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Effect of spacing on growth and reproductive parameters of different cultivars of sweet pepper

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ABSTRACT : The present investigation entitled effect of spacing on plant growth and reproductive parameters of different cultivars of sweet pepper (*Capsicum annuum* var. *grossum*) was undertaken in the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad during the year 2009-2010.The experiment was laid out in 3x5 Factorial Randomized Block Design having 15 treatments and 3 replications. The treatment T_8- (variety Lucky star-165 with spacing 60x45cm) was found to be superior and statically significant over other treatment combinations, which recorded highest plant height (34.66 cm), number of leaves/plant (137.00), number branches/plant (9.57), time of flower bud initiation (52.41 day after transplanting), number of flower bud/plant (6.08), number of flowers/plant (4.41), number of fruits/plant (4.25), fruit diameter (4.91 cm), fruit yield/plant (916.33 g), fruit yield/ha (33.93 tonnes) and benefit cost ratio (3.63).

KEY WORDS : Sweet pepper, Plant density, Growth, Yield, Quality

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Sweet pepper (*Capsicum annuum* L.) is member of family Solanaceae. Tropical South America, especially Brazil is thought to be the original home of pepper (Shomeker and Teskey, 1955). It is known widely cultivated in Central and South America, Peru, Bolivia, Costa Rica, Mexico, in almost all the European countries, Hong Kong and India. The total area under pepper cultivation in India is 1,73,426 hectare with production of 48,982 tonnes and productivity of 0.30 MT (NHB, 2008). In India it is cultivated commercially in Tamil Nadu, Karnataka, Himachal Pradesh and some part of Uttar Pradesh. In northern India it is commonly known as 'Simla Mirch'. It is very important crop for vegetable purpose, and it gained popularity as cash crop too. Sweet pepper is annual or short lived perennial herb upto 1.50 m in height. It has well developed tap root system with many laterals. Stems are branched, erect and often woody at the base. The fruit is many seeded berry. Sweet pepper, green or red, may be eaten cooked or raw, sliced in salads, in stews a little sweet pepper imparts a novel flavor. Ripe pimentos baked with white fish make a delicious dish (Herklots, 1972). Mild sweet pepper is also used for pickling, baking and stuffing. Dried green or red sweet pepper is some times mixed with sweet corrn or other vegetables. A few minor cultivars are yellow when immature and turn to orange-red at maturity. Fruits are mostly non pungent, although a few pungent forms are known. The modem pepper breeders owe a lot to the natives who created wide variability within this horticultural group. This development is thought to have occurred during the last many years (Gill, 1969). Planting density has influence on plant growth and fruit yield of most of the vegetable crops. Recent drive for maximizing the crop production has created a feeling that the higher plant number might be conductive to higher yield. In closer spacing more number of plant/unit area can be accommodated which result into more production/area. Wider spacing facilitiates better growth for each plant. The plant density significantly influence the period of emergence fruit buds. Earlier emergence and opening occur in close planting. The length of fruits and size of fruits also varies with change in planting density of different cultivars. The yield of any crop is primarily a function of leaf area, the leaf area in turn is a function of nutrients status of plant. Leaf area can be increased by increasing the number of plant or increasing the leaf area per plant. It has been argued that the wider spacing in fertile land is to be preferred, since each individual plant is likely to get more nourishment and hence, abundant and better growth is achieved.

