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Response of growth and yield of cucumber (*Cucumis sativus* L.) to staking and plant spacing under protected culture

H. HAMAYOUN*, M. OMER DARWIASH, A.W. TAJZADH, I. AKRAMZOI AND Z. ASLAMI

Horticulture Department, Agriculture Faculty, Ghazni University, Afghanistan

**hamayoun.1383@gmail.com*

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ABSTRACT

The study was performed in Ghazni University Agriculture faculty farm, south-east region of Afghanistan, to determine the effect of staking and plant spacing on the growth and yield of cucumber. Staked and non-staked crops and three plant spacing (60 cm × 20 cm, 60 cm × 30 cm and 60 cm × 40 cm) were evaluated. The study was conducted as a 2 × 3 factorial randomized block design with five replications. Treatment means were separated using least significant difference (LSD=0.05). The result generated from the study showed that staking had no significant effect on weight of fruits, but showed significant effect on number of branches, number of leaves and vine length decreased as the plant spacing increased from 60 cm × 20 cm to 60 cm × 30 cm. The closest plant spacing (60 cm × 20 cm) recorded the highest value in all the parameters assessed in this trial except for number of flowers, days to 50% flowering, length of fruit and weight of fruit. The staked treatment constantly performed better with higher values than the non-staked treatment except for the flowers and number of non-marketable fruits. Hence for maximum production of cucumber staking and closer plant spacing should be adopted.

Key words: Staking, plant spacing, growth, yield

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable and one of the most popular members of the Cucurbitaceae family (Lower and Edwards, 1986; Thoa, 1998). It is a major vegetable crop worldwide. Cucumber is the fourth most important vegetable crop after tomato, cabbage, and onion (Tatlioglu, 1993). Although its calorie and nutritional value is very low, it is a primary source of vitamins and minerals in the human diet (Mah, 1989). In addition to its delicious taste and fairly good caloric value, it has high medicinal value for human beings. It is well known for natural diuretic and thus can serve as an active drug for secreting and promoting flow of urine. Due to high content of potassium (50-80 mg per 100 g), cucumber can highly be useful for both high and low blood pressure (Kashif et al., 2008).

Compared with othercrops, cucumber reaches harvest stage rapidly. The cucumber fruit products are used not only for fresh consumptionand culinary purpose, but also for salad and pickling (Kadans, 1979). Cucumber is good for diabetic patients as it contains low sugar and help in the burning of excess fat in the body. The epicarp of cucumber is used or mixed with pomade or cream to control oily or fatty face (Hardy and Rowell, 2002). With these potential attributes of cucumber, the production of the crop is still mainly in the hands of peasant farmers in Afghanistan especially in Ghazni city who lack information in some important cultural practices such as staking and right spacing for optimum yield of the crop. These farmers allow the vines to trail on the ground leading to the production of fruits with yellow bellies, overcrowding of the vines and subsequent attack by mold due to high humidity. Studies has shown that cucumber appropriately

spaced and staked show enormous disparity and differences with the both un-staked and un-spaced, as a result of avoiding competition, overcrowding and correct exposure of cucumber leaves to sunlight for effective photosynthetic activities, that will enhance fruit yield. Elsewhere, staking of cucumber has been found to help optimize yields for harvest of pickling cucumber. Higher fruit yield was observed on trellis treatment than for the non-trellised treatment (Hardy and Rowell, 2002; Hirata and Tilato, 2000; Nelson, 2005) reported increase in fruit yield as plant density increased. The present investigation shows the effect of plant spacing and staking on the growth and yield of cucumber grown in Ghazni University Agriculture faculty farm (GUAFF).

