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Effect of planting dates, spacing and training systems on growth and yield of cucumber (*Cucumis sativus L.*)

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ABSTRACT

An experiment was conducted to study the effect of different planting dates, spacing and training systems on growth and yield of cucumber (Cucumis sativus L.) under naturally ventilated polyhouseduring the off season 2017 at the Research farm, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The treatment comprised of three planting dates, two spacing and three training system were evaluated in factorial randomized block design (FRBD) with three replications. Among the dates of transplanting, 2nd fortnight of March proved significantly superior to 1stfortnight of March and 1st fortnight of April with respect of vine length (174.2 cm), days to initiation of first female flower (13.5), days to 50% flowering (26.3 days), number of days to first picking (34.6 days). The crop transplanted in first fortnight of March produced the plant with significantly smaller internodal length (9.3 cm) and prolonged harvest duration (59.3 days). Plants grown at wider spacing of 75 cm x 30 cm resulted in significantly smaller internodal length (9.4 cm) and took lesser number of days for initiation of first female flower (14.1 days), days to 50% flowering (28.5 days), days to first picking (36.4 days) and harvest duration (53.9 days) whereas narrow spacing of 60 cm x 30 cm produced significantly higher vine length (171.5 cm) regards to the number of shoots per plants, plants trained to two shoots produced significantly smaller internodal length (9.0 cm), took lesser number of days to 50% flowering (26.6 days), number of days to first picking (36.3 days) while significantly higher vine length (172.1 cm) and prolonged harvest duration (58.8 days) was also recorded with two shoots. In case of fruit yield plants with three shoots, spaced at 60 cm x 30 cm in the 1st fortnight of March recorded significantly higher fruit yield. Interaction effect was found significant for vine length, number of days to first picking and harvest duration.

Key words: Cucumber, polyhouse, training system, planting geometry, interaction

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is one of the most popular vegetable belong to the family Cucurbitaceae with a chromosome number 2n=14 (Bhagwat,2018). It is a warm season vegetable, grown throughout the world under tropical and subtropical conditions. Cucumber is commonly a monoecious plant with trailing or climbing vine habits. Cucumber is a highly cross pollinated crop and grows well under the condition of high light intensity, humidity, moisture and temperature but frost susceptible, growing best at temperature above 20^{0}C. Protected cultivation also known as controlled environment agriculture (CEA) is highly productive, conserve water as well as land and protect the environment (Sharma, 2018). Among vegetables, cucumber is one of the main crop grown in polyhouse. In India, farmers generally adopt open field conditions for the production of cucumber. Nevertheless, biotic and abiotic stresses are the main factor responsible for low yield and poor quality under open field cultivation particularly during rainy season crop (Kapuriya and Ameta 2017). It is not possible to produce high quality cucumber in terms of size, shape, colour also free from diseases and pests as compared to cucumber produced under protected environment. Optimum dateof transplanting is one of the important factors as it bringsdevelopment and vigorous growthof plants resulting in maximum yield of the crop and economic use of land (Islam *et al.* 2010).Greenhouse production technology of cucumber emphasizes the need for proper density in order to boost up the production per unit area by utilizing the available space and nutrients applied. The suitable plant spacing with pruning give higher yield of cucumber. Training methods vary with different growth habits and plant density of cucumber cultivar.Training the plants to two, three or four shoots will not only facilitate easy training operation, but also permit

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closer planting, early harvesting of fruits and get higher yields of large sized fruits (Rajalingham *et al.* 2017).Keeping these points in view, the present investigation was carried out to study the effect of different planting dates, spacing and training systems on the growth and yield of cucumber (*Cucumis sativus* L.) under naturally ventilated polyhouse.

