EFFECT OF SPACING ON THE GROWTH AND YIELD OF SWEET PEPPER (*Capsicum annuum* L.)

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ABSTRACT

A field experiment was carried out at the Horticultural farm of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during September 2006 to April 2007 to investigate growth and yield of sweet pepper as influenced by spacing. There were three levels of spacing viz. 50×50 cm, 50×40 cm, 50×30 cm. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were recorded on various parameters and subjected to statistical analysis. The plant spacing had significant variation in almost all the growth and yield components except pericarp thickness. Number of branches per plant, number of leaves per plant, stem girth, number of fruits per plant, days to first harvest, fruit length, individual fruit weight, yield per plant were found to be significantly increased with the increasing of plant spacing but plant height at different stages, number of fruits per plot, days to 50% flowering, fruit breadth, yield per plot and yield per hectare were found to be significantly increased with the decreasing plant spacing. Considering the yield of fruits per hectare, cost of production and net return, 50×30cm spacing appeared to be recommendable for the cultivation of sweet pepper.

Keywords: spacing, yield, growth, sweet pepper

INTRODUCTION

Sweet pepper (*Capsicum annuum* var. *grossum* L.) belongs to the family solanaceae. Sweet pepper and chilli, the Capsicum, are native to Tropical South America. It is now widely cultivated in Central and South America, Peru, Bolivia, Costa Rica, Mexico, in almost all the European countries, Honkong and India. Most of the peppers cultivated in temperate and tropical areas belong to the botanical species *Capsicum annuum*, thought to originate in Mexico and Central America [1]. It is the world's second most important vegetables after tomato [2]. In Bangladesh, it is minor vegetable but this 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 in several

factors. Sowing date and plant spacing are of the important aspects for production system of different crops. Optimum 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 [4]. There are very few reports regarding the sowing date and spacing to cultivate the crop under the agro-climatic conditions of Gazipur, Bangladesh. Considering the above facts, the present experiment was undertaken to standardize suitable spacing for higher yield at the experimental site.

MATERIALS AND METHODS

The experiment was conducted at the Horticultural farm of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, during the *Kharif* and *Rabi* season (September 2006 to April 2007). The experimental area is situated at 24.00^0N latitude and 90.25^0E longitude at an elevation of 8.4 meters from the sea level [3]. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were in total 9 unit plots, each plot of 3×1m were made and raised by 10 cm which was separated by 0.50 m space. The blocks were also separated by 0.50 m space. The treatments included 3 spacing and 3 replications. There were 9 treatment combinations such as 50×50 cm, 50×40 cm, 50×30 cm. The seeds were sown in October 1, 2006. *Capsicum annuum* var. *grossum* cv. California Wonder, 10 g seeds were needed for sowing. Seeds were soaked in water for 12 hour prior to sowing and thirty days old seedlings were obtained from the seedbed of the Horticultural farm of the Bangladesh Agricultural Research Institute. Half of the quantity of cowdung was applied during final land preparation. The remaining half of Cowdung, the entire quantity of TSP, ZnO, Gypsum and one third each of urea and MP were applied during pit preparation. The rest of Urea and MP were applied in two equal splits, 25 and 50 days after transplanting in the main field (Table 1). Thirty days old seedlings were transplanted on experimental plots at each planting time with 2 cm depth maintaining single seedling per hill. After planting the seedlings, the following intercultural operations

Table 1. Doses of application of manure and fertilizers for of sweet pepper

Elemental form	Fertilizer form
Cowdung	10 t/ha
N-100 kg/ha	Urea-217 kg/ha
P2O5-150 kg/ha	TSP – 333 kg/ha
K2O-120 kg/ha	MP- 200 kg/ha
S-20 kg/ha	Gypsum – 111 kg/ha
Zn-4 kg/ha	ZnO – 5 kg/ha

