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Effect of planting time and spacing on maturity, growth and fruit yield of bell pepper, *Capsicum annuum* L

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ABSTRACT

An experiment was carried out at Vegetable Research Farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during Kharif season of 2011 to investigate the fruit yield and yield attributes of bell pepper cv Solan Bharpur as influenced by planting time and spacing. The experiment was laid out in randomized block design factorial comprising of 24 treatment combinations of different planting time and spacing. The results of the experiment showed that maturity, growth, fruit yield and yield components significantly varied with variation of planting time and spacing. Among all the treatment combinations 16 May and 60 x 45 cm was found the best for days to 50 per cent flowering and days to maturity for fresh fruit whereas 11 April and 60 x 45 cm resulted in highest number of fruits per plant, green fruit weight (g), fruit length (cm), fruit breadth (cm), fruit yield/plant (g), plant height (cm), plant spread/canopy width (cm) and number of branches per plant. In overall 11 April and 45 x 30 cm combination resulted in the highest fruit yield per plot (kg) and per hectare (q) as compared to other treatments.

Keywords: Planting time; spacing; maturity; growth; fruit yield; yield attributes

INTRODUCTION

Bell pepper, *Capsicum annuum* L is a high value solanaceous vegetable crop grown extensively in central and south America, Peru, Bolivia, Costa Rica, Mexico, in almost all the European countries, Honkong and India. It has been originated in new world tropics and subtropics and was introduced in India by the British in 19th century in Shimla, Himachal Pradesh and Nilgiri hills of Tamil Nadu (Greenleaf 1986). Successful cultivation of any crop depends on several factors. Among the various cultural practices followed for capsicum production planting time and plant geometry are of prime importance. There is a wide range of planting time for capsicum which may affect the yield due to varying climatic conditions at different stages of crop growth. The variation in planting time may also affect the plant vigour and spread which further affect the yield and thus the crop requires variable spacing. Optimum

plant spacing ensures proper growth and development of plant resulting in maximum yield of the crop and the best use of land. Yield of bell pepper has been reported to be dependent on the number of plants accommodated per unit area. Considering the above facts the present experiment was undertaken to find out the suitable planting time and optimum plant spacing for obtaining maximum fruit yield of bell pepper.

MATERIAL and METHODS

The experiment was carried out at Vegetable Research Farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during Kharif season of 2011 and laid out in a randomized block design (factorial) with three replications. There were 24 treatment combinations comprising of eight planting times viz P_1 (04 April), P_2 (11 April), P_3 (18 April), P_4 (25 April), P_5 (02 May), P_6 (09 May), P_7 (16 May) and P_8 (23 May) and three spacings viz S_1 (60 x 45 cm), S_2 (45 x 45 cm) and S_3 (45 x 30 cm). Observations were recorded on days to 50 per cent flowering, days to maturity for fresh fruit, number of fruits per plant, green fruit weight (g), fruit length (cm), fruit breadth (cm), fruit yield/plant (g)/ plot (kg)/hectare (q), plant height (cm), plant spread/canopy width (cm) and number of branches per plant. The recommended doses of manures and fertilizers as well as all agronomic practices were adopted timely for raising a healthy and normal crop. Data on different characters were recorded and analyzed statistically as described by Panse and Sukhatme (1987) for randomized block design factorial.

RESULTS and DISCUSSION

Effect of planting time

Significant differences were observed for the effect of planting time on days to 50 per cent flowering and days to maturity for fresh fruit. Minimum days to 50 per cent flowering and days to maturity for fresh fruit (49.67 and 79.11 days respectively) were found with the planting time P_7 (16 May) (Table 1). This may be attributed to the favourable climatic conditions during the growing period. Similar results were reported by Sharma and Peshin (1996) and Islam et al (2011a). It was observed that highest number of fruits per plant (18.46) were obtained with the planting time P_2 (11 April) which might be due to the prevalence of suitable temperature and other climatic conditions during the crop growth and development. Minimum number of fruits per plant (8.12) was found in P_8 (23 May) which was in line with the findings of Sharma and Peshin (1996) and Islam et al (2011a). Influence of planting time on fruit weight was found significant where the highest fruit weight (50.79 g) was obtained with the planting time P_2 (11 April) whereas late planting time P_8 (23 May) gave the significantly lowest fruit weight (40.46 g). Significant variation