RESEARCH METHODS

The experiment was carried out to study the effect of plant density on growth, yield and quality of different cultivars of sweet pepper at Sam Higginbottom Institute of Agriculture, Technology and Sciences Allahabad, during the year 2009-2010. The soil of experimental field was sandy loam with pH 7.3. Five cultivars of sweet pepper were planted at the three spacing (45×30 cm, 60×45 cm, 75×60 cm) and different varities used were Karan, Doctor, Ganga, Lucky star 165 and PS-22. The experiment was laid out in factorial Randomized Block Design with 15 treatments and 3 replications. The fifteen treatments consisted was T_1:V_1 S_1 (Doctor + 45×30 cm), T_2 : V_2 S_1 (Ganga + 45×30 cm),T_3 : V_3 S_1 (Lucky star 165 + 45×30 cm),T_4 : V_4 S_1 (PS-22 + 45×30 cm),T_5 : V_5 S_1 (Karan-25 + 45×30 cm),T_6 : V_1 S_2 (Doctor + 60×45 cm),T_7 : V_2 S_2 (Ganga + 60×45 cm),T_8 : V_3 S_2 (Lucky star 165 + 60×45 cm),T_9 : V_4 S_2 (PS-22 + 60×45 cm),T_{10}:$V_5$$S_2$ (Karan-25 + 60×45 cm),T_{11}: V_1 S_3 (Doctor + 75×60 cm),T_{12} : $V_2$$S_3$ (Ganga + 75×60 cm),T_{13} : V_3 S_3 (Lucky star 165 + 75×60 cm),T_{14}:V_4 S_3(PS-22 + 75×60 cm) and T_{15} : V_5 S_3 (Karan-25 + 75×60). In order to present the occurrence of pathological disease two spraying with diathane M-45@ 2.5 kg/ha was done and for protecting against insect pest metasystox-25EC@ 1.0-1.5 % was used. Observations were recorded on plant height (cm), plant spread (cm), number of leaves/plant, number branches/plant, time of flower bud initiation (days after transplanting), number of flower buds/plant, number of flowers/plant, number of fruits/plant, fruit diameter (cm), fruit yield (g/plant) and fruit yield (t/ha).

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Growth parameters:

Plant height (cm):

The data depicted in Table 1 clearly show that there were significant differences among the treatments 120 DAT at successive stage of growth. The maximum plant height (34.66 cm) was observed with T_8 (Lucky star-165 with 60×45cm) followed by 34.50 cm in T_{13} (Lucky star-165 with 75×60cm). However, minimum (19.16 cm) plant height was observed with T_1 (Doctor+45x30). Similar results were also reported by Singh and Singh (1984), Malik *et al*. (1990) and Singh *et al*. (2005).

Number of leaves per plant:

It is evident from the Table 1 that there were significant differences among the treatments 120 DAT at successive stage of growth. The maximum leaves per plant (137.00) were observed with T_8 (Lucky star-165 with 60×45cm) followed by 136.33 in T_{13} (Lucky star-165 with 75×60cm) and it was minimum (68.08) in T_1 (Doctor+45x30). Such results were also reported by Pall and Padda (1972) and Barman *et al.* (2013).

Plant spread (cm):

Data on the plant spread as influenced by different spacing and varieties presented in Table 1 clearly show that there were significant differences among the treatments 120 DAT at successive stage of growth. Maximum plant spread (60.66cm) was recorded with T_{13} (Lucky star-165 with 75×60cm) followed by 59.20 cm in T_3 (Lucky star-165 with 60×45cm). There was significant difference at 120 DAT with other treatment and minimum (38.66cm) plant spread was recorded in T_1 (Doctor+45x30). Similar findings were also reported by

Table 1 : Effect of different spacing and cultivars and their interaction on growth parameters

Treatments and combinations	Plant height (cm) 120 DAT	Number of leaves per plant 120 DAT	Plant spread cm) 120 DAT	Number of branches per plant 120 DAT
T_1 (Doctor+45x30)	19.16	68.08	38.66	3.08
T_2 (Ganga+45x30)	26.91	104.50	50.27	7.50
T_3 (Lucky star 165+45x30)	33.58	136.08	54.0	9.16
T_4 (PS-22+45x30)	22.58	87.50	48.70	3.75
T_5 (Karan-25+45x30)	24.25	90.75	49.42	4.58
T_6 (Doctor+60x45)	19.83	69.75	46.36	3.41
T_7 (Ganga+60x45)	27.41	105.66	56.73	7.58
T_8 (Lucky star 165+60x45)	34.66	137.0	59.20	9.57
T_9 (PS-22+60x45)	22.66	88.25	52.79	4.25
T_{10} (Karan-25+60x45)	24.33	91.25	56.31	4.41
T_{11} (Doctor+75x60)	19.50	69.33	42.10	3.33
T_{12} (Ganga+75x60)	27.50	105.25	52.61	7.08
T_{13} (Lucky star 165+75x60)	34.50	136.33	60.66	9.58
T_{14} (PS-22+75x60)	22.16	87.50	53.91	3.58
T_{15} (Karan-25+75x60)	24.16	91.16	42.40	4.41
C.D. (P=0.05)	0.57	0.55	1.52	0.31

Singh and Singh (1984), Malik *et al*. (1990) and Singh *et al*. (2005).