were accomplished for their better growth and development. The crop was irrigated when needed depending on the moisture status of the soil and requirement of plants. Plots with transplanted seedlings were regularly observed to find out any damage or dead seedlings for its replacement and weeding was done as per requirement and also plant protective measures were done against insect and disease. Data were collected from five plants were randomly selected from each plot for data collection on growth and yield characteristics during the growth of plants and at harvesting time of the crop. These were plant height (cm), number of branches per plant, number of leaves per plant, stem girth (mm), fruit length (cm), fruit breadth (cm), days 50% to flowering, days to 1st harvest, number of fruits per plant, individual fruit weight (g), yield per plant (g) and yield per plot (kg). The recorded data for different characters were analyzed statistically using 'MSTAT-C' program to find out the significance of variation among the treatments. The analysis of variance was performed by F-test, while the significance of difference between the pairs of treatment means were evaluated by the Duncan's Multiple Range Test (DMRT) test at 5% and 1% level of probability [5].

RESULTS AND DISCUSSION

The effect of plant spacing was found to be significant on plant height at different stage of plant growth (Figure 1). It was also found that the lowest spacing 50×30 cm produced the plants with higher plant height at all stages of plant growth as compared to other higher spacing. The closest spacing (50×30 cm) produced the

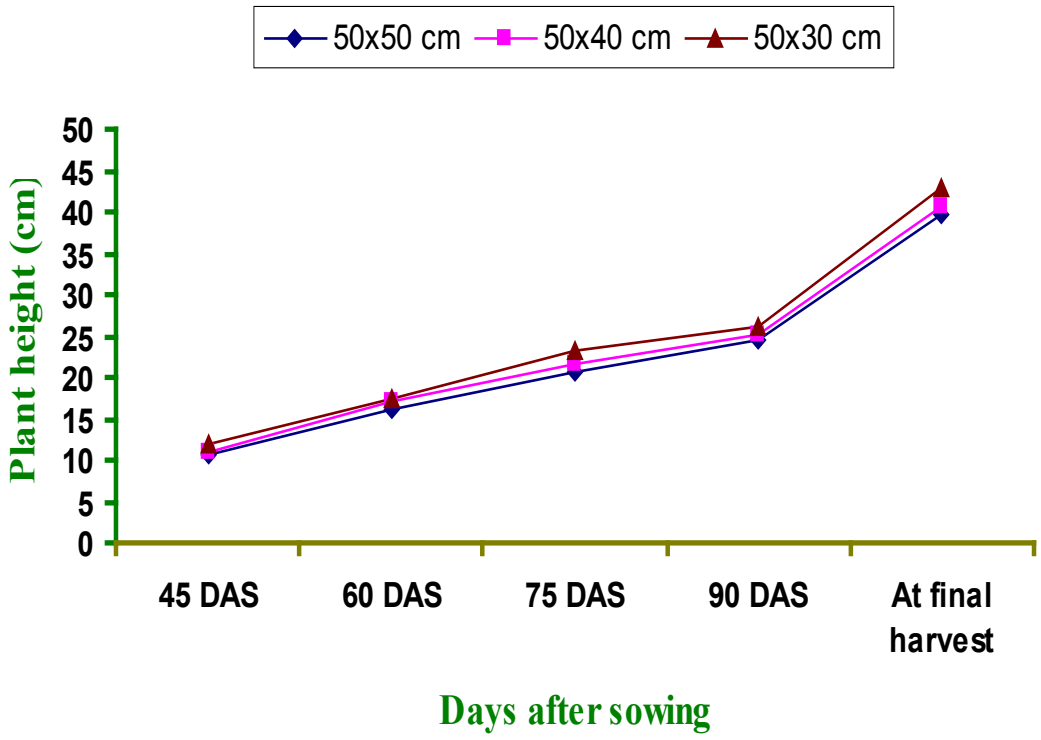

Figure 1. The effect of plant spacing on plant height of sweet pepper at different stages of plant growth.

tallest plant (42.99 cm) and the shortest plants (39.54 cm) were obtained from the widest spacing (50×50 cm) as comparable to that of 50×40 cm spacing at final harvesting stage. The results of the present study for this character are in agreement with the findings of Maya et al. [9] who stated that, plant height of sweet pepper was significantly increased with close spacing. Viloria et al. [16] and Manchanda et al. [8] also expressed similar opinion on plant height of sweet pepper. Number of branches per plant differed significantly by different spacing levels (Table 2). Maximum average number of branches (5.63) per plant was recorded from plants of the widest spacing (50×50 cm). The lowest number of branches (4.12) per plant was recorded from the closest spacing (50×30 cm) which was statistically different from other treatments.

