

Research Article

Response of Crop Geometry on the Performance of Parthenocarpic Varieties of Cucumber (*Cucumis sativus* L.) Under Controlled Polyhouse Condition

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Abstract

An experiment was conducted to assess the effects of cultivars and spacing on yield and yield attributes of parthenocarpic cucumber grown under controlled polyhouse during summer. There were six cultivars *viz.* Nun-3134, Kian, Isatis, Infinity, Nun-3121 and Nun-3141 along with three levels of spacing *viz.* 45 cm × 30 cm, 45 cm × 45 cm and 45 cm × 60 cm. The experiment was laid out in factorial completely randomized design with three replications. The results showed that all vegetative characters under study were significantly influenced by various cultivars and levels of spacing. Cultivar V₁(Nun-3134) was best in regards vegetative traits. Interaction effects of cultivars and spacing were significant for most of vegetative characteristics except days to anthesis of first flower and days to first harvest. The cultivar V₁ (Nun-3134) was found to be significantly superior in respect of yield and yield attributing traits having maximum values of 3.98 kg and 20.88 kg for yield per vine and per square meter, respectively. Among the treatment combinations, maximum yield per vine (4.30 kg) was reported for V₅S₁ (Nun-3121 + 45 cm × 30 cm). However, maximum yield per square meter (26.66 kg) was recorded in V₁S₁ (Nun-3134+ 45 cm × 30 cm).

Keywords: Parthenocarpic cucumber, controlled polyhouse, green house and planting density

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Introduction

Cucumber (*Cucumis sativus* L.) belongs to family cucurbitaceae. It is a warm season vegetable, grows throughout the world under tropical and subtropical conditions. It is said to be the native northern India [1]. Archeological evidences support that cultivation of cucumber in India dated back to 3000 years and 2000 years in China. China is considered as one of the secondary centers of genetic diversification [2]. Family Cucurbitaceae consisting of 118 genera and 825 species [3], among those genus *Cucumis* comprises about 30 species. Cucumber is commonly a monoecious annual (one can encounter with androecious, gynoecious, hermaphrodite and andromonoecious sex types also), trailing or climbing vine [4]. The fruits of cucumber possesses various medicinal properties *e.g.* cooling effect, prevents constipation, checks jaundice and indigestion [5]. Parthenocarpic and gynoecious cucumber cultivars increase the potential to yield a high fruit load in controlled environments resulting in a high harvest index. Plants exhibiting a high harvest index will more efficiently use the limited growing area in a growth chamber. Polyhouse cultivation is still a new and emerging trend for growing vegetables in India. Production of cucumber in India is mainly restricted to its open field cultivation. It is mainly grown in summer and rainy season in northern plains of India. Nevertheless, biotic and abiotic stresses are the main factors responsible for low yield and poor quality under open field cultivation. India, being a vast country with diverse and extreme agro climatic conditions, the protected vegetable cultivation technology can be utilized for year round production of high value quality vegetable crops, with high yield. Besides this, limited availability of land for cultivation hampers the vegetable production. Hence, to obtain good quality produce and production during off season, there is a need to cultivate cucumber under protected condition. In green houses plants are grown under controlled or partially controlled environment resulting in higher yields as compare to open conditions [6]. The nature of growth is more of vertical due to congenial climate under polyhouses. Hence, the plant density under protected condition is usually more. On the other hand, in order to optimize yield, selection of varieties is of much importance.

Material and Methods

The experiment was conducted under controlled polyhouse at Hi-tech Horticulture Unit, Rajasthan College of Agriculture, Udaipur (Rajasthan) India, during June, 2011 to April, 2012. The trial was laid out in Factorial Completely Randomized Design with three replications. The size of the fully controlled polyhouse was 28m×32m (896 sq.m) covered with aluminate screen and ultra violet stabilized low density polyethylene sheet having 200 micron thickness with provision of cooling pads and exhaust fan. The experiment was comprised of six parthenocarpic cultivars viz. Nun-3134 (V₁), Kian (V₂), Isatis (V₃), Infinity (V₄), Nun-3121 (V₅) and Nun-3141 (V₆) and three levels of spacing viz. 45 cm × 30 cm (S₁), 45 cm × 45 cm (S₂) and 45 cm × 60 cm (S₃). For green house cultivation of cucumber, the seedlings were raised on soil-less media (Mixture of vermiculite, perlite and cocopith) in plug trays having cells of 2" in size. Two weeks old seedlings at 2-3 true leaf stage were transplanted according to the different treatment combinations. All the cultural practices including irrigation and hoeing were carried out as per the standard commercial procedures. Spraying for pests and diseases were applied whenever it appeared necessary throughout the growing season. Plants were vertically trained with plastic ropes. Data on vegetative characteristics (vine length), stem diameter, number of primary branches per vine and number of secondary branches per vine, number of first flowering node, internodal distance, days to anthesis of first flower and days to first harvest) yield and yield contributing characteristics (number of fruits per vine, fruit weight, fruit length, fruit volume, fruit diameter, yield per vine and yield per square meter) and quality characteristics (specific gravity, TSS and moisture content) were recorded from randomly selected five tagged plants of each treatment and further analyzed. All data were subjected to analysis of variance to determine main effects and interaction effects.