Protected cultivation or greenhouse cultivation is the most contemporary approach to produce mainly horticultural crops qualitatively and quantitatively and has spread extensively over the world in the last few decades. Protected cultivation also known as controlled environment agriculture (CEA) is highly productive, conservative of water and land and also protective of the environment (Jensen, 2002). The technology involves the cultivation of crops in a controlled environment wherein the factors like the temperature, humidity, light, soil, water, fertilizers etc. are manipulated to attain maximum produce as well as allow a regular supply of them even during off-season. By adopting protected cultivation technology, the growers can look forward to a better and additional remuneration forhigh yield andgood quality produce.

MATERIALS AND METHODS

Site location

Ghazni is located in the southeast region of Afghanistan. The study was conducted in Ghazni University Agriculture faculty farm, near to Unit mountain, Ghazni, Afghanistan during the period from June to October, 2018. The day temperatureof experimental area is 15-20°C and receives an annual rainfall of 400- 450 mm. The soil is sandy loam, low in organic matter content having approximately pH 7.5 (Hamayoun et al., 2018).

Field management and experimental design

The experimental field was clear of its natural weeds, the debris burnt and the field bed was divided into plots (3 m × 4 m). The experiment was conducted as 2 × 3 (FRBD) with five replications. Treatments (staked, unstaked) and three-plant spacing (60 cm × 20 cm; 60 cm × 30 cm and 60 cm × 40 cm) were used for the study. Two seeds of cucumber were planted per hole at a depth of about 2 cm and later thinned down to one plant per stand, two weeks after germination. NPK fertilizer at the rate of 102 kg NPK per ha was applied as a blanket treatment to all the plots, using broadcasting method two weeks after germination. Weeds were manually controlled and the crop was sprayed with wood ash at 4^{th} and 5^{h} week after planting to protect the crop against cucumber beetle, Zonocerusvariegates and lady beetle identified in the locality. Parameters evaluated were number of branches, number of leaves, leaf area, vine length, number of flowers, days to 50% flowering, number of fruits, length of fruits, number of non-marketable and marketable fruits and weight of fruits. All data generated during the experiment were subjected to statistical analysis using the procedure outlined by Steel and Torrie (1980) for a factorial experiment in randomized complete block design and the means were separated by the least significance difference at 5% alpha level.

RESULTS AND DISCUSSION

The staked cucumber plants produced more number of leaves than the unstaked treatment and they were statistically similar (Table 1), showing that staking treatments has no significant effect on the number of leaves. The resultalso shows that the number of leaves was not significantly affected by plant spacing. Though the number of leaves decreased as plant spacing increased from 60 cm × 20 cm to 60 cm × 30 cm, but increased in 60 cm × 40 cm, the least value was recorded in 60 cm × 30 cm, while the closest plant spacing (60 cm × 20 cm) produced the highest number of leaves. The leaf area (Table 1) value in staked cucumber was found to be higher than the unstaked plants. The value was decreased, as the plant spacing increased.

Table 1. Response of growth and yield of cucumber (*Cucumis sativus* L.) to staking and plant spacing under protected culture

Plant spacing (cm)				
Plant spacing (cm)	60 × 20	60 × 30	60 × 40	Mean
Staked	68.70	55.55	42.55	55.6
Number of leaves unstaked	47.55	45.75	65.30	52.9
	Mean	58.1	50.7	53.9
Staked	157.91	134.02	134.89	142.3
Leaf area (cm^2) unstaked	126.54	147.49	138.20	137.4
Mean	142.2	140.8	136.55	
LSD 0.05 (Number of leaves) Staking= NS Spacing=NS, Staking x Spacing=N Interaction		LSD 0.05 (leaf area) Spacing=NS Staking=NS Spacing × Interaction=NS		

Table 2. Response of branches, vine length, number of flowers, days to 50 % flowering to stalking and plant spacing