Table 2. The effect of plant spacing on number of branches per plant, of leaves per plant and stem girth of sweet pepper

Treatment (Spacing)	No. of branches/ plant	No. of leaves/plant	Stem girth (mm)
50 × 50cm (S1)	5.63a	204.39a	14.79a
50 × 40cm (S2)	4.79b	182.51b	14.48b
50 × 30cm (S3)	4.12c	185.97b	12.80c
Level of Significance	**	**	**

** Significant at 1% level of probability measured by DMRT

The results of the present study for this character is in agreement with the findings of Ravanappa et al. [12] who reported that the lowest plant density treatment obtained from the widest spacing (75×60 cm) produced the highest number of branches per plant. This might be due to the plants of wider spacing could receive more light, nutrients and other resources than the plants of close spacing. Plant spacing also showed significant influence on number of leaves per plant of sweet pepper (Table 2). The maximum number of leaves per plant (204.39) was recorded from 50×50 cm spacing. The minimum number of leaves per plant of sweet pepper (182.51) was recorded from 50×40 cm plant spacing which was statistically similar (185.97) to 50×30 cm plant spacing. The stem girth of sweet pepper was found to be statistically significant due to different plant spacing (Table 2). The widest spacing (50×50 cm) produced the maximum (14.79 mm) stem girth and it was gradually decreased with decreasing plant spacing. It was recorded the lower (12.08 mm) stem girth with the closest plant spacing (50×30 cm). The result of the present study for this character is in agreement with the findings of Sundstrom et al. [14]. Kim et al. [6] also expressed similar opinion on stem diameter of Capsicum. The plant spacing was found to influence significantly at 1% level of probability to the days to 50% flowering (Table 3). Flowering occurred earlier (104.29 days) in plant when grown as higher spacing (50×50 cm) but late flowering (110.93 days) occurred in plant with closer spacing (50×30 cm) which was statistically similar (108.81 days) to that of 50×40 cm spacing. The result is consistent with that of Srivastava [13] who reported that days to

50% flowering decreased with increasing spacing. The main effect of spacing was found to influence significantly at 1% level of probability to days to 1st harvest (Table 3). It was observed that the first harvest was earlier (136.72 days) at the closest spacing (50×30 cm). On the other hand, first harvest was later (145.90 days) at 50×40 cm spacing. The number of fruits per plant varied significantly under different plant spacings (Table 3). The highest average number of fruits (6.08) per plant was recorded from the widest spacing (50×50 cm) which was significantly higher than

Table 3. The effect of plant spacing on days to 50% flowering, number of fruits per plant and days to 1st harvest of sweet pepper

Treatment Spacing	Days to 50% flowering	No. of fruits/plant	Days to 1st harvest
50 × 50cm (S1)	104.29b	6.08a	142.19b
50 × 40cm (S2)	108.81a	5.37b	145.90a
50 × 30cm (S3)	110.43a	4.63c	136.72c
Level of Significance	**	**	**

**Significant at 1% level of probability measured by DMRT

those of other spacings (50×40 cm and 50 × 30 cm). The lowest number of fruits (4.63) per plant was noted under the closest spacing (50×30 cm). Reduced number of plants under wider spacing undergone less inter or intra plant competition which caused an increased number of fruits per plant. The results are in agreement with the report of Mishriky and Alphonse [10] who stated that the number of fruits per plant and yield per plant decreased with closer plant spacings. There was also significant variation in fruit length of sweet pepper due to plant spacing (Table 4). Significantly longer fruit (5.97 cm) was obtained from the widest plant spacing (50×50 cm). The closest plant spacing (50×30 cm) produced the shortest fruits (5.45 cm) and the medium plant spacing (50×40 cm) produced the medium fruits (5.67 cm). The result is in agreement with the report of Manchanda et al. [8] who reported that the number