was observed on fruit size at different planting dates in respect of length and breadth. Planting time P_2 (11 April) resulted in the maximum fruit length and breadth (6.51 and 6.06 cm respectively) and minimum fruit length and breadth (4.87 and 4.38 cm respectively) with the planting time P_8 (23 May) which was in agreement with the findings of Abdullah et al (2003) and Islam et al (2011a). Considerable diversity was visible on yield per plant where planting time P_2 (11 April) resulted in maximum fruit yield per plant (916.39 g) which might be due to the favorable environment for crop growth and thus produced the highest number of fruits per plant with appropriate size whereas planting time P_8 (23 May) resulted in minimum fruit yield per plant (324.27 g). Sharma and Peshin (1996) and Islam et al (2011a) have also reported the similar findings. Planting time P_2 (11 April) resulted in maximum fruit yield per plot and per hectare (19.04 kg and 376.03 q respectively). On the other hand planting time P_8 (23 May) resulted in minimum fruit yield per plot and per hectare (6.68 kg and 132.04 q respectively) which might be due to unfavorable growing conditions. Planting time significantly influenced the plant height. The highest plant height (59.13 cm) was recorded with the planting time P_2 (11 April) whereas planting time P_8 (23 May) gave the lowest plant height (35.44 cm). Maximum plant spread/canopy width (49.69 cm) was observed with the planting time P_2 (11 April) whereas minimum plant spread/canopy width (32.36 cm) was obtained with the planting time P_8 (23 May). The effect of planting time was significantly pronounced on the number of branches per plant. Maximum number of branches per plant (7.54) was observed with the planting time P_2 (11 April) whereas minimum (3.77) obtained with the planting time P_8 (23 May). These results are in agreement with the findings of Sharma and Peshin (1996) and Islam et al (2011a).

Effect of spacing

The plant spacing significantly influenced the days to 50 per cent flowering and days to maturity for fresh fruit. Minimum days to 50 per cent flowering and days to maturity for fresh fruit (51.75 and 80.42 days respectively) were recorded in S_1 (60 x 45 cm) (Table 1). Maximum number of fruits per plant (15.13) was recorded in S_1 (60 x 45 cm) whereas minimum number of fruits per plant (13.08) was found in S_3 (45 x 30 cm). Spacing S_1 (60 x 45 cm) gave the highest average fruit weight (51.33 g). Similar findings were also recorded by Islam et al (2011b) and Aminifard et al (2012). Maximum fruit length and breadth (6.38 and 5.91 cm respectively) was attained with the spacing S_1 (60 x 45 cm) whereas minimum fruit length and breadth (5.19 and 4.71 cm respectively) with spacing S_3 (45 x 30 cm) which is in agreement with the report of Manchanda and Singh (1988). Spacing S_1 (60 x 45 cm) gave the maximum fruit yield per plant (768.53 g) whereas minimum fruit yield per plant (541.29 g) was observed with the closest spacing S_3 (45 x 30 cm).

Table 1. Effect of planting time and spacing on maturity, growth and fruit yield of bell pepper, *Capsicum annuum* L

