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Performance of Chilli (*Capsicum annuum* L.) Genotypes for Yield and Yield Attributing Traits

Mopidevi M Nagaraju[1]*, R.V.S.K. Reddy[2], K. Madhavi Reddy[3], L. Naram Naidu[4], A. Snehalata Rani[5] and K. Uma Krishna[6]

[1]Department of Vegetable Science, [6]Department of Statistics, College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem - 534 101, Andhra Pradesh, India
[2]Director of Extension, Dr. Y.S.R Horticultural University, Venkataramannagudem - 534 101, Andhra Pradesh, India
[3]Division of Vegetable Crops, ICAR - Indian Institute of Horticultural Research (IIHR), Bengaluru, Karnataka, India
[4]Horticultural Research Station, Dr. Y.S.R Horticultural University, Lam Guntur, Andhra Pradesh, India
[5]Horticultural Research Station, Kovvur, West Godavari District, Andhra Pradesh, India

**Corresponding author*

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A B S T R A C T

An experiment was conducted during *kharif* 2017-2018 at College of Horticulture, Venkataramannagudem, Dr. YSR Horticultural University, Andhra Pradesh (India) to identify potential genotypes for twelve quantitative traits among fifty three genotypes of chilli (*Capsicum annuum* L.). The analysis of variance revealed significant differences among the genotypes for all the twelve characters indicating the presence of genetic variability among the genotypes. Among fifty three genotypes, the genotype Meghalaya Local recorded maximum plant height, plant spread and number of primary branches per plant. Whereas, the genotype IHR 2900 recorded the earliest for days to 50 per cent flowering and days to 50 per cent ripening. However, the maximum red ripe fruit yield was recorded in genotype IHR 4611. Meghalaya Local recorded maximum number of fruits per plant, whereas, California Wonder was recorded maximum fruit length, fruit width and fruit weight. The genotype IHR 3478 recorded highest number of seeds per fruit, whereas, the genotype IHR 4604 recorded highest 1000 seed weight. The characters showing wide range of variation provide an ample scope for selecting superior types and the selected genotypes can be used in further breeding programme.

Introduction

Chilli (*Capsicum annuum* L.) an important spice cum vegetable crop, is extensively cultivated in India both under rainfed and irrigated conditions. Chilli belongs to the genus Capsicum of family Solanaceae. It has originated in Mexico, Southern Peru and

Bolivia. There are mainly five cultivated *Capsicum spp. viz., C. annuum, C. baccatum, C. chinense, C. frutescens,* and *C. pubescens* of which *Capsicum annuum* is the dominant species world over and could be broadly classified into non-pungent (sweet pepper) and pungent (chilli or hot pepper) based on their level of pungency (Bosland and Votava, 2000). In India, it is an important ingredient in daily cuisine and is a rich source of vitamin A, E, C and potassium. It is also a good source of oleoresin which has good export potential.

India is the largest producer, consumer and exporter of chilli with an annual production of 2.09 million tonnes from 0.84 million ha (National Horticulture Board, 2016-17). According to an estimate for 2016, in India, chillies (dry-red and fresh-green fruits) were cultivated in 797,029 ha with a total production of 1.3 million tonnes of dry fruits and 679,17 tonnes of fresh fruits. Average yield of dry chilli harvest was around 1.7 t/ha compared to that of 8.4 t/ha for green chilli (FAOSTAT, 2016). In India, the states of Andhra Pradesh, Telangana, Karnataka, Maharashtra, Orissa and Tamil Nadu account for more than 75% of the area and production of chilli.

The alkaloid 'capsaicin' present in placenta of the chilli fruit responsible for its pungency has diverse prophylactic and therapeutic uses in Allopathic and Ayurvedic medicine (Sumathy and Mathew, 1984) and directly scavenge various free radicals (Kogure *et al.,* and 2002; Bhattacharya *et al.,* 2010) and has wide applications in the food, medicine and pharmaceutical industries. Chilli is a good source of vitamin C (ascorbic acid) used in food and beverage industries (Bosland and Votava, 2000). It has also acquireda great importance because of the presence of 'oleoresin', which permits better distribution of color and flavor in foods. The assessment of nature and magnitude of variability in the available germplasm is the prerequisite of any breeding programme. The effectiveness of selection and development of improved varieties depends on the nature of variability expressed for yield and its contributing characters in the gene pool. High yield and yield contributing characters with improved quality parameters have been the major objective of chilli breeding programme. The importance of genetically diverse genotypes with desirable combinations has also been realized by several workers (Peter and Rai, 1978 and Das *et al.,* 1998). Keeping in view the above facts, the present investigation was undertaken to observe the performance of genotypes of chilli for quantitative traits and to screen the best performing genotypes for utilization in further breeding programme.