Table 4. Main effect of plant spacing on fruit length, fruit breadth and pericarp thickness of sweet pepper

Treatment Spacing	Fruit length (cm)	Fruit breadth (cm)	Pericarp thickness (mm)
50 × 50cm (S1)	5.97a	5.64b	4.50
50 × 40cm (S2)	5.67b	5.94a	4.46
50 × 30cm (S3)	5.45c	5.88a	4.19
Level of Significance	**	**	NS

**Significant at 1% level of Probability measured by DMRT
NS Non significant

of fruits per plant and fruit length increased with decreasing plant density. The spacing level varied significantly in respect of fruit breadth (Table 4). The highest fruit breadth (5.94 cm) was obtained in plants of 50×40 cm spacing which was statistically similar (5.88 cm) to 50×30 cm spacing. The lowest fruit breadth (5.64 cm) was recorded in the widest spacing (50×50 cm). The results of the present experiment showed disagreement with the report of Kim et al. [6] who stated that planting systems and distances did not significantly alter plant height, main stem length, fruit length, fruit diameter or thickness of pericarp. The plant spacing level did not vary significantly in respect of pericarp thickness, which ranged from 4.19 mm to 4.50 mm (Table 4). The maximum thickness (4.50 mm) was obtained in plant 50×50 cm spacing and the minimum thickness (4.19 mm) was recorded in the closest spacing (50×30 cm). Plant spacing also influenced the individual fruit weight (Table 5).

Table 5. The effect of plant spacing on individual fruit weight, yield per and yield per plot of sweet pepper

Treatment Spacing	Individual fruit weight (g)	Yield per plant (g)
50 × 50cm (S1)	45.09a	271.12a
50 × 40cm (S2)	44.69a	238.50b
50 × 30cm (S3)	41.12b	191.73c
Level of Significance	**	**

**Significant at 1% level of probability measured by DMRT

The maximum fruit weight (45.09 g) was obtained in the widest spacing (50×50 cm), which was statistically identical to that of 50×40 cm plant spacing. The closest spacing (50×30 cm) performed the significantly least fruit weight (41.12 g). The result is in agreement with the report of Verheij and Verwer [15] who reported that the individual fruit weight declined with increased plant density. Yield per plant was significantly influenced by spacing levels (Table 5). The maximum yield (271.12 g) was recorded from the widest spacing (50×50 cm) and differed significantly from that of the other spacings. The lowest yield (191.73 g) per plant was obtained from the closest spacing (50×30 cm). The wider spacing facilitated the plants to develop properly with less inter and intra plant competition for utilizing the available resources resulting higher yield per plant. On the other hand, in higher population density reduced yield per plant might be attributed to lesser fruit yield per plant. The result of the present experiment is in agreement with the findings of Ravanappa et al. [12], who also obtained the highest yield with the lowest plant density treatment of 75×60 cm. Plant spacing had significant effect on yield per plot and per hectare (Figure 2). The closest spacing (50×30 cm) produced the maximum yield of fruit (3.83 kg/plot and 12.78 t/ha) and the widest (50×50 cm) spacing showed the minimum (3.25 kg/ plot) fruit weight per plot which was statistically similar weight of fruit per plot where plant grown at 50×40 cm spacing. It was observed that the yield of fruits per unit area

was inversely related to the plant spacing i.e. the closer plant spacing produced the higher yield of fruits per plot and per hectare. The higher yield of fruits was mainly contributed by the higher plant population per unit area in closer spacing. The result of the present experiment is in agreement with the findings of Manchanda et al. [8], and Ramachandran and Subbiah [11]. Mishriky and Alphonse [10] also obtained the highest yield (22.9 t/ha) from 30 cm plant spacing.