Treatment	Days to 50% flowering	Days to maturity for fresh fruit	# fruits/ plant	Green fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit yield/plant (g)	Fruit yield/plot (kg)	Fruit yield/ha (q)	Plant height (cm)	Plant spread/ canopy width (cm)	# branches /plant
Planting time												
P_1 (Apr 04)	56.11	85.56	17.23	49.57	6.27	5.77	834.07	17.45	344.73	56.09	44.34	6.38
P_2 (Apr 11)	54.22	83.78	18.46	50.79	6.51	6.06	916.39	19.04	376.03	59.13	49.69	7.54
P_3 (Apr 18)	53.56	83.00	17.57	49.90	6.40	5.92	856.31	17.87	352.95	56.89	43.93	6.29
P_4 (Apr 25)	53.11	82.67	14.23	46.57	5.20	4.89	648.66	13.48	266.31	48.48	41.33	5.72
P_5 (May 02)	52.22	81.67	13.12	45.46	5.75	5.18	583.26	12.17	240.47	45.97	35.72	4.50
P_6 (May 09)	50.00	79.56	12.12	44.46	5.70	5.20	527.99	10.97	216.61	43.65	34.60	4.26
P_7 (May 16)	49.67	79.11	11.23	43.57	5.38	4.90	480.21	9.95	196.49	41.70	33.30	3.98
P_8 (May 23)	50.33	79.89	8.12	40.46	4.87	4.38	324.27	6.68	132.04	35.44	32.36	3.77
Mean	52.40	81.90	14.01	46.35	5.76	5.29	646.40	13.45	265.70	48.42	39.28	5.31
$CD_{0.05}$	1.04	1.46	1.62	2.14	0.27	0.30	100.38	2.07	40.79	3.97	2.73	0.48
Spacing												
S_1 (60 x 45 cm)	51.75	80.42	15.13	51.33	6.38	5.91	768.53	11.53	227.71	44.83	41.24	5.71
S_2 (45 x 45 cm)	52.21	81.54	13.83	45.93	5.71	5.24	629.37	12.59	248.64	46.86	40.21	5.48
S_3 (45 x 30 cm)	53.25	83.75	13.08	41.78	5.19	4.71	541.29	16.24	320.76	53.57	36.78	4.73
Mean	52.40	81.90	14.01	46.35	5.76	5.29	646.40	13.45	265.70	48.42	39.28	5.31
$CD_{0.05}$	0.64	0.89	0.99	1.31	0.16	0.18	61.47	1.26	24.98	2.43	1.67	0.29

Table 2. Effect of interaction of planting time and spacing on maturity, growth and fruit yield of bell pepper, *Capsicum annuum* L

Treatment	Days to 50% flowering	Days to maturity for fresh fruit	# fruits/ plant	Green fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Fruit yield/plant (g)	Fruit yield/plot (kg)	Fruit yield/ha (q)	Plant height (cm)	Plant spread/ canopy width (cm)	# branches /plant
P_1S_1	55.67	84.33	18.30	54.50	6.90	6.41	970.99	14.56	287.70	50.65	47.12	6.98
P_1S_2	55.67	85.00	17.03	49.13	6.22	5.69	814.54	16.29	321.79	53.96	45.43	6.62
P_1S_3	57.00	87.33	16.37	45.07	5.70	5.21	716.68	21.50	424.70	63.66	40.47	5.54
P_2S_1	53.67	82.33	19.97	56.17	7.20	6.75	1090.78	16.36	323.19	54.10	52.26	8.10
P_2S_2	54.00	83.33	18.37	50.47	6.47	6.02	900.29	18.01	355.67	57.25	50.65	7.75
P_2S_3	55.00	85.67	17.03	45.73	5.86	5.41	758.10	22.74	449.24	66.04	46.16	6.77
P_3S_1	52.67	81.33	18.63	54.83	7.03	6.57	993.07	14.90	294.24	51.29	46.80	6.91
P_3S_2	53.67	83.00	17.70	49.80	6.38	5.90	856.77	17.14	338.48	55.58	44.60	6.44
P_3S_3	54.33	84.67	16.37	45.07	5.78	5.29	719.10	21.57	426.13	63.80	40.40	5.52
P_4S_1	52.67	81.33	15.63	51.83	5.79	5.44	788.01	11.82	233.48	45.39	42.91	6.07
P_4S_2	52.67	82.00	13.70	45.80	5.12	4.86	611.33	12.23	241.51	46.17	42.52	5.98
P_4S_3	54.00	84.67	13.37	42.07	4.70	4.36	546.64	16.40	323.93	53.88	38.57	5.12
P_5S_1	51.33	80.00	13.97	50.17	6.35	5.81	682.61	10.24	202.25	42.35	37.56	4.91
P_5S_2	52.33	81.67	13.03	45.13	5.71	5.16	573.34	11.47	226.50	44.71	36.36	4.64
P_5S_3	53.00	83.33	12.37	41.07	5.20	4.59	493.84	14.82	292.64	50.84	33.23	3.96
P_6S_1	49.33	78.00	13.30	49.50	6.35	5.85	642.16	9.63	190.27	41.19	35.86	4.53
P_6S_2	49.67	79.00	11.70	43.80	5.62	5.12	498.84	9.98	197.07	41.85	35.52	4.46
P_6S_3	51.00	81.67	11.37	40.07	5.14	4.65	442.98	13.29	262.50	47.91	32.42	3.79
P_7S_1	49.00	77.67	12.30	48.50	5.99	5.52	582.21	8.73	172.51	39.47	34.44	4.23
P_7S_2	49.33	78.67	11.03	43.13	5.33	4.85	464.37	9.29	183.46	40.53	33.90	4.11
P_7S_3	50.67	81.00	10.37	39.07	4.82	4.35	394.06	11.82	233.51	45.10	31.56	3.60
P_8S_1	49.67	78.33	8.97	45.17	5.44	4.95	398.40	5.98	118.04	34.18	33.00	3.91
P_8S_2	50.33	79.67	8.03	40.13	4.84	4.35	315.48	6.31	124.63	34.82	32.67	3.84
P_8S_3	51.00	81.67	7.37	36.07	4.35	3.84	258.94	7.77	153.44	37.32	31.39	3.56
Mean	52.40	81.90	14.01	46.35	5.76	5.29	646.40	13.45	265.70	48.42	39.28	5.31
$CD_{0.05}$	1.80	2.53	2.80	3.71	0.46	0.52	173.86	3.58	70.66	6.88	4.73	0.83