Result and Discussion

Vegetative Characteristics

The data revealed (**Table 1** and **Table 2**) that the vine length, stem diameter, number of primary branches per vine and number of secondary branches per vine were significantly influenced by various cultivars having a range of 5.48 m to 7.28 m, 0.73 cm to 0.87 cm, 2.31 to 8.5 and 7.54 to 9.02, respectively. The maximum values of these traits have been reported for cultivar V₁ (Nun-3134). It was due to genetic makeup of the cultivar. However, greenhouse environment favoured the growth of the lines by modifying the natural environment and micro climatic conditions surrounding the plants, similar trend was observed in tomato under green house conditions [7-9].

Table 1 Effect of cultivars and spacing on vine length, stem diameter, no. of primary branches per vine, no. of secondary branches per vine, no. of nodes at flowering, internodal distance, days to anthesis of first flower and days to first harvest of parthenocarpic cucumber under polyhouse condition

Treatments	Vine length (m)	Stem diameter (cm)	Number of primary branches per vine	Number of secondary branches per vine	Number of nodes at flowering	Internodal distance (cm)	Days to anthesis of first flower	Days to first harvest
Cultivars (V)								
V ₁	7.28	0.87	2.85	9.02	3.73	8.58	34.47	43.46
V ₂	6.45	0.77	2.31	8.44	3.90	8.94	37.76	46.58
V ₃	5.48	0.73	2.42	8.00	3.97	9.43	36.37	45.23
V ₄	6.33	0.74	2.76	8.81	3.43	7.88	35.56	44.46
V ₅	5.98	0.81	2.71	8.72	3.64	9.00	36.08	44.97
V ₆	5.79	0.73	2.31	7.54	4.18	9.65	37.66	46.53
SEm±	0.047	0.033	0.061	0.096	0.097	0.096	0.115	0.142
CD at 5%	0.136	0.095	0.176	0.277	0.280	0.278	0.332	0.408
Spacing (S)								
S ₁ (45x30) cm	5.79	0.73	2.58	8.13	3.70	8.99	36.06	44.84
S ₂ (45x45) cm	6.23	0.79	2.58	8.40	3.86	8.77	36.49	45.39
S ₃ (45x60) cm	6.64	0.81	2.51	8.72	3.87	8.99	36.41	45.37
SEm±	0.033	0.034	0.051	0.068	0.079	0.068	0.082	0.100
CD at 5%	0.096	0.098	0.147	0.196	0.229	0.196	0.235	0.289

Table 2 Interaction effect of cultivars and spacing on vine length, stem diameter, no. of primary branches per vine, no. of secondary branches per vine, no. of nodes at flowering, internodal distance, days to anthesis of first flower and days to first harvest of parthenocarpic cucumber under polyhouse condition

Treatment combinations	Vine length (m)	Stem diameter (cm)	Number of primary branches per vine	Number of secondary branches per vine	Number of nodes at flowering	Internodal distance (cm)	Days to anthesis of first flower	Days to first harvest
V ₁ S ₁	6.58	0.92	2.90	8.83	3.66	8.74	34.30	43.267
V ₁ S ₂	7.17	0.88	2.93	8.96	3.80	8.30	34.30	43.167
V ₁ S ₃	8.08	0.82	2.73	8.9.2	3.73	8.71	34.83	43.933
V ₂ S ₁	6.04	0.79	2.53	8.20	3.90	9.10	37.63	46.600
V ₂ S ₂	6.54	0.77	2.20	8.40	3.96	8.97	37.76	46.600
V ₂ S ₃	6.76	0.75	2.20	8.73	3.83	8.77	37.90	46.533
V ₃ S ₁	5.25	0.74	2.43	7.60	3.73	9.29	35.86	44.567
V ₃ S ₂	5.42	0.72	2.36	8.06	4.13	9.53	36.60	45.533
V ₃ S ₃	5.78	0.72	2.46	8.33	4.06	9.49	36.66	45.600
V ₄ S ₁	5.94	0.86	2.83	8.73	3.36	7.96	35.30	43.933
V ₄ S ₂	6.36	0.79	2.90	8.90	3.43	7.84	36.10	45.167
V ₄ S ₃	6.70	0.56	2.56	8.80	3.50	7.84	35.30	44.267
V ₅ S ₁	5.56	0.81	2.53	8.43	3.46	9.00	35.86	44.500
V ₅ S ₂	6.04	0.80	2.80	8.63	3.73	8.82	36.20	45.267
V ₅ S ₃	6.34	0.81	2.80	9.10	3.73	9.19	36.20	45.133
V ₆ S ₁	5.34	0.73	2.30	7.03	4.10	9.84	37.40	46.200
V ₆ S ₂	5.84	0.76	2.33	7.46	4.10	9.17	38.00	46.633
V ₆ S ₃	6.18	0.71	2.30	8.13	4.36	9.95	37.60	46.767
SEM±	0.082	0.077	0.106	0.167	0.169	0.167	0.200	0.245
CD at 5%	0.236	0.222	0.305	0.485	NS	NS	0.579	0.710