Materials and Methods

The experiment was carried out with 53 chilli genotypes (Table 1) at Collage of Horticulture, Venkataramannagudem, Dr. YSR Horticultural University, Andhra Pradesh, India during 2017-2018 in a randomized block design with three replications. Each genotype was raised in 3.6 m × 1.8 m plot size with a spacing of 60× 45 cm accommodating 24 plants per plot. The crop was grown with standard package of practices. Five competitive plants were selected at random for recording the observations on 12 characters *viz.,* plant height (cm), plant spread (cm^2), number of primary branches per plant, days to 50 per cent flowering, days to 50 per cent ripening, number of fruits per plant, fruit length (cm), fruit width (cm), fruit weight (cm), number of seeds per fruit, seed weight (g/1000 seed) and red ripe fruit yield per plant (g). The crop was raised as per the recommended package of practices. Analysis of variance was carried out as per the procedure given by Panse and Sukhatme (1985).

Results and Discussion

The analysis of variance (Table 2) revealed significant differences among the genotypes for all the twelve characters studied indicating the presence of genetic variability in the genotypes and considerable scope for their improvement. These results are in conformity with earlier reports of Farhad *et al.,* (2008), Gupta *et al.,* (2009), Suryakumari *et al.,* (2010) and Kumar *et al.,* (2012) in chilli.

Plant height of genotypes varied from 39.40 to 109.33 cm with a mean of 65.60cm (Table 3). Among the genotypes, Meghalaya Local (109.33 cm) recorded maximum plant height followed by IHR 4597 (88.40 cm), whereas, minimum plant height was recorded in IHR 3024 (39.40 cm). Twenty five genotypes recorded significantly more plant height than grand mean. The trait, plant spread varied from 47.05to 108.07 $cm^2$with over all mean of 62.79 cm^2. Significantly highest plant spread was observed in Meghalaya Local (108.07 cm^2) followed by BhutJolokia (92.07 cm^2), whereas, IHR 1485 (47.05 cm^2) recorded lowest plant spread. Plant spread of twenty four genotypes was significantly higher than grand mean. The mean values for number of branches per plant varied from 2.20 to 5.33 with a grand mean of 3.44. Number of primary branches per plant was least in IHR 3449 (2.20), significantly highest number of primary branches per plant was recorded in Meghalaya Local (5.33). Twenty six genotypes recorded significantly higher number of primary branches than grand mean. These results are in line with findings of Munshi *et al.,* (2010) and Nehru *et al.,* (2012), who also reported highest variability for above traits. The mean values for number of days to 50 per cent flowering ranged from 27.33 to 52.67 days with a general mean of 37.64 days. The genotype IHR 2900 was found to be early (27.33 days) followed by IHR 3315 (29.67 days), whereas, Bhut Jolokia (52.67days) recorded maximum number of days for 50 per cent flowering. Twenty five genotypes recorded less number of days to 50 per cent flowering compared to grand mean. The mean values for number of days to 50 per cent ripening ranged from 68.67 to 97.67 days with a general mean of 81.07 days. The genotype IHR 2900 was found to be early (68.67 days), closely followed by IHR 3315 (69.00 days), whereas Meghalaya Local (97.67 days) recorded maximum number of days to 50 per cent ripening. Twenty three genotypes recorded less number of days to 50 per cent ripening compared to grand mean. Bharadwaj *et al.,* (2007), Tembhurne *et al.,* (2008) and Arup *et al.,* (2011) reported same trends of flowering in chilli.

