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EFFECT OF SOWING TIME AND PLANT SPACING ON THE YIELD AND YIELD ATTRIBUTES OF SWEET PEPPER (*Capsicum annuum)*

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Abstract

An experiment was carried out at the Olericulture field of Horticulture Research Centre of BARJ, Joydebpur, Gazipur during September 2006 to April 2007 to investigate yield and yield attributes of sweet pepper as influenced by plant spacing and sowing time. There were altogether 21 treatments comprising seven sowing dates viz. 1 September, 15 September, 1 October, 15 October, 30 October, 15 November, 30 November and three spacings viz. 50 × 50 cm, 50x40 cm, and 50 × 30 cm. The experiment was laid out in a Randomized Complete Block Design (factorial) with three replications. The results of the experiment showed that majority of the yield and yield components significantly varied with variation of spacing and sowing time. Only number of fruits per plant and fruit yield per plant resulted significantly higher which reflected higher yield for 1 October sowing. The number of branches per plant, number of fruits per plant, fruit length, individual fruit weight, yield per plant were found significantly increased with the increasing plant spacings but other parameters were found to be significantly increased with the decreasing plant spacing. The combined effect of sowing date and plant spacing also had significant effect on different growth and yield parameters and yield. The highest yield (19.36 t/ha) of fruit was recorded from the earlier sowing (1 October) with the closest spacing (50 × 30 cm). But reasonable yield could be obtained up to 30 October with same spacing.

Keywords: Sowing time and plant spacing, yield and yield attributes, sweet pepper.

Introduction

Sweet pepper *(Capsicum annuum* var. *grossum* L.) belongs to the family solanaceae under the genus *capsicum.* Sweet pepper is native to Tropical South America. Especially Brazil is thought to be the original home of peppers (Shoemaker and Teskey, 1955). It is now widely cultivated in Central and South America, Peru, Bolivia, Costa Rica, Mexico, in almost all the European countries, Honkong, and India. The sweet pepper is relatively non-pungent with thick flesh and it is the world's second most important vegetables after tomato (AVRDC, 1989). Sweet pepper is used either green or red, and may be eaten as cooked or raw vegetable, as well as in salad. It is used for piciking in brine,

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baking and stuffing. Sweet pepper has a little energy value. But the nutritive value of sweet pepper is high as it contains 1.29 mg protein, 11 mg calcium, 870 I.U vitamin-A, 175 mg ascorbic acid, 0.06 mg thiamine, 0.03 mg riboflavin and 0.55 mg niacin per 100 g edible fruit (Joshi and Singh, 1975). The vitamin C content was found as high as 321 mg.

Meanwhile, Macrae *et al.* (1993) stated that green peppers, with a β-carotene equivalent to 180 g per 100 g contain approximately as much carotene as spinach. Sweet pepper is a minor vegetable in Bangladesh and its production statistics is not available (Hasanuzzaman, 1999). A small-scale cultivation is found in peri-urban areas primarily for the supply to some city markets in Bangladesh. The crop has got high export potentiality. Considering its high nutritive value and export potentiality, it is imperative to take attempts for its successful cultivation in the country. Successful cultivation of any crop depends on several factors. Sowing or planting time and plant spacing are of the important aspects for production system of different crops. Optimum sowing or planting time and plant spacing ensures proper growth and development of plant resulting maximum yield of crop and economic use of land. Yield of sweet pepper has been reported to be dependent on the number of plants accommodated per unit area of land but there are very few reports regarding sowing or planting time and spacing to cultivate the crop under the agro-climatic conditions of Bangladesh. Considering the above facts, the present experiment was undertaken to find out the ortimum sowing time and spacing for higher yield of sweet pepper in Bangladesh.

Materials and Method

The experiment was conducted at HRC, BARI, Gazipur during September 2006 to April 2007 and set up in a randomized complete block design (factorial) with three replications. There were seven sowing dates viz. 1 September, 15 September, 1 October, 15 October, 1 November, 15 November, and 30 November and three spacings, namely 50 × 50 cm, 50 × 40 cm, and 50 × 30 cm. Thus, there were altogether 21 treatment combinations in the experiment. Thirty days old seedlings were transplanted in the main field in each of the sowings. The crop was fertilized with cowdung @ 10 t/ha and Urea, TSP, MoP, Gypsum and ZnO @ 217, 333, 200, 111, and 5 kg/ha, respectively. Half of the quantity of cowdung was applied during final land preparation. The remaining half of the cowdung. the entire quantity of TSP, ZnO, Gypsum and one-third each of Urea and MoP were applied during pit preparation. The rest of Urea and MoP were applied in two equal splits at 25 and 50 days after transplanting in the main field. Irrigation along with other intercultural operations were done as and when needed Data on different yield contributing characters were recorded and analyzed statistically. The mean data were separated by DMRT for interpretation of the results.