Planting density also significantly affected these traits (Table 1). Plants at wider spacing (45 cm x 60 cm) gave maximum vine length (6.64 m), stem diameter (0.81 cm) and number of secondary branches (8.72). The present results were in conformity with the work done in melons [10] and [11]. Among the treatment combinations, maximum vine length (8.08 m) was reported in treatment combination V₁S₃ (Nun-3134 + 45 cm x 60 cm), maximum plant height at wider spacing was also observed in brinjal [12]. Whereas, number of primary branches and secondary branches were maximum for V₁S₂ (Nun-3134 + 45 cm x 45 cm) and V₅S₃ (Nun-3121 + 45 cm x 60 cm), respectively. These findings were in conformity with results in cucumber [13] where, number of branches and plant spread increase with increase in spacing. Minimum number of flowering node (3.43) and internodal distance (7.88 cm) were observed for V₄ (Infinity) whereas maximum number of nodes at flowering (4.18) and internodal distance (9.65 cm) were observed for cultivar V₆ (Nun-3141). This performance may be due to genetic makeup of the cultivar. Cultivar V₁ (Nun-3134) was on top in regards of days to anthesis of first flower and days to first harvest having values of 34.47 and 43.46, respectively. Treatment S₁ (45 cm x 30 cm) found best for earliness as the values for number of nodes at flowering, days to anthesis of first flower and days to first harvest were minimum *i.e.* 3.70, 36.06 and 44.84, respectively. Whereas minimum internodal distance was observed for S₂ (45 cm x 45 cm) having value of 8.77 cm, these findings were supported with the work in cucumber [14] where, plant growth was stimulated with increasing plant density. Treatment combination V₁S₂ (Nun-3134 + 45 cm x 45 cm) took minimum days for first harvest whereas maximum days were taken by V₆S₃ (Nun-3141 + 45 cm x 60 cm). Minimum internodal distance was reported in two treatment combinations *i.e.* V₄S₂ (Infinity + 45 cm x 45 cm) and V₄S₃ (Infinity + 45 cm x 60 cm). However, minimum number of first flowering node was observed in the treatment combination V₄S₁ (Infinity + 45 cm x 30 cm) as compared to maximum days taken by V₆S₃ (Nun-3141 + 45 cm x 60 cm).

Yield and Yield Attributing Characteristics

All the yield attributing traits were found to be significantly influenced by effects of cultivars (Table 3). Cultivar V₁ (Nun-3134) recorded significantly highest number of fruits per vine, fruit weight, fruit length, fruit volume and fruit diameter having values of 37.44, 103.30 g, 18.24 cm, 109.74 cc, and 3.49 cm, respectively. This performance may be

due to genetic makeup of the cultivar. Maximum values of these traits were also observed for cultivar Hilton in greenhouse grown cucumber [15]. Plant spacing also significantly influenced these traits. Among various levels of spacing treatment S₃ (45 cm x 60 cm) was significantly superior for number of fruits per vine, fruit weight, fruit length and fruit volume having values of 29.90, 104.16 g, 17.26 cm and 109.82 cc, respectively. This might be due to more fruit set, more photosynthesis as it produced more vine length at wider spacing. These findings were in conformity with the findings in capsicum [16], where values of above traits were maximum at the spacing of 45 cm x 60 cm in controlled polyhouse. A perusal of data presented in **Table 4** revealed that interaction effect of cultivars and spacing had significant influence on number of fruits per vine, fruit weight, fruit length, fruit volume and fruit diameter. The data showed that maximum value for these traits were observed in treatment combination V₁S₃ (Nun-3134 + 45 cm x 60 cm). Similar trend for number of fruit per vine in cucumber [17] were also observed.