The number of fruits per plant varied from 11.44 to 798.67 with an overall mean of 197.09. Significantly highest number of fruits per plant was observed in Meghalaya Local (798.67) followed by IHR 4597 (384.11), whereas, California Wonder (11.44) recorded the least number of fruits. Thirty one genotypes recorded significantly more number of fruits compared to grand mean. Fruit length varied from 2.15 to 14.48 cm with an overall mean of 8.12 cm. Highest fruit length was recorded in California Wonder (14.48 cm) which, was on par with IHR 4611 (14.24cm), whereas, the lowest fruit length was recorded in Meghalaya Local (2.15 cm). Twenty five genotypes recorded significantly more fruit length than overall mean. The character, fruit width ranged from 2.09 to 22.42 cm with a grand mean of 4.68 cm. California Wonder (22.42 cm)recorded the highest fruit width followed by IHR 3478 (15.57cm), whereas, Meghalaya Local (2.09 cm) recorded the least fruit width. Fifteen genotypes recorded significantly higher fruit diameter than grand mean. Padhar and Zaveri (2010), Arup *et al.,* (2011), Lakshmi and Padma (2012) and Vijaya *et al.,* (2014) also reported same trend of range for number of fruits and fruit length.

Table.1 Germplasm accessions of chilli (*Capsicum annuum* L.)

Treatments	Accession number or Varieties	Source
T_1	IHR 1485	Indian Institute of Horticultural Research, Bengaluru
T_2	IHR 1732	IIHR, Bengaluru
T_3	IHR 2452	IIHR, Bengaluru
T_4	IHR 2596	IIHR, Bengaluru
T_5	IHR 2900	IIHR, Bengaluru
T_6	IHR 3014	IIHR, Bengaluru
T_7	IHR 3024	IIHR, Bengaluru
T_8	IHR 3310	IIHR, Bengaluru
T_9	IHR 3315	IIHR, Bengaluru
T_{10}	IHR 3443	IIHR, Bengaluru
T_{11}	IHR 3447	IIHR, Bengaluru
T_{12}	IHR 3448	IIHR, Bengaluru
T_{13}	IHR 3449	IIHR, Bengaluru
T_{14}	IHR 3455	IIHR, Bengaluru
T_{15}	IHR 3478	IIHR, Bengaluru
T_{16}	IHR 3517	IIHR, Bengaluru
T_{17}	IHR 3587	IIHR, Bengaluru
T_{18}	IHR 3915	IIHR, Bengaluru
T_{19}	IHR 4597	IIHR, Bengaluru
T_{20}	IHR 4595	IIHR, Bengaluru
T_{21}	IHR 4598	IIHR, Bengaluru
T_{22}	IHR 4600	IIHR, Bengaluru
T_{23}	IHR 4601	IIHR, Bengaluru
T_{24}	IHR 4602	IIHR, Bengaluru
T_{25}	IHR 4603	IIHR, Bengaluru
T_{26}	IHR 4604	IIHR, Bengaluru
T_{27}	IHR 4605	IIHR, Bengaluru
T_{28}	IHR 4606	IIHR, Bengaluru
T_{29}	IHR 4607	IIHR, Bengaluru
T_{30}	IHR 4608	IIHR, Bengaluru
T_{31}	IHR 4609	IIHR, Bengaluru
T_{32}	IHR 4610	IIHR, Bengaluru
T_{33}	IHR 4611	IIHR, Bengaluru
T_{34}	IHR 4612	IIHR, Bengaluru
T_{35}	IHR 4031	IIHR, Bengaluru
T_{36}	IHR 4516	IIHR, Bengaluru
T_{37}	IHR 4592	IIHR, Bengaluru
T_{38}	IHR 4593	IIHR, Bengaluru

T_{39}	IHR 4594	IIHR, Bengaluru
T_{40}	G3	Horticultural Research Station, Lam farm, Guntur
T_{41}	G4	HRS, Lam farm, Guntur
T_{42}	G5	HRS, Lam farm, Guntur
T_{43}	LCA 206	HRS, Lam farm, Guntur
T_{44}	LCA 235	HRS, Lam farm, Guntur
T_{45}	LCA 305	HRS, Lam farm, Guntur
T_{46}	LCA 334	HRS, Lam farm, Guntur
T_{47}	LCA 353	HRS, Lam farm, Guntur
T_{48}	LCA 620	HRS, Lam farm, Guntur
T_{49}	LCA 625	HRS, Lam farm, Guntur
T_{50}	LCA 960	HRS, Lam farm, Guntur
T_{51}	BhutJolokia	Tura, Meghalaya
T_{52}	Meghalaya Local	Tura, Meghalaya
T_{53}	CaliforniaWonder	Namdhari Seed Company