Results and Discussion

Effects of sowing time

Sowing time significantly influenced the plant height of sweet pepper. Plant height ranged from 37.62 cm to 46.32 cm at final harvest. The tallest plant (46.32 cm) was found in 1 October sowing but at par to 1 September sowing whereas, the shortest plant was found in 30 November sowing. The effect of sowing dates was significantly pronounced on the number of branches per plant. The maximum branches (5.20) were produced in 1 September and 1 October sowings followed by 15 September, 15 October, and 30 October sowings which were statistically identical. The minimum branches (4.30) were produced in 30 November sowing but statistically at par to 15 November sowing. It was observed that 1 October sowing produced the maximum number of fruits per plant (8.69) and 30 November produced the minimum (Table 1). Significant variation was observed on fruit size at different sowing dates in respect of length and diameter. September 1 sowing gave the highest fruit length (6.54 cm) where the diameter was measured the lowest (5.32 cm). The lowest length of fruit (5.25 cm) was found in 30 October sowing and 15 October sowing gave the maximum diameter (6.20 cm), which was statistically identical to other date of October sowing. Influence of sowing time on individual fruit weight was found significant where the highest individual weight of fruit (49.26 g) was produced from 15 September sowing and the lowest (37.57 g) was produced by the plant sown on 30 November. Considerable diversity was visible on yield per plant where the highest fruit yield per plant (326.91g) was obtained from 1 October sowing which was significantly different from other sowings and the minimum from 30 November sowing (Table 1). Fruit yield/ha, of sweet pepper differed significantly due to sowing time and it varied from 7.19 to 16.33 t/ha. The highest yield was 16.33 t/ha as observed in 1 October sowing due to higher fruits/plant and fruit yield/plant. Fruit yield was reduced considerably after October sowing and lowest yield was recorded from 30 November sowing.

Effects of spacing

Effects of plant spacing was found to be significant on plant height at final harvest (Table 2). The closest spacing (50x30 cm) produced the tallest (45.14 cm) plant and the shortest plants were obtained from the wider spacing The results of the present study for this character are in agreement with the findings of Maya *et al.* (1997) who stated that plant height of sweet pepper was significantly increased with closer spacing. Viloria *et al.* (1998) and Manchanda *et al.* (1988) also expressed similar opinion on plant height of sweet pepper. Number of branches per plant differed significantly by different spacings (Table 2). The highest number of branches per plant (5.63) was recorded from wider spacing (50×50 cm) and the closest spacing (50×30 cm) gave the lowest number of branches (4.12). The plant spacing influenced significantly at 1% level of

Table 1. Effect of sowing time yield and yield contributing characters of sweet pepper.

Sowing time	Plant height (cm)	No. of branches/ plant	Days to 50% flowering	No. of fruits/ plant	Fruit length (cm)	Fruit breadth (cm)	Individual fruit weight (g)	Fruit yield/ plant (g)	Fruit yield (t/ha)
1 Sept.	43.92ab	5.20a	74.78b	5.13c	6.54a	5.32c	41.32c	218.95d	10.96d
15 Sept.	41.71 bc	4.78ab	69.l0c	4.99c	5.99b	5.49bc	49.26 a	246.03c	12.49c
1 Oct.	46.32 a	5.20a	75.06b	8.69*	5.78b	6.12a	41.28c	326.91a	16.33a
15 Oct.	43.70b	5.15a	77.00b	6.41b	5.44c	6.20a	44.75b	287.64b	14.18b
30 Oct.	40.89c	4.98a	78.55b	4.66cd	5.25c	6.13a	44.47b	225.20d	11.20d
15 Nov.	38.32 d	4.32b	85.07 a	4. 17d	5.47c	5.79b	40.78 c	185.31e	9.08e
30 Nov.	37.62d	4.30b	84.22a	3.48e	5.38c	5.67b	37.57d	146.64f	7.19f
Level of significance	**	**	**	**	**	**	**	**	**

Means in a column followed by the same letters are not significantly different at 1% level of probability as per DMRT

** Significant at 1% level of probability.

Table 2. Effect of spacing on yield and yield contributing characters of sweet pepper.