Number of branches per plant:

The perusal of data depicted in Table 1 clearly shows that there were significant differences among the treatments 120 DAT at successive stage of growth. The maximum number of branches per plant (9.58) was observed with T_{13} (Lucky star-165 with 75×60cm) followed by 9.57 in T_8 (Lucky star-165 with 60×45cm). However, minimum number of branches per plant (3.08) was recorded in T_1 (Doctor+45x30). Similar findings were also reported by Pall and Padda (1972) and Barman *et al.* (2013).

Reproductive parameters:

First flower bud initiation:

The data relevant to the first flower bud initiation are inscribed in the Table 2. The data reveals distinctive differences with respect to first flower bud initiation in all the treatment applied at successive stage of growth. The first

Table 2 : Effect of different spacing and cultivars and their interaction on reproductive parameters

Treatments and combinations	First flower bud initiation	Number of flower buds per plant	Number of flower per plant	Number of fruits per plant
T_1 (Doctor+45x30)	60.41	0.33	0.16	0.06
T_2 (Ganga+45x30)	55.08	3.50	2.66	2.16
T_3 (Lucky star 165+45x30)	55.25	4.33	4.16	2.75
T_4 (PS-22+45x30)	56.5	0.41	0.58	0.50
T_5 (Karan-25+45x30)	59.33	0.83	0.66	0.50
T_6 (Doctor+60x45)	60.83	0.41	0.25	0.25
T_7 (Ganga+60x45)	55.83	5.08	3.16	3.75
T_8 (Lucky star 165+60x45)	52.41	6.08	4.41	4.25
T_9 (PS-22+60x45)	59.08	0.58	0.50	0.75
T_{10} (Karan-25+60x45)	53.91	0.83	0.66	0.75
T_{11} (Doctor+75x60)	60.83	0.41	0.41	0.25
T_{12} (Ganga+75x60)	56.75	5.16	3.41	3.25
T_{13} (Lucky star 165+75x60)	55.00	6.16	4.50	4.08
T_{14} (PS-22+75x60)	59.83	0.50	0.41	0.58
T_{15} (Karan-25+75x60)	59.16	0.83	0.66	0.50
C.D. (P=0.05)	2.38	0.27	0.36	0.38

Table 3 : Effect of different spacing and cultivars and their interaction on reproductive parameters

Treatments and combinations	Average fruit yield per plant (g)	Average fruit yield per hectare (ton)	Average fruit diameter (cm)	Average fresh fruit weight (g)	C:B
T_1 (Doctor+45x30)	114.0	8.63	2.08	20.0	1:1.04
T_2 (Ganga+45x30)	377.20	27.93	3.50	37.66	1:2.73
T_3 (Lucky star 165+45x30)	442.56	32.78	4.58	42.66	1:3.15
T_4 (PS-22+45x30)	150.20	11.12	2.45	23.0	1:1.29
T_5 (Karan-25+45x30)	159.13	11.78	3.01	25.33	1:1.36
T_6 (Doctor+60x45)	237.0	8.77	2.36	22.0	1:1.12
T_7 (Ganga+60x45)	801.16	29.66	3.58	41.33	1:3.23
T_8 (Lucky star 165+60x45)	916.33	33.93	4.91	48.0	1:3.63
T_9 (PS-22+60x45)	304.66	11.28	2.71	26.33	1:1.40
T_{10} (Karan-25+60x45)	344.66	12.76	3.08	27.33	1:1.59
T_{11} (Doctor+75x60)	234.60	5.21	2.55	23.0	1:0.70
T_{12} (Ganga+75x60)	809.33	17.97	4.58	44.0	1:2.17
T_{13} (Lucky star 165+75x60)	920.00	20.44	6.65	52.33	1:2.44
T_{14} (PS-22+75x60)	314.25	6.97	3.20	31.0	1:0.91
T_{15} (Karan-25+75x60)	343.16	7.62	3.25	33.33	1:1.00
C.D. (P=0.05)	5.42	0.18	0.35	0.30	0.49

flower bud initiation (52.41 Days) was observed with T_8 (Lucky star-165 with 60×45cm) followed by 55.00 days in T_{13} (Lucky star-165 with 75×60cm). Similar results were also reported by Raijadhav *et al*. (1992) and Barman *et al*. (2013).