Table.2 Analysis of variance for yield, yield attributing traits in chilli

S. No	Character	Mean sum of Squares		
		Replications	**Treatments**	**Error**
1.	Plant height (cm)	28.54	601.62 **	33.62
2.	Plant spread (cm^2)	43.86	336.19 **	30.03
3.	Number of primary branches per plant	0.34	0.87 **	0.12
4.	Days to 50% flowering	11.84	74.03 **	6.29
5.	Days to 50% ripening	31.13	104.82 **	21.56
6.	Number of fruits per plant	1830.81	41832.40 **	1706.66
7.	Fruit length (cm)	0.030	21.18 **	0.128
8.	Fruit width (cm)	0.26	34.01**	0.09
9.	Fruit weight	0.22	423.80 **	0.17
10.	Number of seeds per fruit	32.36	2023.27 **	19.28
11.	Seed weight (g/1000 seed)	0.03	4.19 **	0.03
12.	Red ripe fruit yield (g/plant)	10125.08	72208.23 **	13671.31

* Significant at 5 % level ** Significant at 1 % level

Table.3 Mean performance of yield, yield contributing traits of various chilli genotypes

S. No	Genotypes	Plant height (cm)	Plant spread (cm^2)	No of primary branches/ plant	Days to 50% flowering	Days to 50% ripening	No of fruits/ plant	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Number of seeds per fruit	Seed weight (g/1000 seed)	Red ripe fruit yield (g/plant)
T_1	IHR 1485	71.53	47.05	3.86	46.33	85.67	264.55	4.96	3.17	2.12	54.47	4.47	555.33
T_2	IHR 1732	61.20	56.06	3.60	43.00	83.67	256.00	8.01	3.49	2.82	72.07	4.44	678.89
T_3	IHR 2452	57.13	55.17	3.60	36.33	79.33	212.44	4.84	3.53	1.84	69.87	5.62	355.44
T_4	IHR 2596	44.20	55.77	2.87	32.00	76.67	116.78	5.78	4.86	4.62	88.20	6.35	470.78
T_5	IHR 2900	42.07	53.43	4.13	27.33	68.67	300.00	7.38	3.45	2.80	73.47	4.38	637.55
T_6	IHR 3014	72.73	58.63	4.33	39.67	77.33	256.44	5.08	2.86	1.39	56.93	3.83	345.22
T_7	IHR 3024	39.40	58.00	3.67	30.67	71.67	306.11	7.82	2.63	1.97	79.27	4.95	502.22
T_8	IHR 3310	50.27	58.87	3.67	31.33	73.00	156.56	10.47	5.07	5.84	127.47	6.05	816.78
T_9	IHR 3315	52.27	60.47	2.53	29.67	69.00	72.00	13.00	5.48	9.53	124.13	5.42	655.56
T_{10}	IHR 3443	64.53	63.33	3.60	36.00	82.67	229.11	8.85	3.26	2.89	65.07	5.56	553.45
T_{11}	IHR 3447	41.13	54.43	3.53	32.33	72.67	214.33	8.58	3.54	2.86	66.20	5.66	528.89
T_{12}	IHR 3448	65.33	65.70	3.80	34.00	81.67	238.00	7.68	3.14	2.25	72.20	6.46	488.89
T_{13}	IHR 3449	43.73	54.50	2.20	38.33	82.67	72.78	10.27	4.57	5.69	73.73	7.70	467.55
T_{14}	IHR 3455	65.40	54.23	2.73	35.00	86.00	69.22	10.57	7.39	9.59	115.60	7.01	645.78
T_{15}	IHR 3478	65.00	55.40	3.27	37.67	77.67	16.56	9.23	15.57	50.07	153.62	5.64	852.11
T_{16}	IHR 3517	76.27	62.87	3.87	34.67	79.00	201.11	8.59	3.37	3.36	57.27	5.99	674.00
T_{17}	IHR 3587	85.07	61.03	3.20	44.33	82.33	92.56	9.26	4.19	2.79	67.87	6.46	238.89
T_{18}	IHR 3915	49.40	65.43	4.00	34.00	84.00	234.11	9.05	3.26	2.83	73.20	6.80	623.89
T_{19}	IHR 4597	88.40	70.10	4.33	37.33	83.67	384.11	5.08	2.89	1.28	67.33	6.03	452.78
T_{20}	IHR 4595	93.80	74.77	4.53	48.33	89.67	202.33	6.03	4.94	3.88	100.60	7.09	722.22
T_{21}	IHR 4598	63.87	70.13	3.33	35.67	79.67	248.44	6.89	3.91	2.88	86.05	4.62	619.78
T_{22}	IHR 4600	67.27	50.37	3.27	39.33	84.33	53.22	11.79	6.69	10.06	126.35	6.92	501.45
T_{23}	IHR 4601	69.53	50.53	3.60	38.67	73.33	20.00	7.53	12.00	27.73	80.39	6.88	570.56
T_{24}	IHR 4602	77.07	52.17	4.27	43.33	80.67	253.00	6.88	3.01	2.00	55.33	5.81	478.56
T_{25}	IHR 4603	73.93	78.10	3.80	35.33	78.00	175.89	13.58	2.86	3.29	59.83	6.69	586.00
T_{26}	IHR 4604	64.07	49.73	2.73	34.67	75.00	51.11	11.63	7.05	10.04	92.80	10.07	510.33
T_{27}	IHR 4605	43.33	52.47	2.73	33.33	83.33	183.33	3.87	4.01	2.85	92.00	5.46	446.22
T_{28}	IHR 4606	77.53	60.63	3.27	37.00	87.67	85.89	6.38	3.43	3.22	75.53	6.17	259.22