Spacing (cm^2)	Plant height (cm)	No. of branches plant	Days to 50% flowering	No. of fruits /plant	Fruit length (cm)	Fruit breadth (cm	Individual fruit weight (g)	Fruit yield /plant	Fruit yield (t/ha)
50×50	39.54b	5.63a	75.14b	6.08*	5.97a	5.64b	44.84 a	271.12a	10.99b
50×40	40.67b	4.79b	78.25a	5.37b	5.67b	5.94a	42.65 b	238.50b	11.13b
50×30	45.14a	4. 12c	79.65a	4.63c	5.45c	5.88a	40.84 c	191.73c	12.78a
Level of significance	**	**	**	**	**	**	**	**	**

Means in a column followed by the same letters are not significantly different at 1% level of probability as per DMRT
** Significant at 1% level of probability.

probability as to the days to 50% flowering. Flowering occurred earlier (75 days) when plants were grown at wider spacing (50 × 50 cm) but late flowering (78.80 days) occurred in plants with closer spacing. The result is in consistent with that of Srivastava (1996) who reported that days to 50% flowering decreased with increasing spacing. Marked variation was observed on the number of fruits per plant under different plant spacings, which ranged from 4.63 to 6.08. It was noted that wider spacing produced significantly highest (6.08) number of fruits per plant. Mishriky and Alphose (1994) also supported these findings. The highest (5.97 cm) and the lowest (5.45 cm) fruit length were measured from the spacings 50x50 cm and 50 × 30 cm, respectively, where fruit breadth was measured the highest (5.94 cm) and the lowest (5.64 cm) from the spacings 50x40 cm and 50x50 cm, respectively. Manchanda *et al.* (1988) reported that the number of fruits per plant and fruit length increased with decreasing plant density, which is in agreement with the present study. Diversity was observed due to different levels of spacing on the parameters individual fruit weight as well as yield per plant (Table 2). The highest individual fruit weight (44.84 g) consequently the highest yield per plant (27.12 g) were found at the widest spacing (50 × 50 cm), while the lowest individual fruit weight was found at the closest (50 × 30 cm) spacing. Verheij and Verwer (1973) also found the similar trend who reported that the individual fruit weight declined with increased plant density. Plant spacing had significant effect on yield per hectare (Table 2). The closest spacing (50 × 30 cm) produced the maximum yield of fruit (12.78 t/ha) and the widest (50 × 50 cm) spacing showed the minimum (10.99 t/ha). Though fruits/plant, fruit weight, and yield/plant were lower in closer spacing but due to higher plants/m^2 resulted high yield from closer spacing (50 × 30 cm). The result of the present experiment is in agreement with the findings of Manchanda *et al.* (1988), Ramachandran and Subbiah (1981). Mishriky and Alphons (1994) also obtained the highest yield (22.9 t/ha) from closer spacing.

Combined effect of sowing time and spacing

The combined effect of sowing date and spacing on plant height at final harvest was statistically significant (Table 3). The maximum plant height (47.92 cm was obtained from I October sowing with spacing (50x30 cm) and the shortest (34.62 cm) plant was found in 15 and 30 November sowings with wider spacing. There was trend to increased plant height with the decrease of spacing irrespective of sowing date. The combined effect of sowing date and spacing was found to be significant on number of branches per plant. The maximum branches were produced when plants were sown on 15 October followed by 1 October with 50x50 cm spacing and the minimum branches (3.21) were found in 15 November sowing with 50x30 cm spacing. Days to 50% flowering was significantly influenced where late sowing (30 November) took the maximum period (89 days) with the closest spacing (50x30 cm). Earlier sowing (1-15 September) took

Table 3 Combined effect of planting time and plant spacing on yield and yield contributing characters of sweet pepper.