Plant spacing had significant effect on yield per unit area. The closest spacing S_3 (45 x 30 cm) gave the maximum fruit yield per plot and per hectare (16.24 kg and 320.76q respectively) whereas minimum fruit yield per plot and per hectare (11.53 kg and 227.71q respectively) was observed in spacing S_1 (60 x 45 cm). Effect of spacing was found significant on height of plant at final harvest. The highest plant height (53.57 cm) was resulted with the spacing S_3 (45 x 30 cm). Manchanda and Singh (1988), Maya et al (1997), Viloria et al (1998) and Faiza et al (2002) also stated that plant height of bell pepper was significantly increased with the closer spacing. Maximum plant spread/canopy width (41.24 cm) was obtained with spacing S_1 (60 x 45 cm). Number of branches per plant differed significantly by different spacings. Maximum number of branches per plant (5.71) was obtained with the spacing S_1 (60 x 45 cm) whereas minimum (4.73 cm) with the spacing S_3 (45 x 30 cm). Jovicich and Cantliffe (2002), Islam et al (2011b) and Aminifard et al (2012) reported similar results that number of branches per plant increased with the increase in plant spacing.

Combined effect of planting time and spacing

Interaction study revealed that the combination P_7 x S_1 (16 May and 60 x 45 cm) gave the minimum days to 50 per cent flowering (49.00 days) and minimum days to maturity for fresh fruit (77.67 days) (Table 2). The combination P_2 x S_1 (11 April and 60 x 45 cm) gave the maximum number of fruits per plant (19.97), highest fruit weight (56.17 g), maximum fruit length and breadth (7.20 and 6.75 cm respectively), highest fruit yield per plant (1090.78 g), maximum plant spread/canopy width (52.26 cm) and maximum number of branches per plant (8.10). On the other hand interaction between P_2 x S_3 (11 April and 45 x 30 cm) gave highest fruit yield per plot and per hectare (22.74 kg and 449.24 q respectively) and maximum plant height (66.04 cm). The combination P_8 x S_1 (23 May and 60 x 45 cm) gave the lowest fruit yield per plot and per hectare (5.98 kg and 118.04 q respectively) and minimum plant height (34.18 cm). Findings of current study are in line with that of Islam et al (2011c) who also reported that highest fruit yield per unit area was recorded from the early sowing and closest spacing.

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