T_{29}	IHR 4607	45.07	68.43	3.20	35.67	80.00	218.33	5.84	2.44	2.23	75.67	5.90	421.22
T_{30}	IHR 4608	71.00	69.87	3.33	41.33	88.00	255.22	6.14	3.08	2.81	71.53	6.53	549.33
T_{31}	IHR 4609	62.40	67.13	3.47	34.33	81.33	127.89	10.90	4.21	3.35	100.84	6.53	373.56
T_{32}	IHR 4610	68.93	65.37	3.27	38.67	79.00	102.11	10.97	5.58	7.83	82.53	7.83	795.33
T_{33}	IHR 4611	68.33	66.00	3.60	31.00	73.33	143.11	14.24	4.87	7.97	136.60	8.15	1028.45
T_{34}	IHR 4612	69.33	75.97	3.67	34.00	75.33	231.22	12.14	3.23	3.66	80.87	4.96	769.33
T_{35}	IHR 4031	64.27	56.50	3.20	40.67	82.33	197.66	8.14	3.17	3.27	55.67	6.14	600.67
T_{36}	IHR 4516	56.13	57.13	3.20	34.33	80.00	227.78	8.26	3.16	2.80	61.73	4.65	561.00
T_{37}	IHR 4592	67.47	62.40	3.47	36.33	77.67	280.45	5.95	4.15	2.18	50.07	4.37	540.56
T_{38}	IHR 4593	65.13	55.33	3.67	36.67	81.33	267.00	7.23	3.35	3.03	57.97	6.64	708.22
T_{39}	IHR 4594	73.67	70.23	3.47	32.00	74.33	275.22	6.82	3.25	2.94	75.20	5.54	740.45
T_{40}	G3	83.87	77.73	3.53	41.33	80.67	199.33	7.57	3.49	3.04	69.49	6.65	568.22
T_{41}	G4	69.67	67.00	3.00	41.00	86.67	205.11	8.54	3.91	2.81	53.53	6.10	516.67
T_{42}	G5	73.27	58.77	3.40	40.00	83.33	156.00	5.07	5.56	4.10	68.60	7.28	612.78
T_{43}	LCA 206	78.47	67.03	3.20	40.67	86.00	193.44	7.29	3.82	3.69	52.40	7.06	643.44
T_{44}	LCA 235	51.13	58.27	2.87	36.00	79.00	257.33	5.16	3.05	1.78	79.10	5.97	376.45
T_{45}	LCA 305	56.87	65.93	3.27	37.67	80.67	217.89	7.40	3.76	2.68	69.20	6.73	513.78
T_{46}	LCA 334	62.47	61.87	3.13	41.00	87.67	218.78	6.94	3.45	2.53	65.20	5.85	515.11
T_{47}	LCA 353	63.47	65.10	3.07	39.00	85.33	242.22	8.23	2.98	2.28	58.73	4.93	508.11
T_{48}	LCA 620	66.47	65.80	3.27	41.33	88.00	190.56	9.06	3.75	4.08	91.33	6.19	693.56
T_{49}	LCA 625	61.53	63.37	3.00	39.00	87.33	232.11	8.13	3.08	2.42	59.87	6.11	549.22
T_{50}	LCA 960	84.40	60.07	2.67	38.67	81.33	129.00	9.21	5.23	5.59	115.93	7.38	770.00
T_{51}	BhutJolokia	81.27	92.07	3.13	52.67	95.33	102.00	5.30	7.50	3.33	28.27	4.40	298.00
T_{52}	Meghalaya Local	109.33	108.07	5.33	49.33	97.67	798.67	2.15	2.09	0.52	24.40	3.38	410.45
T_{53}	California Wonder	57.13	52.83	3.60	36.67	76.00	11.44	14.48	22.42	72.47	118.27	6.63	759.00
	Mean	**65.60**	**62.79**	**3.44**	**37.64**	**81.07**	**197.09**	**8.12**	**4.68**	**6.34**	**77.92**	**6.05**	**567.19**
	SEm±	**3.35**	**3.16**	**0.21**	**1.45**	**2.68**	**23.85**	**0.21**	**0.18**	**0.24**	**2.54**	**0.11**	**67.51**
	C.D at 5%	**9.39**	**8.87**	**0.58**	**4.06**	**7.52**	**66.89**	**0.58**	**0.51**	**0.67**	**7.11**	**0.30**	**189.32**
	C.V	**8.84**	**8.73**	**10.47**	**6.67**	**5.73**	**20.96**	**4.42**	**6.68**	**6.58**	**5.64**	**3.08**	**20.61**
	Lowest	**39.40**	**47.05**	**2.20**	**27.33**	**68.67**	**11.44**	**2.15**	**2.09**	**0.52**	**24.40**	**3.38**	**238.89**
	Highest	**109.33**	**108.07**	**5.33**	**52.67**	**97.67**	**798.67**	**14.48**	**22.42**	**72.47**	**153.62**	**10.07**	**1028.45**