Plant spacing (cm)				
Staking	60 × 20	60 × 30	60 × 40	Mean
Staked	6.80	4.10	5.75	5.6
Branches unstaked	3.70	3.30	4.50	3.8
Mean	5.3	3.7	5.1	
Staked	131.37	110.25	125.05	122.2
Vine length unstaked	24.45	16.35	13.75	18.2
Mean	121.5	97.9	104.8	
Staked	24.45	16.35	13.75	18.2
Number of flowers untaked	15.80	24.10	17.45	19.1
Mean	20.1	20.2	15.6	
Staked	40.25	46.30	43.70	43.42
Days to 50 % flowering unstaked	43.70	40.35	42.25	42.10
Mean	41.98	43.33	42.98	
LSD 0.05 Staking = NS Spacing = NS Staking × Spacing = NS	LSD 0.05 (Vine length) Staking = NS Spacing = NS Staking × Spacing = NS	LSD 0.05 (Days to 50 % Anthesis) Staking = NS Spacing = NS Staking × Spacing = NS	LSD 0.05 (Number of Flowers) Staking = NS Spacing = NS Staking × Spacing = NS	

Table 3. Response of length of fruit, marketable fruit, non-marketable fruit and weight of fruit to stalking and plant spacing

Plant spacing (cm)				
Staking	60 × 20	60 × 30	60 × 40	Mean
Staked	46.40	22.40	14.00	27.6
Number of fruits unstaked	18.60	17.40	21.20	19.1
Mean	32.5	19.90	17.6	
Staked	21.36	22.07	20.76	21.4
length of fruit (cm) unstaked	20.10	20.74	21.40	20.7
Mean	20.8	21.4	21.1	20.7
Staked	3.40	2.80	1.80	2.7
Number of non-marketable fruit unstaked	3.80	3.80	4.60	4.1
Mean	3.6	3.3	3.2	
Staked	43.40	20.60	12.80	25.6
Number of marketable fruit unstaked	16.40	16.80	18.00	17.1
Mean	29.9	18.7	15.4	
Staked	0.34	0.37	0.33	0.4
Weight of fruit (kg) unstaked	0.31	0.38	0.34	0.4
Mean	0.3	0.4	0.3	
LSD 0.05 (number of fruit) Spacing = 8.34 Staking =6.81 Spacing × Staking =5.8 LSD 0.05 (marketable fruit) Spacing = 8.87 Staking =7.24 Spacing × Staking =5.13	LSD 0.05 (length of fruit Staking= NS Spacing=NS Spacing × Staking =NS	LSD 0.05 (weight of fruit Spacing = 0.02 Staking =NS Spacing × Staking =NS	LSD 0.05 (nun-marketable fruit) Spacing = NS Staking =NS Spacing × Staking =NS	

The closest plant spacing (60 cm × 20 cm) recorded the highest value of leaf area and both the staking and plant spacing showed no significant effect on the leaf area value of the cucumber plant. The values recorded for number of branches, vine length, number of flowers and days to 50% flowering showed that staking and plant spacing treatments have no significant effect on all these parameters assessed. However, the result (Table 2) showed that higher values are recorded in staked plants than the unstaked ones. The effect of plant spacing however does not follow this trend, the number of branches and vine length decreased in 60 cm × 30 cm spacing and increased in 60 cm × 40 cm plant spacing. The number of flowers and 50% flowers increased as plant spacing increased, but decreased in the widest space, 60 cm × 40 cm.

The results of the field trial showed that staking and plant spacing had effect on the vegetative growth of cucumber, although all the parameters measured for vegetative growth were non-significant at P=0.05. The number of leaves, branches and vine length decreased as the plant spacing increased from 50 cm × 30 cm to 50 cm × 40 cm,

but not beyond 60 cm × 30 cm. There was also a decrease in leaf area as the plant spacing increased from 60 cm × 20 cm to 60 cm × 40 cm. The closest plant spacing 60 cm × 20 cm produced the highest number of branches, leaves, and leaf area and vine length. The number of branches, number of leaves, vine length and leaf area were higher in the staked than the non-staked treatment. This may suggest that the leaves on the staked plants were all exposed to greater light interception leading to a higher accumulation of photosynthesis for vegetative growth. Hanna and Adams (1991) reported that staking cucumber increased the fruit yield because of better light interception. The number of days to 50% flowering was higher in the staked than the non-staked treatment. This agrees with the findings of Jansen (1985) who observed that staking prolongs vegetative growth and delays fruit formation. The non-staked treatment consistently produced lower values in all the vegetative parameters evaluated except in the number of flowers.