Treatment		Plant height (cm)	No. of branches/ plant	Days to 50% flowering	No. of fruits/ plant	Fruit length (cm)	Fruit breadth (cm)	Individual fruit wt (g)	Fruit yield /plant (g)	Fruit yield (t/ha)
Sowing time	Spacing (cm)									
1 Sept.	50×50	41.91 b-e	5.47ab	70.33 efg	5.36dc	7.16a	5.27e	43.30c-g	237.48de	9.5ij
	50×40	42.95 a-e	5.80a	76.00 c-f	5.24de	6.7lab	5.24e	40.67 e-i	228.75e	10.67ghi
	50×30	46..90 ab	4.33c	78.00 cd	4.77eg	5.75de	5.44cde	39.99 ghi	190.61fg	12.70ef
15 Sept.	50×50	38.78d-g	5.54ab	67.33g	5.9lcd	6.56bc	5.4lcde	51.36 a	289.80c	12.60ef
	50×40	40.68 c-f	4.67bc	69.30 fg	4.88efg	6.01de	5.70cde	48.98 ab	250 .67d	I 1.69fg
	50×30	45.66 abc	4.l3cd	70.67 efg	4.17f-i	5.42fgh	5.33de	47.43 abc	197.62f	13.l7de
1 Oct	50×50	45.37 abc	6.06a	79.67 bcd	10.41a	6.22cd	5.67cde	46.28 bcd	388.63a	14.08cd
	50×40	45.66abc	4.80bc	70.25 efg	7.83b	5.61dfg	6.0lbc	40.35 f-i	301.64c	15.55b
	50×30	47.92 a	4.73cd	75.25 def	7.85b	5.56efg	6.68a	37.21 i	290.45c	19.36a
15 Oct.	50×50	42.84b-e	6.1la	76.33 c-f	7.52b	5.27fgh	5.90bcd	46.68 bad	339.34b	13.57d
	50×40	43.17a-e	4.63bc	76.67cde	6.33c	5.37fgh	6.36ab	45.08b-e	295.61c	13.79de
	50×30	45.10 abc	4.70dc	78.00 cd	5.37de	5.67ef	6.36ab	42.48 d-h	227.97e	15.l9bc
30 Oct.	50×50	38.64 efg	5.88a	74.67 def	5.0ldef	5.29 fgh	5.67cde	45.06 b-e	250.84d	10.03hij
	50×40	39.12 d-g	4.67bc	80.33 bcd	4.83efg	5.03gh	6.70a	44.83 b-f	236.02de	11.01gh
	50×30	44.92 abc	4.40c	80.65 bcd	4.13f-i	5.33fgh	6.03bc	43.53 c-g	188.20fg	12.55cf
15 Nov.	50×50	34.62 g	5.47ab	82.67 abc	4.62e-h	5.53def	5.l3cde	42.70 d-h	220.81e	8.83j
	50×40	36.73 fg	4.27c	86.54 ab	4.52e-h	5.47fgh	5.82b-e	41.42 e-i	196.41f	9.16j
	50×30	43.62 a-d	3.21e	86.00 ab	3.38ij	5.40fgh	5.82b-e	38.21 hi	138.72i	9.25j
30 Nov.	50×50	34.62 g	4.87bc	75.00 def	3.69h-i	5.75def	5.80b-d	38.51 hi	170.97gh	6.84k
	50×40	36.41 fg	4.67bc	88.67 a	3.98ghi	5.37fgh	5.l3cde	37.21 i	160.42h	7.5 1k
	50×30	41.84cde	3.37de	89.00a	2.76j	5.00h	5.50cde	37.00i	108.52j	7.23k
Level of significance		**	**	**	**	**	**	**	**	**
CV(%)		4.68	7.60	3.72	7.40	3.64	4.12	4.25	3.68	4.40

Means in a column followed by the same letters are not significantly different at 1% level of probability as per DMRT

