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Evaluation of parents and hybrids of chilli (*Capsicum annuum* L.) for yield and resistance to chilli leaf curl disease

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Abstract

Chilli (*Capsicum annuum* L.), one of the most important vegetable cum spice crops belongs to the family Solanaceae. The yield of chilli is adversely affected due to leaf curl disease caused by *chilli leaf curl virus*. Thirty F₁ hybrids developed by crossing six diverse parents under full diallel mating design were screened under natural field conditions along with their parents for yield and its related characters and resistance to chilli leaf curl disease. The analysis of variance indicated the presence of significant variation among the hybrids for the characters observed. Based on the *per se* performance, the hybrid CA 116 x AVPP 0717 recorded the highest individual fruit weight, number of fruits per plant and green fruit yield among the 30 hybrids. The hybrid CA 116 x EC 739329 found to yield earlier. The hybrids CA 116 x AVPP 0717, AVPP 0716 x CA 116 and AVPP 0717 x CA 116 were found to have higher tolerance to chilli leaf curl disease.

Keywords: Parents, hybrids, chilli, *Capsicum annuum* L., yield, resistance, chilli leaf curl disease

Introduction

Chilli (*Capsicum annuum* L.), one of the most important vegetable cum spice crops belongs to the family Solanaceae. India is the foremost producer and exporter of chillies contributing to one fourth of the production of chilli globally. Andhra Pradesh, Karnataka, Madhya Pradesh, West Bengal, Maharashtra and Tamil Nadu are the major chilli growing states of India. In India, chilli is cultivated in an area of about 2.8 lakh hectares for vegetable purpose (green chilli) with an annual production of 34.06 lakh tonnes and 18.72 lakh tonnes of dried chilli was produced from an area of about 8.31 lakh hectares during the year 2016-17 (Horticultural Statistics, 2017) [5].

The yield of chilli is adversely affected due to leaf curl disease caused by *Chilli leaf curl virus* coming under the genus *Begomovirus* and family *Geminiviridae* (Raj *et al.*, 2005) [10]. White fly (*Bemisia tabaci*) acts as a vector for the transmission of virus into the host plant. The symptoms of the disease includes stunting of plant growth, upward curling of leaves and puckering, rosette appearance of the leaves on the top of the plant, reduced internodes and petioles, thickening of veins. The older leaves become leathery and brittle and the affected plant fails to produce flowers and fruits. The reduction in yield of chilli due to leaf curl disease may extend up to 100 per cent thus causing a great loss to the farmers (Zehra *et al.*, 2010) [13].

Among the various management techniques available to check this viral disease in chilli, the most efficient way is by controlling the vector population using systemic insecticides but it makes chilli cultivation costly and hazardous to human health and environment. On the other hand, growing of chilli varieties/ hybrids with resistant to leaf curl disease will serve as a simplest and convenient method to the farmers to control the disease and pave way to reduce the yield loss, cost of cultivation and enables an eco-friendly cultivation. Therefore the present study was conducted to identify the high yielding hybrids combined with resistance to leaf curl disease among thirty F₁ hybrids developed utilizing six parents through diallel mating design.

Materials and Methods**Experimental site**

The entire experiment was conducted at College orchard, Department of Vegetable crops, Horticultural College and Research institute, Tamil Nadu Agricultural University, Coimbatore during March – June 2019. The experiment was conducted during the summer season favourable for white fly incidence and also the experimental site was found to be naturally conducive for incidence and multiplication of whiteflies in the past years.

Experimental material and experimental design

Six diverse chilli parents namely AVPP 0716, AVRDC 1127, CA 116, EC 739329, AVPP 0717 and VIO 37449 were crossed in a full diallel mating design (Method I under model I) as suggested by Griffing (1956) [4] to develop 30 F₁ hybrids. The F₁ hybrids along with their parents were screened under field condition under Randomized Block Design with two replications. The seedlings of the parents and hybrids were raised in portraits and transplanted to the field when they were 45 days old at a spacing of 60 x 60 cm in raised beds. All the package of practices for cultivation of chilli recommended by TNAU was followed uniformly in all the plots except spraying of insecticides.

Observations recorded

Five plants in each entry in each replication were randomly selected, tagged and the following observations were recorded from the tagged plants.

The data on growth and yield parameters viz., plant height, number of branches per plant, days to first flowering, fruit length, fruit girth, individual green fruit weight and green fruit yield per plant. Per cent of disease infection under natural field conditions was recorded based on the scales for classifying leaf curl disease reactions as developed by Banerjee and Kalloo (1987) [2] which is given in the Table 1. The observations are recorded regularly and subjected to analysis of variance as suggested by Panse and Sukhatme (1967) [7].