Fruit weight ranged from 0.52 g to 72.47 g with a grand mean of 6.34 g. Highest fruit weight was recorded in California Wonder(72.47 g) which was on par with IHR 3478 (50.07 g), whereas, the lowest fruit weight was recorded in Meghalaya Local(0.52 g). Nine genotypes recorded significantly more fruit weight than overall mean. These findings were in accordance with earlier reports of Gupta *et al.,* (2009). Number of seeds per fruit varied from24.40 to 153.62 with an average of 77.92 IHR 3478 (153.62) recorded the highest number of seeds per fruit and the lowest number of seeds per fruit was observed in Meghalaya Local (24.40). Twenty genotypes recorded more number of seeds per fruit than overall grand mean. Seed weight ranged from 3.38 to 10.07g with an average of 6.05g. Highest seed weight was recorded in IHR 4604 (10.07g) followed by IHR 4611 (8.15g), whereas, the lowest seed weight was recorded in Meghalaya Local(3.38g).Twenty eight genotypes recorded significantly more seed weight compared to overall mean. Similar range was reported by Shirshat *et al.,* (2007) and Arup *et al.,* (2011).

Range of red ripe fruit yield per plant varied from 238.89g to 1028.45g with a mean of 567.19g. Highest red ripe fruit yield was recorded in IHR 4611 (1028.45g) which is on par with IHR 3478 (852.11g), while IHR 3587 (238.89g) recorded lowest red ripe fruit yield per plant.

Twenty five genotypes recorded significantly more red ripe fruit yield compared to overall grand mean. Suryakumari *et al.,* (2010) and Kumar *et al.,* (2012) were also observed wider range of variation between the genotypes studied. The characters showing wide range of variation provide an ample scope for selecting superior types and the selected genotypes can be used in further crossing programme for introgression of their desired genes and to obtain heterotic hybrids.

It is concluded in the present study as, a high range of variability was observed for all the characters. It was maximum for red ripe fruit yield per plant (238.89 to 1028.45 g),followed by number of fruits per plant (11.44 to 798.67), number of seeds per fruit (24.40 to 153.62) and minimum for number of primary branches per plant (2.20 to 5.33 cm) and 1000 seed weight (0.30 to 3.38 g). The characters showing wide range of variation provide an ample scope for selecting superior types and the selected genotypes can be used in breeding programme for introgression of their desired genes into the high yielding varieties. The genotypes which perform better for various yield traits may be further evaluate to find the best one at other location to use in breeding programme.

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