** Significant at 1% level of probability.

the shortest period with the widest (50x50 cm) spacing for obtaining 50% flowering. A significant combined effect of sowing date and plant spacing was also observed on number of fruits per plant. The highest (10.41) number of fruits per plant (4) was found from the plants of 1 October sowing with spacing 50x50 cm and significantly different form other treatments. The lowest (2.76) number of fruits per plant was noticed in delayed sowing on 30 November with 50 × 30 cm spacing. Fruit size in respect of length and breadth varied significantly due to the combined treatment (Table 3). The longest fruit (7.16 cm) was produced by the plants sown on 1 September with the widest spacing (50 × 50 cm) and (50 × 40 cm), while the shortest length was produced at 30 November sowing with the closest spacing (50 × 30 cm). On the other hand, the highest (6.70 cm) and the lowest (5.24 cm) fruit breadth were measured from 30 October and 1 September sowings when plants were spaced 50 × 40 cm. The combined effect of sowing date and spacing had a great influence on individual fruit weight. The maximum individual fruit weight (51.36g) was obtained from 15 September sowing with 50 × 50 cm spacing closely followed by 50 × 40 cm, while the lowest individual fruit weight (37 g) was obtained from the lowest spacing of 50 × 30 cm. Diversity was found on yield per plant due to different treatment combinations (Table 3). Sowing on 1 October resulted significantly the highest fruit yield/plant (388.63 g) with wider spacing (50 × 50 cm), while the lowest fruit yield per plant (108.52 g) was obtained from 30 November sowing with 50 × 30 cm spacing. It was evident that the combined effect between sowing time and spacing significantly affected the yield per hectare. The highest fruit yield (19.36 t/ha) was recorded from the treatment combination of 1 October sowing with 50 × 30 cm spacing, which was statistically different from other treatment combination. The lowest yield (6.84 t/ha) was recorded from the treatment combinations of 30 November sowing with 50 × 50 cm spacing. There was trend to decrease yield/hectare irrespective of spacing after October sowing and also lower on early sowing (1 September). Only breadth of fruit was recorded highest from 1 October sowing with lower spacing. Combined effect of plants/m^2 and other yield parameters revealed higher fruit yield from October sowing with lower spacing (50 × 30 cm).

Considering the above findings, 1 October sowing along with lowest spacing (50x30 cm) appeared to be suitable for higher fruit yield but sweet pepper could be sown up to 30 October with same spacing for reasonable fruit yield. These findings need to be verified at different ABZs of Bangladesh.

References

AVRDC. 1989. Tomato and Pepper Production in the Tropics. AVRDC, Taiwan. p. 585.

Hasanuzzaman, S. M. 1999. Effect of hormone on yield of Bell pepper (*Capsicum annum*). M.S. Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. p.2

Joshi, M. C. and D.P. Singh, 1975. Chemical composition in Bell pepper. *Indian Hort.* **20:**19-21.

Macrae, R, R. Robinson, and M. Sadler. 1993. Encyclopaedia of Food Science, Food Technology and Nutrition. Academic Press Ltd. pp. 3496-3504.

Manchanda, A.K., S. Bhopal, and B. Singh. 1988. Effect of plant density on growth and fruit yield of Bell pepper (*Capsicum annuum* L.). *Indian J. Agron.* **33**(4): 445-447.

Maya, P., S. Natarajan and S. Thamburaj. 1997. Effect of spacing. N and P on growth and yield of sweet pepper cv. California Wonder. *South Indian Hort.* **45:** (1-2): 16-18.

Mishriky, J. F. and M. Alphose. 1994. Effect of nitrogen and plant spacing on growth, yield and fruit mineral composition of pepper (*Capsician annuum* L.). *BulL Fac. Agric. Cairo Univ.* **45**(2):41 3-431.

Ramachandran, S. and K. K. Subbiah.1981. Studies on the effect of plant density and graded levels of nitrogen on yield and yield components of chillies (*Capsicum annuum*). *South Indian Hort.* **29**(4): 178-181.

Shoemker, J. S. and B. J. E. Teskey, 1955. Practical Horticulture. John Wiley and Sons, Inc. New York. p. 371.

Srivastava, A.K. 1996. Effect of fertilizer levels and plant spacings on flowering, fruit-set and yield of sweet pepper (*Capsicum annuum* var. grossum L.) cv. *Hybrid Bharat. Advan. Plant Sc*. **9**(2): 171-1 75.

Verheij, E. W. M. and F. L. J. A. W. Verwer. 1973. Light interception and yield of peppers grown under glass in relation to plant spacing *Acta. Hort.* **32:**149-159.

Viloria, Z.A, R. L. Arteaga and H. A. Radrigues. 1998. Effect of planting distance on bell pepper plant structures. Effect de la distancia de siembra en las estructuras de la planta del pimenton. *Agronomia Tropical* **48** (A): 413-423 [Cited from HorL Abstr., **69**(8): 922, 1999].