Table 1: Scale for classification of disease severity

S. No	Symptoms	Symptom severity grade	Response value	Coefficient of infection	Disease reaction
1	No symptom	0	0	0-4	Highly Resistant (HR)
2	Very mild curling (up to 25% leaves)	1	0.25	5-9	Resistant (R)
3	Curling, puckering of 26-50% leaves	2	0.50	10-19	Moderately Resistant (R)
4	Curling, puckering of 51-75% leaves	3	0.75	20-39	Moderately Susceptible (MS)
5	Severe curling, puckering of > 75% leaves	4	1.00	40-69	Susceptible (S)
6				70-100	Highly Susceptible (HS)

Results and Discussion

The analysis of variance for the characters observed in the chilli parents and hybrids under study is given in Table 2. The analysis of variance indicated the presence of significant variation among the hybrids for the characters of observed. The mean performance of the parents and hybrids of chilli for yield and its related characters are presented in the Table 3.

The plant height was found to be the highest in the hybrid CA 116 x EC 739329 (130.45cm) followed by VIO 37449 (116.07cm) while the hybrid AVPP 0717 x AVRDC 1127 (81.66cm) recorded the lowest plant height. Among the parents CA 116 (82.53cm) and AVRDC 1127 (57.55cm) recorded the highest and lowest plant height respectively.

The number of branches per plant was highest in the hybrid CA 116 x AVPP 0717 (12.70) followed by AVPP 0717 x EC 739329 (12.10). The parent CA 116 (9.80) recorded the highest number of branches. Among the thirty hybrids, EC 739329 x AVPP 0717 was observed to take minimum days (64.17 days) of flowering followed by CA 116 x EC 739329 whereas the hybrid AVPP 0717 x AVPP 0716 took the longest number of days.

The hybrid CA 116 x AVPP 0717 (187.80) recorded the highest number of fruits per plant followed by AVPP 0717 x CA 116 (183.60) and AVPP 0717 x EC 737329 (174.80). Similarly the parents CA 116 (105.60) and AVPP 0717 (76.80) recorded the highest and lowest number of fruits per plant. The results were in accordance with the study conducted by Kumar *et al.*, (2013) [6], Sitaesmi *et al.*, (2016)

[12] and Sharma *et al.*, (2013) [13]. The fruit length was highest in the hybrid AVPP 0716 x AVPP 0717 (9.83cm) followed by AVPP 0716 x EC 737329 (8.87cm). Fruit girth among thirty hybrids varied from 6.07cm to 2.67cm. The fruit girth was highest in CA 116 x AVPP 0717 followed by AVPP 0717 x EC 737329. The present results are in confirmation with the findings of Kumar *et al.*, (2013) [6], Patil *et al.*, (2005) [8] and Bhutia *et al.*, (2015) [3].

The highest individual green fruit weight of 4.31g was recorded by the hybrid CA 116 x AVPP 0717 followed by AVPP 0717 x AVPP 0716. The present results were in concurrence with the earlier findings of Sitaesmi *et al.*, (2016) [12] and Sharma *et al.*, (2013) [13]. Per cent of infection for leaf curl disease found to be the lowest in the parents AVPP 0717 and AVPP 0716 and in the hybrids CA 116 x AVPP 0717 while the highest per cent of infection was observed in EC 739329 x VIO 37449 and AVRDC 1127 x VIO 37449. A similar result for this trait was recorded by Kumar *et al.*, (2013) [6], Anandhi and Khadher (2011) [1] and Rai *et al.*, (2010) [9].

Among the chilli hybrids, the hybrid CA 116 x AVPP 0717 (719.87g) recorded the highest mean value of green fruit yield per plant followed by CA 116 x AVPP 0716 (691.08g) and AVPP 0717 x EC 739329 (684.22g). The increased yield of first generation hybrids obtained in the present study correlates with the findings of Sitaesmi *et al.*, (2016) [12] and Sharma *et al.*, (2013) [13].

Table 2: Analysis of variance for the characters observed

S. No	Characters	Mean sum of squares	
		Genotypes	Error
1	Plant height	835.52**	31.79
2	Number of branches per plant	5.6071**	0.38
3	Days to first flowering	39.97**	23.61
4	Number of fruits per plant	2006.15 **	152.07
5	Fruit length	1.37**	0.21
6	Fruit girth	0.73**	0.39
7	Individual green fruit weight	0.88**	0.03
8	Green fruit yield per plant	42014.56**	548.30
9	Per cent of disease infection	869.98**	9.37

** significant at 1% level

* significant at 5% level

Table 3: Mean performance of the parents and hybrids of chilli for yield and its related characters