Number of flower bud per plant:

The data relevant to the first flower bud initiation are inscribed in the Table 2. The data reveals distinctive differences with respect to first flower bud initiation in all the treatment. The maximum number of flower bud per plant (6.16) was observed with T_{13} (Lucky star-165 with 75×60cm) followed by 6.08 in T_8 (Lucky star-165 with 45×30cm) and minimum flower bud per plant (0.33) was observed with T_1 (Doctor + 45 x 30). Such results were also reported by Raijadhav *et al*. (1992) and Barman *et al*. (2013).

Number of flowers per plant:

The data presented in Table 2 indicate that numbers of flower per plant were influenced by different treatment at different stage of reproductive growth. The maximum number of flower per plant (4.50) was observed with T_{13} (Lucky star-165 with 75×60cm) followed by 4.41 in T_8 (Lucky star-165 with 60×45cm) and it was minimum (0.16) in T_1 (Doctor+45x30). Similar results were also reported by Raijadhav *et al*. (1992) and Barman *et al*. (2013).

Number of fruits per plant:

Distinctive divergences with respect to number of fruit/ plant were observed with different treatment at 165 DAT at successive vegetative stage. The data presented in the Table 2 indicated that there was significant alteration in the number of fruit per plant at all successive stage of reproduction. The maximum number of fruit per plant (4.25) was observed with T_8 (Lucky star-165 with 60×45cm) followed by 4.08 in T_{13} (Lucky star-165 with 75×60cm). However, minimum number of fruits per plant (0.16) were recorded with T_1 (Doctor+45x30). Similar findings were also reported by Ahmed (1984), Shrivastava (1996) and Gare *et al.* (2009).

Average fruit yield per plant (g):

Data on the fruit yield as influenced by different spacing and varieties are presented in Table 3. It is evident from the table that maximum fruit yield per plant (920.0 g) was observed with T_{13} (variety Lucky star-165 with spacing 75× 60 cm) which was followed by 916.33g in T_8 (variety Lucky star-165 with spacing 60×45cm) and it was minimum (114.0 g) in T_1 (Doctor+45x30). Similar results were also reported by Shrivastava (1996), Maya *et al* .(1999) and Dobromilska (2000).

Average fruit yield per ha (tonnes):

Data on the fruit yield as influenced by different spacing and varieties are presented in Table 3. It is evident from the table that maximum fruit yield per ha (33.93 tonnes) was observed with T_8 (variety Lucky star-165 with spacing 60×45cm). However, minimum fruit yield per ha (8.63 tonnes) was recorded with T_1 (Doctor+45x30). Similar findings were also reported by Shrivastava (1996), Maya *et al* .(1999) and Dobromilska (2000).

Average fruit diameter (cm):

Fruit diameter as influenced by different spacing and varieties are presented in Table 3. It is evident from the table that maximum fruit diameter (6.65 cm) was observed with T_{13} (variety Lucky star-165 with spacing 75×60cm) and was followed by 4.91 cm in T_8 (variety Lucky star-165 with spacing 60×45cm) and minimum fruit diameter (2.08 cm) was recorded in T_1 (Doctor+45x30). Similar results were also reported by Dasgan and Abak (2003) and Saurabh (2009).

Average fresh fruit weight (g):

The data presented in Table 3 indicated significant response of spacing and varieties with respect to fruit weight. Maximum fresh fruit weight (52.33 g) was observed with T_{13} (variety Lucky star-165 with spacing 75×60cm) and was followed by (48.00 g) in T_8 (variety Lucky star-165 with spacing 60×45cm). However, minimum fresh fruit weight (20.00 g) was recorded with T_1 (Doctor+45x30). Similar results were also reported by Buczkowska and Kossowski (1987) and Saurabh (2009).

Economics of treatments:

The data presented in Table 3 revealed that the highest benefit cost ratio was found in T_8 (1:3.63) and was followed by T_7 (1.3.23) whereas minimum benefit cost ratio was found in T_{11} (1:0.70).

Conclusion:

Considering the finding of the present investigation it may be concluded that treatment T_8 (variety Lucky star 165 with spacing 60×45 cm) was found to be the most suitable for better growth and yield of sweet pepper. Again the treatment T_8 was found economically better with maximum cost benefit ratio (1:3.63) as compared to the other treatment combination.

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