms of fruit shape, size and their consumption patterns. Based on its uses, chilli has been classified into bell group, pimento group, squash/cheese group, ancho group, anaheim group (long green chile group), cayenne group, cuban group, jalapeno group, small hot group, cherry group and short wax group thus, adding pungency, aroma, taste, flavour and colour to the dishes.

Yield is a quantitative character and is influenced by various yield contributing traits. The germplasm serves as a valuable source of base population and provides scope for building up of genetic variability. Therefore, proper understanding and evaluation of germplasm is necessary for effective crop improvement program. In any breeding program, improvement is possible through selection of superior elite germplasm and discarding the undesirable ones based on their yield contributing traits. Thus, selection of desirable genotypes is proportional to the amount of genetic variation present in germplasm and the extent to which the characters can be inherited. In order to assess the genetic potential of the germplasm, the present investigation was undertaken to

determine the nature and magnitude of genetic variability, heritability and genetic advance and interrelationships of traits among each other with respect to yield and its contributing traits.

2. Materials and Methods

The evaluation was carried out at the Experimental Farm of Regional Horticultural Research and Training Station Dhaulakuan, District Sirmour (HP), Dr. YS Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh, during Kharif season, 2018. The experimental area is located at 30º4' North of latitude and 77° 5' East of longitude and lies at an elevation of 468m above mean sea level under the sub-tropical low hills. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 21 genotypes (20 genotypes+1 check) and three replications at 45× 45 cm^2 row to row and plant to plant spacing. All the recommended cultural practices were adopted to raise the healthy crop. The observations pertaining to green fruit traits were recorded on five selected plants and another five plants were tagged for recording red fruit traits in each genotype in each replication and their means were worked out for statistical analysis. The observations were recorded on fourteen traits *viz*., days to 50% flowering, days to first green fruit picking, days to first red fruit maturity, plant height (cm), fruit length (cm), fruit diameter (cm), fruit dry matter content (%), number of fruits $plant^{-1}$, fruit weight at edible maturity (g), green fruits yield $plant^{-1}$ (g), red fruits yield $plant^{-1}$ (g), number of seeds $fruit^{-1}$, 1000-seed weight (g) and pungency.

3. Results and Discussion

3.1. Mean performance

The mean value of different yield and its contributing parameters are presented in Table 1. The genotypes showed

Table 1: Mean performance of chilli genotypes for yield and its contributing characters

Genotypes	Days to 50% flowering	Days to first green fruit picking	Days to first red fruit maturity	Plant height (cm)	Fruit length (cm)	Fruit diameter (cm)	Fruit dry matter content (%)
RACH- 1	78.00	103.67	126.33	63.82	6.13	0.72	10.75
RACH- 5	69.33	92.33	115.33	54.10	7.58	0.77	12.97
RACH- 11	65.33	93.33	120.00	72.01	7.13	0.71	12.23
RACH- 15	53.33	83.00	109.33	75.23	6.89	0.79	10.93
RACH- 16	58.00	86.67	108.33	87.45	6.93	0.84	11.00
RACH- 28	54.67	84.33	107.67	66.70	7.39	0.81	12.59
RACH- 51	48.33	76.33	104.33	79.01	7.32	0.74	12.80
RACH- 74	52.33	76.00	97.33	85.15	5.70	0.83	15.98
RACH- 112	42.00	69.33	100.67	89.08	8.67	0.87	20.53
RACH- 114	38.95	71.67	101.67	93.87	8.33	0.90	18.77
RACH- 117	35.16	58.67	89.67	74.42	10.59	0.76	11.37
RACH- 121	31.36	66.67	98.33	72.21	9.21	0.95	15.29
RACH- 131	27.57	63.00	87.67	83.92	7.10	0.90	13.18
RACH- 132	34.67	63.33	87.67	91.32	6.49	1.23	19.47
RACH- 133	51.00	77.33	102.33	102.11	9.53	0.75	15.90
RACH- 135	49.33	74.67	100.67	76.09	8.46	0.81	11.57
RACH- 136	47.33	66.67	89.33	82.17	7.37	0.83	14.80
RACH- 137	57.67	79.33	96.67	70.14	8.31	0.82	10.42
RACH- 138	45.00	72.67	97.67	82.68	7.38	0.84	12.86
DKC- 2363	51.00	83.00	101.67	77.60	8.25	0.82	15.77
DKC- 8 (C)	58.00	87.00	104.33	61.03	6.17	0.88	18.73
Range	27.57-78.00	58.67-103.67	87.67-126.33	54.10-102.11	5.70-10.59	0.71-1.23	10.42-20.53
Mean	49.92	77.57	102.24	78.10	7.66	0.84	14.19
SEm±	1.98	1.62	0.76	1.46	0.16	0.01	0.54
CD (*p*=0.05)	5.65	4.63	2.17	4.16	0.45	0.03	1.55

Table 1: Continue...