MATERIALS AND METHODS

A field experiment was conducted in naturally ventilated polyhouse during off-season, 2017 at Research Farm, CSKHPKV, Palampur. The experimental site is located at $32^0 6'$ N latitude, $76^0 3'$ E longitude with an elevation of 1290.8 meters above mean sea level. The area represents the sub-humid mid hill zone of Himachal Pradesh and is characterized by the sub-tropical climate. The mean maximum temperature was observed during the standard week starting from 7^{th} May to 13^{th} May and mean minimum temperature was recorded during 12^{th} March to 18^{th} March. On an average, the greenhouse recorded 6.5^0C higher temperature than outside the polyhouse. The average relative humidity inside polyhouse ranged between 35.1 and 77.8 per cent during the growth period of the crop. A total rainfall of 1182.6 mm was received during the crop season outside the polyhouse. The experimental soil was silty clay loam in texture, acidic in reaction, high in organic carbon and medium in available nitrogen, phosphorus and potassium. The experiment was laid out in a factorial randomized block design with three replications, consisting of eighteen treatments having combinations of three dates of transplanting (1^{st} fortnight of March, 2^{nd} fortnight of March and 1^{st} fortnight of April), two planting geometry (S_1 60 cm x 30 cm) and (S_2 75 cm x 30 cm) and three training systems viz., two shoots (T_1), three shoots (T_2) and four shoots (T_3). The healthy and disease free seedlings of cucumber were transplanted in the beds according to different treatments. When the seedlings were well established, irrigation with drip irrigation system was applied. Observations on vine length, internodal length**,** number of days taken to first female flower**,** days to 50 % flowering**,** number of days to first picking and harvest duration were recorded. The economics of different treatments were calculated on the basis of prevailing market price of inputs and produce.The data recorded for various characters were subjected to statistical analysis using Cochren and Cox (1963) method.

RESULTS AN1D DISCUSSION

Growth and development studies

In general, an increase in plant height was rapid upto 80 days after transplanting, thereafter the elongation rate of the plant declined suddenly. Second fortnight of March (174.2 cm) recorded significantly taller plants than transplanting in the 1^{st} fortnight of March and 1^{st} fortnight of April. Plant spacing of 60 cm x 30 cm produced significantly taller plants (171.5 cm) than plants spaced at 75 cm x 30 cm (167.0 cm) at all the stages of crop growth (Table 1). This might be due to the great competition for space and light, thereby forcing the plants to grow taller. Similar observations were also reported by Jaffar and Wahid (2014) and Aniekwe and Anike (2015).Plants trained to two shoots recorded significantly taller plants (172.1 cm) than three shoots (170.9 cm) and four shoots (164.8 cm) at all the stages of crop growth. On the other hand, plants with four shoots recorded the minimum vine length. This increase in vine length with two shoots may be due to training of side branches causing reduced flow of nutrients to the auxiliary branches which in turn led to enhanced flow to the apical tissues leading to elongation of shoot. Similar findings were also reported by Nweke *et al.* (2013). Planting geometry x training systems significantly influenced the vine length at 60 days after transplanting (Table 2). The highest vine length was recorded from three shoots trained plants spaced at 60 cm x 30 cm (122.4 cm) which was however, statistically at par with the four shoots trained plants spaced at 75 cm x 30 cm (117.1 cm).Early transplanting in the 1^{st} fortnight of March produced the plants with significantly smaller internodal length (9.4 cm) than crop transplanted in the 2^{nd} fortnight of March (9.5 cm) and 1^{st} fortnight of April (9.5 cm). Islam *et al.* (2010) have also reported similar findings.Internodal length was also significantly influenced by planting geometry. Wider spacing (75 cm x 30 cm) resulted in smaller internodal distance (9.4 cm) as compared to narrow spacing (60 cm x 30 cm) (9.5 cm).Plants trained to two shoots produced significantly smaller internodal length as compared to three and four shoot plants (Table 1). Similar findings were also reported by Ekwu *et al.* (2012).