Hybrids & parents	Plant height (cm)	No. of branches/plant	Days to first flowering	No. of fruits/Plant	Fruit length (cm)	Fruit girth (cm)	Individual green fruit weight (g)	Green fruit yield per plant (g)	Per cent of disease infection
P ₁ X P ₂	81.86	7.50	81.37	115.50	9.83	4.74	2.48	285.41	22.90
P ₁ X P ₃	112.05	9.60	74.47	123.10	7.53	4.68	2.73	335.42	17.95
P ₁ X P ₄	81.26	10.20	74.20	103.30	8.87	4.70	2.46	300.04	46.40
P ₁ X P ₅	88.30	7.00	73.97	116.50	8.64	4.85	2.33	272.07	39.03
P ₁ X P ₆	106.88	10.50	77.57	85.10	7.32	4.67	2.35	200.58	69.04
P ₂ X P ₁	82.54	7.40	72.98	109.30	8.11	5.25	2.57	279.89	31.00
P ₂ X P ₃	88.68	7.30	69.35	144.50	7.68	5.27	2.80	406.24	56.88
P ₂ X P ₄	84.59	9.90	76.80	107.50	8.84	5.65	2.57	274.70	64.17
P ₂ X P ₅	86.38	8.30	78.34	102.70	7.28	5.37	3.74	385.12	21.48
P ₂ X P ₆	99.96	11.00	75.24	92.90	7.13	5.73	3.12	288.37	68.26
P ₃ X P ₁	114.43	11.80	70.35	166.80	7.32	5.67	4.14	691.08	40.42
P ₃ X P ₂	99.77	11.15	78.99	106.40	7.50	5.57	4.01	426.77	39.17
P ₃ X P ₄	130.45	11.10	65.78	136.40	7.47	4.99	3.70	504.16	45.04
P ₃ X P ₅	100.44	12.70	76.33	187.80	8.13	6.07	4.31	719.87	8.41
P ₃ X P ₆	128.07	10.10	75.66	117.70	7.49	4.43	3.34	317.88	73.82
P ₄ X P ₁	71.89	9.80	74.23	109.80	7.94	5.21	3.84	421.71	54.15
P ₄ X P ₂	79.43	10.40	71.71	111.60	7.98	5.02	2.88	321.08	51.90
P ₄ X P ₃	83.00	9.40	70.73	77.20	8.35	5.31	2.93	226.07	78.79
P ₄ X P ₅	77.16	10.20	64.17	150.20	7.53	5.82	2.81	425.71	36.83
P ₄ X P ₆	89.98	7.70	68.76	112.80	8.20	5.21	2.80	312.93	70.63
P ₅ X P ₁	69.08	11.64	84.63	146.40	6.48	5.88	4.16	520.53	24.93
P ₅ X P ₂	81.66	8.80	80.19	111.64	7.56	5.30	2.83	316.71	36.25
P ₅ X P ₃	87.78	10.50	76.84	183.60	6.67	5.67	3.22	590.48	12.52
P ₅ X P ₄	92.24	12.10	81.74	174.80	7.25	5.97	4.16	684.22	31.20
P ₅ X P ₆	98.86	9.22	76.19	101.31	7.10	5.16	3.08	328.22	45.91
P ₆ X P ₁	101.24	10.70	72.96	98.80	6.54	5.27	2.11	189.10	52.61
P ₆ X P ₂	92.60	8.60	75.78	102.80	6.23	2.67	2.30	235.64	45.53
P ₆ X P ₃	116.07	11.00	79.39	72.00	6.31	5.40	2.81	205.64	62.86
P ₆ X P ₄	104.16	9.40	72.98	89.20	7.01	5.52	2.38	212.17	60.48
P ₆ X P ₅	94.32	10.10	80.80	140.80	6.27	5.15	2.11	299.38	34.59
P ₁	64.45	7.30	73.78	78.10	8.17	4.57	2.17	166.43	4.96
P ₂	57.55	7.91	80.36	97.31	8.78	5.37	2.57	253.02	3.04
P ₃	85.58	9.80	73.69	105.60	7.52	5.95	3.31	349.75	35.07
P ₄	62.80	8.51	72.50	100.20	7.67	5.10	3.24	322.98	48.14
P ₅	59.92	5.80	79.17	76.80	6.92	5.48	2.42	185.47	2.92
P ₆	76.66	6.75	73.28	103.20	6.54	5.49	2.03	220.04	26.10
Mean	89.78	9.48	75.15	113.55	7.56	5.23	2.97	346.52	40.65
S.Ed.	3.47	0.39	3.02	8.50	0.31	0.46	0.11	16.49	1.96
CD (0.05)	9.86	1.11	8.57	24.17	0.88	1.30	0.32	46.87	5.56

P₁: AVPP 0716, P₂: AVRDC 1127, P₃: CA 116, P₄: EC 739329, P₅: AVPP 0717, P₆: VIO 37449

Conclusion

In the present study the hybrids CA 116 x AVPP 0717, CA 116 x AVPP 0716 and AVPP 0717 x EC 739329 were identified as superior hybrids having high yield and low incidence of leaf curl disease based on the *per se* performance among thirty hybrids. The study of heterosis and combining ability of the parents and hybrids will provide useful information for further improvement in yield in future breeding program.

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