Genotypes	No. of fruits plant^{-1}	Fruit weight at edible maturity (g)	Green fruit yield plant^{-1} (g)	Red fruit yield plant^{-1} (g)	No. of seeds fruit^{-1}	Thousand seed weight (g)	Capsaicin content (%)
RACH- 1	33.87	2.05	71.52	65.55	64.20	3.16	0.21
RACH- 5	44.00	2.45	100.36	92.31	68.60	2.77	0.23
RACH- 11	46.13	2.50	110.37	107.32	67.27	3.23	0.30
RACH- 15	52.40	2.66	139.71	134.21	68.60	2.87	0.19
RACH- 16	51.67	2.23	106.02	97.44	61.00	3.53	0.22
RACH- 28	47.13	3.19	117.32	106.01	81.07	3.01	0.41
RACH- 51	65.07	2.44	149.13	146.14	59.00	3.30	0.32
RACH- 74	61.13	2.43	169.05	163.01	57.47	3.98	0.41
RACH- 112	73.53	3.40	223.01	205.35	85.00	4.87	0.33
RACH- 114	72.80	3.69	218.34	201.22	75.93	3.69	0.44
RACH- 117	73.87	1.92	142.35	139.82	66.07	3.63	0.42
RACH- 121	81.20	3.03	244.85	242.10	100.40	5.12	0.31
RACH- 131	74.53	2.48	186.01	182.27	78.40	4.11	0.39
RACH- 132	97.27	4.08	280.10	275.89	92.60	4.58	0.34
RACH- 133	88.40	2.29	177.63	172.09	81.00	3.90	0.42
RACH- 135	77.00	3.18	215.58	195.67	67.80	3.13	0.21
RACH- 136	71.93	2.71	172.46	161.25	71.47	3.73	0.24
RACH- 137	64.20	3.07	173.63	148.47	76.07	3.79	0.22
RACH- 138	63.47	3.19	149.20	138.47	73.13	3.81	0.25
DKC- 2363	57.87	2.67	115.12	103.85	68.87	3.80	0.36
DKC- 8 (C)	83.40	2.65	188.54	180.99	60.67	4.96	0.49
Range	33.87-97.27	1.92-4.08	71.52-280.10	65.55-275.89	57.47-100.40	2.77-5.12	0.19-0.49
Mean	65.76	2.78	164.30	155.21	72.60	3.76	0.32
SEm±	1.71	0.08	7.08	4.92	1.97	0.08	0.01
CD (p=0.05)	4.89	0.24	20.25	14.06	5.64	0.23	0.02

a wide range of variation in different yield component traits. Earliness in flowering is the desirable character for any crop especially in multiple harvest crops like vegetables to get early harvest and to fetch better price in the market. The genotype RACH-131 (27.57 days) was the earliest to exhibit blooming in 50% plants followed by RACH-121 (31.36 days), however, late flowering was recorded in RACH-1 (78.00 days). RACH-117 was the earliest in producing green fruits of marketable maturity (58.67 days) while maximum days were exhibited by RACH-1 (103.67 days). The genotypes RACH-131 and RACH-132 both maturing in 87.67 days, were the earliest in producing red fruits, while, RACH-1 (126.33 days) took the maximum days to produce red mature fruits. The plant height varied from 54.10 cm to 102.11cm, maximum and minimum recorded in RACH-133 and RACH-5 respectively. Maximum fruit length was attained by RACH-117 (10.59 cm) while RACH-74 (5.70 cm), the minimum fruit length. The data pertaining to fruit diameter showed the range from 0.71 cm to 1.23 cm with the population mean of 0.84±0.01 cm, being maximum in RACH-132 (1.23 cm) and minimum in RACH-11 (0.71 cm). The genotype RACH-132 recorded the maximum number of fruits plant^{-1} (97.27), fruit weight at edible maturity (4.08 g), green fruit yield plant^{-1} (280.10 g) and red fruit yield plant^{-1} (275.89 g) which was found superior to the check variety by 16.6%, 53.9%, 48.5% and 52.4%, respectively. RACH-121 recorded both maximum number of seeds fruit^{-1} (100.40) and thousand seed weight (5.12 g) while RACH-74 (57.47), the minimum seeds fruit^{-1} and RACH-5 (2.77 g) recorded the minimum thousand seed weight. DKC-8 was the most pungent genotype and recorded the maximum capsaicin content (0.49%).

3.2. Variability parameters

The extent of variability with respect to range, mean, phenotypic and genotypic coefficients of variation, heritability and genetic advance as percentage of mean is given in Table 2. High phenotypic and genotypic coefficients of variation

Table 2: Estimates of phenotypic and genotypic coefficient of variation, heritability, genetic advance and genetic gain for various characters in chilli