Table 1: Effect of transplanting date, planing geometry and training system on the growth and yield of cucumber

Treatment	Vine length (cm)				Internodal length(cm)	Days to initiation of first female flower	Number of days to 50% flowering	Number of days to first picking	Harvest duration (days)	Fruit yield (kg/100m^2)
	40 days	60 days	80 days	At harvest						
Date of transplanting										
D_1	36.6	115.3	157.0	168.5	9.52	15.2	30.2	41.3	59.4	1154.02
D_2	39.7	121.0	162.3	174.3	9.48	13.6	26.3	34.6	52.2	964.44
D_3	33.1	105.2	150.5	165.2	9.37	17.0	33.1	43.1	48.6	816.48
CD(P=0.05)	1.56	4.23	4.23	3.82	0.11	0.71	0.21	0.33	0.37	41.43
Planting geometry (cm)										
60 x 30	37.6	116.3	159.1	171.5	9.51	16.4	31.2	42.9	52.9	1024.02
75 x 30	35.4	111.3	154.1	167.1	9.40	14.2	28.5	36.5	53.9	932.61
CD(P=0.05)	1.27	3.45	3.45	3.12	0.09	0.86	0.17	0.27	0.30	33.83
Training system (shoots)										
Two shoots	37.8	116.4	159.2	172.1	9.07	14.1	26.7	36.4	58.9	978.16
Three shoots	36.9	115.1	157.9	170.9	9.6	15.0	31.0	40.2	51.5	1084.69
Four shoots	34.9	109.9	152.6	164.9	9.7	16.8	31.9	42.5	49.9	872.09
CD (P=0.05)	1.27	3.45	3.45	3.12	0.11	0.86	0.21	0.33	0.37	41.43

(D_1= First fortnight of March, D_2= Second fortnight of March, D_3= First fortnight of April)

Cucumber crop transplanted in the 2nd fortnight of March took significantly lesser number of days (13.5days) to initiate flowering as compared to the crop transplanted in the 1st fortnight of March (15.2 days) and first fortnight of April (17.0 days). This could be because of appropriate temperature (25^{0}C) prevailing during 2nd fortnight of March, which was found to be favourable for hormonal activation responsible for flowering. Similar effect of temperature on days to first flowering was reported by Jaffar and Wahid (2014).The wider spacing of 75 cm x 30 cm took significantly lesser number of days (14.1 days) for the initiation of first female flower than closer spacing of 60 cm x 30 cm (16.3 days). This might be due to availability of good sunshine and nutrients in the soil resulting in the accumulation of more photosynthates and induction of early flowering compared to closer spacing. Plants trained to two shoots took significantly lesser number of days (14.0 days) to initiate first female flower than plants trained to three shoots (14.9 days) and four shoots (16.7 days).The findings of present investigation are in accordance with the findings of Hirama *et al.* (2011).

Data (Table 1) on the days taken to 50% flowering showed that the plants transplanted in the 2nd fortnight of March took significantly lesser number of days to 50% flowering (26.3) in comparison with 1st fortnight of March (30.2) and 1st fortnight of April (33.1). It might be the favourable temperature and good sunshine resulting in the accumulation of more photosynthates and induction of early flowering (Islam *et al.* 2010).Planting geometry and training system also had significant effect on the days taken to 50 per cent flowering.Plants spaced at 75 cm x 30 cm apart and trained to two shoots took significantly lesser number of days to 50 per cent flowering (26.6) than plants trained to three (31.0) and four shoots (31.9).This might be due to availability of good sunshine and more uptake of nutrients resulting in the accumulation of more photosynthates inducing early flowering compared to the closer spacing. The results are in close conformity with the findings of Jaffar and Wahid (2014).

Table 2: Interaction effect of planting geometry and training systems on vine length (cm) at 60 days after transplanting

Planting geometry	Training systems		
	Two shoots	Three shoots	Four Shoots
60 cm x 30 cm	110.6	122.4	115.7
75 cm x 30 cm	109.1	107.8	117.1
CD (P=0.05)		**5.97**	