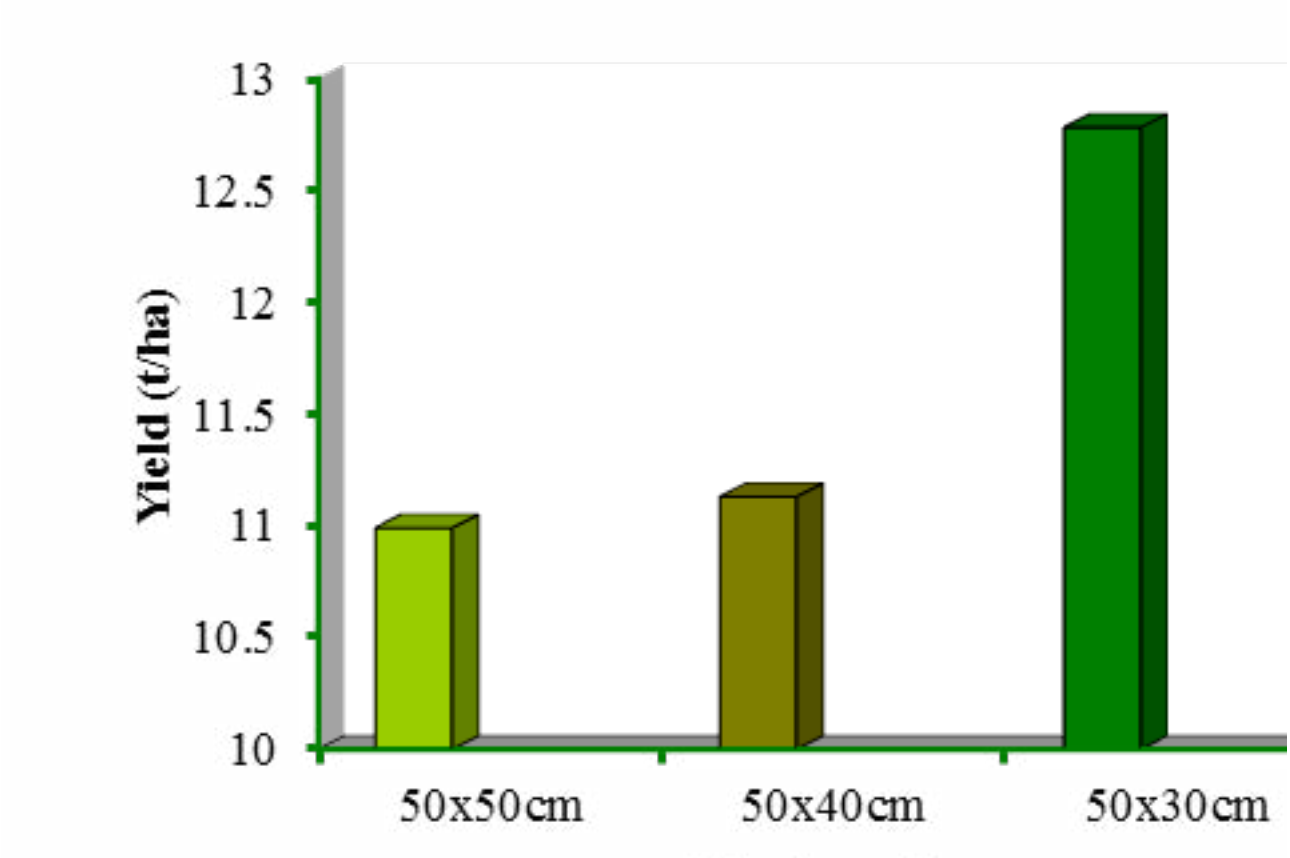

Figure 2. The effect of plant spacing on yield (t/ha) of sweet pepper

CONCLUSION

Therefore, it was evident from the above results, 50×30 cm spacing with October 1 sowing found to be the best for production of sweet pepper under the Horticultural farm of the Bangladesh Agricultural Research Institute, Gazipur, Bangladesh conditions.

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