The results of variables of fruit parameters presented in Table 3 showed that staked plants produced higher values than the unstaked plants except in weight of fruit where their fruit yield are equal and in non-marketable fruit, where staked value is less than unstaked. Table 3 also showed that staking has significant (p=0.05) effect on the number of fruits and number of marketable fruits but showed no effect on length of fruit, number of non-marketable fruits, and weight of fruit. The value recorded for number of fruits, number of non-marketable fruits and number of marketable fruits decreased as plant spacing increased. The widest plant spacing produced the least value in number of fruits, non-marketable and marketable fruits. The plant spacing of 60 cm × 30 cm produced the highest length of fruit and fruit weight. Also significant differences between plant spacing was observed in the number of fruits and staking × spacing interaction was significant at P=0.05. However, the value obtained in 60 cm × 30 cm and 60 cm × 40 cm spacing was statistically similar.

The result of number of marketable fruits also showed significant differences among the treatments in both staking and plant spacing treatments (Table 3) and staking × plant spacing interaction was equally significant at P=0.05. The effect of 60 cm × 30 cm and 60 cm × 40 cm spacing was similar. Staking treatment had no significant effect on the weight of fruit, while plant spacing showed significant effect on the weight of fruit, however the effect of the closest (50 cm × 30 cm) and widest (60 cm × 40 cm plant spacing were statistically similar and their interaction (staking × plant spacing) had no significant effect on the weight of fruit.

The closest plant spacing (50 cm × 30 cm) produced the highest number of fruit, number of marketable and non-marketable fruits, while length of fruit and weight of fruit was highest at 50 cm × 40 cm. Gebologu and Saglam (1999) reported the highest fruit yield in 20 cm, the closest plant spacing used. While Quian (2000) observed that the closest plant spacing gave the highest early yield. Jacques et al. (2002) reported that the number of fruit decreased as the plant density changed from four to ten plants per meter square. However, the observations made in the trial is contrary to the findings of Phamthic (1991), Jonathan et al. (1996) and Paulo et al. (2003), who obtained highest yield at higher plant spacing. The yield parameters assessed were found to be higher on the staked plants than that vine grown on the ground. The result agreed with the findings of Hardy and Rowell (2002), who observed that the yield of super select cucumbers were higher for the trellised treatment than the non-trellised treatment. Hanna and Adams (1991) reported that staked cucumber gave an average marketable yield of 25 ton per acre as against 16.4 tons per acre of the non-staked cucumber. While Jansen (1985) concluded that staked cucumber produced fruits that double the quantity of the crops on the ground. The number of non-marketable fruit was higher in the non-staked than the staked treatment. This could be attributed to the poor quality in the color of the fruit, reduced length of fruit and development of yellow bellies on the fruits, which predisposes them to spoilage. Hanna and Adams (1991) reported that staking brings about an increase in color quality, fruit length and sugar content of the fruits.

Also Hardy and Rowell (2002) affirmed that staking improves the color and lowers the incidence of yellow bellies in cucumber. The non-staked treatment consistently gave the least values in all the yield parameters evaluated except in the number of non-marketable fruits.

CONCLUSION

The result showed that staking and plant spacing treatment had effect on the vegetative growth and yield of cucumber. The non-staked treatment consistently gave least values in all the vegetative and yield parameters measured except in the number of flowers and number of non-marketable fruits respectively, while the closer plant spacing produced the highest values virtually in all the parameters assessed in this trial. The result, therefore, suggest that the vegetable farmers who have the intention of producing high quality cucumber fruit from the agro-ecological zone understudy should adopt staking and use a plant spacing of 50 cm × 30 cm for the maximum production.

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