Data (Table 1) showed that the plants transplanted in the 2nd fortnight of March recorded significantly lesser number of days (34.6) to first picking in comparison with the 1st

fortnight of March (41.3) and 1st fortnight of April (43.0). It may be due to favorable temperature and good sunshine resulting in the accumulation of more photosynthates and early flowering inducing early picking as compared to the plants transplanted in the 1st fortnight of March and first fortnight of April (Wolska *et al.* 2008). Plants spaced at 75 cm x 30 cm (36.4) apart and trained to two shoots (36.3) recorded significantly lesser number of days to first picking. Early fruit setting coupled with exposure of fruits to sunlight and better aeration could also be the reasons for early picking at wider spacing of 75 cm x 30 cm. Interaction effect of dates of transplanting and planting geometry also influenced the number of days to first picking (Table 3). Plants trained to two shoots and transplanted in the second fortnight of March (31.6) took significantly lesser number of days to first picking in comparison with other treatment combinations of this study.

Table 3: Interaction effect of planting geometry and training systems on number of days taken to first picking and harvest duration

Training systems	Dates of transplanting					
	Days taken to first picking			Harvest duration		
	D_1	D_2	D_3	D_1	D_2	D_3
Two shoots	38.3	31.6	39.2	64.8	57.4	54.3
Three shoots	41.5	35.1	43.7	57.0	50.3	47.0
Four shoots	44.0	37.0	46.3	56.1	48.9	44.5
CD(P=0.05)		0.57			0.64	

Dates of transplanting had significant effect on harvest duration (Table 1) which was maximum in 1st fortnight of March (59.3) followed by 2nd fortnight of March (52.2) and 1st fortnight of April (48.6) transplanting. Low average temperature during flowering and fruiting prolonged the duration of anthesis and fruit setting in 1st fortnight of March transplanting. The wider spacing of 75 cm x 30 cm (53.9) resulted in prolonged harvest duration than closer spacing of 60 cm x 30 cm (52.9) which may be due to availability of good sunshine and more uptake of nutrients resulting in the accumulation of more photosynthates and induction of early flowering compared to closer spacing. Maximum harvest duration was recorded when plants were trained to two shoots (58.8) which was significantly higher than plants trained to three (51.4) and four shoots (49.9). The interaction between dates of transplanting and training systems significantly influenced the harvest duration (Table 3). Plants trained to two shoots and transplanted in the 1st fortnight of March (64.8) significantly recorded the longest harvest duration. Plants transplanted in the 2nd fortnight of March and trained to two shoots remained statistically at par with the plants transplanted in the 1st fortnight of March and trained to three shoots.

Yield

Maximum fruit yield/100 m^2 (1154.0kg) was obtained when crop was transplanted in the 1st fortnight of March (Table 1). This yield was significantly higher than plantings in the 2nd fortnight of March and 1st fortnight of April.This might be attributed to the favourable climatic conditions that prevailed throughout the growth period of the crop transplanted in the 1st fortnight of March leading to higher vegetative growth, contributing to more number of flowers, more number of fruits, maximum fruit weight and fruit volume. Similar results were reported by Guo *et al.* (2008). Planting geometry produced significantly higher fruit yield/100m^2 (1024.02 kg)with the closer spacing of 60 cm x 30 cm and lowest (932.6kg) with the wider spacing of 75 cm x 30 cm. Closer spacing of 60 cm x 30 cm, on an average, registered an increase of 9.80 % over wider spacing which may be due to higher plant population per unit area at narrow spacing.These results are in agreement with those of Kapuriya and Ameta (2017).Training the plants to three shoots recorded significantly higher fruit yield (1084.6) than plants trained to two (978.1) and four shoots (872.0), respectively. This increase in yield may be attributed to its better performance in yield per plant which ultimately resulted in an increase in yield per 100 m^2. Similar results were also reported by Bhatia *et al.* (2012) and Dhillon *et al.* (2017).

It may be concluded from the results that the transplanting of cucumber in the 1st fortnight of March, trained to three shoots and spaced at 60 cm x 30 cm apart were found to be the best for obtaining higher yield. Hence, transplanting of cucumber at a spacing of 60 cm x 30 cm in the 1st fortnight of March and the plants trained to three shoots can be recommended for growing cucumber in cost effective naturally ventilated polyhouse for higher fruit yield in mid hills of Himachal Pradesh.

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