Characters	Range	Mean	Coefficient of Variability (%)		Heritability (%)	Genetic advance	Genetic gain (%)
			Phenotypic	Genotypic			
Days to 50% flowering	27.57-78.00	49.92	25.74	24.81	92.91	24.60	49.27
Days to first green fruit picking	58.67-103.67	77.57	14.93	14.48	94.12	22.45	28.94
Days to first red maturity	87.67-126.33	102.24	9.93	9.85	98.32	20.57	20.12
Fruit length (cm)	5.70-10.59	7.66	16.04	15.65	95.15	2.41	31.44
Fruit diameter (cm)	0.71-1.23	0.84	13.24	13.08	97.60	0.22	26.63
Plant height (cm)	54.10-102.11	78.10	15.09	14.74	95.42	23.17	29.66
Fruit dry matter content (%)	10.42-20.53	14.19	22.62	21.62	91.40	6.04	42.58
No. of fruits plant^{-1}	33.87-97.27	65.76	24.71	24.30	96.68	32.36	49.22
Fruit weight at edible maturity (g)	1.92-4.08	2.78	19.99	19.31	93.28	1.07	38.42
Green fruit yield (g plant^{-1})	71.52-280.10	164.30	32.63	31.77	94.76	104.66	63.70
Red fruit yield (g plant^{-1})	65.55-275.89	155.21	33.76	33.31	97.36	105.08	67.70
No. of seeds per fruit	57.47-100.40	72.60	15.66	14.93	90.96	21.30	29.34
Thousand seed weight (g)	2.77-5.12	3.76	18.17	17.77	95.67	1.35	35.81
Capsaicin content (%)	0.19-0.49	0.32	28.60	28.41	98.67	0.19	58.14

(PCV & GCV) were recorded for red fruit yield plant^{-1} followed by green fruit yield plant^{-1}, capsaicin content, days to 50% flowering, number of fruits plant^{-1} and fruit dry matter content indicating that the population had sufficient variability and effective selection could be made using these traits for the improvement of yield and related characters. The results of present investigation were within agreement to the finding of Chattopadhyay et al. (2011), Pandit and Adhikary (2014), Patel et al. (2015), Bijalwan and Naidu (2016) and Bundela et al. (2017) for number of fruits plant^{-1} and green fruit yield plant^{-1}. High GCV and PCV has also been reported by Manju and Sreelathakumary (2002), Chattopadhyay et al. (2011), Datta and Das (2013) and Patel et al. (2015) for capsaicin content and Zehra et al. (2017) reported high GCV and PCV for fruit dry matter content. Similarly, high GCV and PCV for days to 50% flowering were reported by Smitha and Basavaraja (2006), Chattopadhyay et al. (2011) and Pandit and Adhikary (2014). Krishnamurthy et al. (2013) reported high GCV and PCV for red fruit yield plant^{-1}. Days to first red fruit maturity had low coefficient of variation at both genotypic and phenotypic level. Similar results for days to first red maturity were also recorded by Amit et al. (2014) and Zehra et al. (2017).

3.3. Heritability parameters

In present study, all the characters exhibited high estimates of heritability which suggested that reliable selection could be made for these traits based on phenotypic expression. Similar results on high heritability have also been reported in chilli by Manju and Sreelathakumary (2002) for yield plant^{-1}, capsaicin content, fruits plant^{-1}, fruit length, fruit girth, fruit weight, number of seeds fruit^{-1}, thousand seed weight; Chattopadhyay et al. (2011) for days to 50% flowering, number of seeds fruit^{-1}, green fruit yield plant^{-1} and capsaicin content, Rosmaina et al. (2016) for plant height, fruit length, fruit diameter, number of fruits plant^{-1}, Bijalwan and Naidu (2016) for days to 50% flowering, days to first picking, dry matter content, fruit weight at edible maturity and yield plant^{-1}, Zehra et al. (2017) for days to first green fruit harvest, days to first ripe fruit harvest, plant height, fruit length, fruit diameter, average fruit weight, number of fruits plant^{-1}, dry matter content and capsaicin content.

Genetic advance along with heritability help to ascertain the possible genetic control for any particular trait. High estimate of genetic gain was recorded for red fruit yield plant^{-1} followed by green fruit yield plant^{-1}, capsaicin content, days to 50% flowering, number of fruits plant^{-1}, fruit dry matter content, fruit weight at edible maturity, thousand seed weight, fruit length, plant height, Number of seeds fruit^{-1}, days to first green fruit picking, fruit diameter and days to first red fruit maturity. The results were in accordance with Manju and Sreelathakumary (2002) for plant height, fruits plant^{-1}, fruit length, fruit girth, fruit weight, seeds fruit^{-1}, 1000-seed weight, yield plant^{-1} and capsaicin content. Krishnamurthy et al. (2013) reported high genetic advance as percentage of mean for plant height, fruit length, fruits plant^{-1} and red fruit yield plant^{-1}. Pandit and Adhikary (2014) reported high level of genetic gain for days to 50% flowering, fruit length, fruit width, number of fruits plant^{-1}, fruit weight, number of seeds plant^{-1} and green fruit yield plant^{-1}.

4. Conclusion

Analysis of variance revealed highly significant differences among the genotypes for all the characters studied indicating the existence of substantial variability, pointing ample scope for their improvement through selection. In the present study, the green fruit yield per plant, red fruit yield per plant and capsaicin content had maximum heritability coupled with maximum genetic gain, the selection or hybridization practiced, based on these traits could show 100 per cent transmittance, as the differences in PCV and GCV are negligible.

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