Table 3 Effect of cultivars and spacing on number of fruits per vine, fruit weight, fruit length, fruit volume, fruit diameter, yield per vine, yield per square meter, specific gravity, TSS and moisture content of parthenocarpic cucumber under polyhouse condition

Treatment	Number of fruits per vine	Fruit weight (g)	Fruit length (cm)	Fruit volume (cc)	Fruit diameter (cm)	Yield per vine (kg)	Yield per square meter (kg)	Specific gravity (g/cc)	TSS (°Brix)	Moisture content (%)
Cultivars(V)										
V ₁	37.44	103.30	18.24	109.74	3.49	3.98	20.88	0.94	3.53	95.19
V ₂	25.21	99.97	17.71	105.31	2.86	3.18	16.43	0.94	3.50	95.24
V ₃	19.48	100.22	16.77	105.58	3.4	2.52	13.29	0.95	3.55	95.58
V ₄	29.75	99.60	16.67	104.76	3.48	3.24	16.04	0.95	3.59	95.29
V ₅	29.11	101.08	16.47	107.63	3.40	3.20	16.57	0.93	3.63	95.39
V ₆	18.75	99.02	14.97	104.91	3.14	2.39	12.24	0.94	3.58	95.26
SEm±	0.510	0.652	0.195	0.843	0.022	0.084	0.395	0.003	0.052	0.090
CD at 5%	1.468	1.878	0.561	2.428	0.063	0.171	1.138	NS	NS	NS
Spacing (S): S₁(45x30 cm), S₂ (45x45 cm) and S₃ (45x60 cm)										
S ₁	23.02	98.32	16.20	104.36	3.32	2.54	18.84	0.94	3.56	95.35
S ₂	26.95	99.11	16.96	104.79	3.29	3.21	15.89	0.94	3.59	95.40
S ₃	29.90	104.16	17.26	109.82	3.30	3.51	13.00	0.94	3.54	95.23
SEm±	0.360	0.461	0.138	0.596	0.076	0.059	0.279	0.002	0.037	0.064
CD at 5%	1.038	1.328	0.396	1.717	0.220	0.241	0.805	NS	NS	NS

The effects of cultivars on yield per vine and yield per square meter were significant. However, among the various cultivars tested in the present study, cultivar V₁ (Nun-3134) was found to be significantly superior with the highest yield per vine and per square meter with values of 3.98 kg and 20.88 kg, respectively. Better performance of cultivar Nun-3134 may be due to the highest number of fruits per vine and weight of fruit. Similar trend have been seen in cucumber [14], where cultivar Kian was best among three cultivars tested in polyhouse condition. Spacing also had a significant influence on yield per vine and yield per sq meter. Maximum yield per vine (3.51 kg) was obtained in S₃ (45 cm x 60 cm) as compared to minimum at closest spacing (45 cm x 30 cm) with value of 2.54 kg. It is concluded that total yield significantly increased as the spacing between plants within rows was increased. The results of the present study are in the close conformity with [18] and [19] in tomato crop. Among the various levels of spacing, maximum yield per sq meter (18.84 kg) was reported in the treatment S₁ (45 cm x 30 cm). This was due to increase in number of plants per unit area. Similar trend of increase in yield per unit area with decrease in plant spacing have been observed in cucumber [20], [17] and [21]. Interaction treatments attempted in the present investigation showed the significant influence on yield per vine and yield per square meter of cucumber (Table-4). The maximum yield per vine (4.30 kg) was reported for V₅S₁ (Nun-3121 + 45 cm x 30 cm). However, on the basis of analysis, the maximum yield per square meter (26.66 kg) was recorded in V₁S₁ (Nun-3134+ 45 cm x 30 cm). Such beneficial effect of these interactions might be due to mutual complementary influence of cultivars and plant geometry. Significant effects of treatment combinations on yield were also reported in polyhouse grown cucumber [22] and [14].

Table 4 Interaction effect of cultivars and spacing on number of fruits per vine, fruit weight, fruit length, fruit volume, fruit diameter, yield per vine, yield per square meter, specific gravity, TSS and moisture content of parthenocarpic cucumber under polyhouse condition

Treatments	Number of fruits per vine	Fruit weight (g)	Fruit length (cm)	Fruit volume (cc)	Fruit diameter (cm)	Yield per vine (kg)	Yield per square meter (kg)	Specific gravity	TSS (°Brix)	Moisture content (%)
V ₁ S ₁	32.93	102.5	17.76	108.60	3.480	3.60	26.66	0.947	3.52	95.09
V ₁ S ₂	38.13	103.1	18.36	110.65	3.507	2.76	20.44	0.933	3.56	95.48
V ₁ S ₃	41.26	104.2	18.60	109.99	3.510	2.31	17.13	0.950	3.51	95.02
V ₂ S ₁	21.10	97.80	17.43	104.58	2.937	2.14	15.85	0.937	3.54	95.26
V ₂ S ₂	25.50	98.20	17.70	103.17	2.817	2.63	19.50	0.950	3.46	95.27
V ₂ S ₃	29.03	103.9	18.00	108.20	2.840	1.82	13.48	0.957	3.50	95.20
V ₃ S ₁	16.73	97.93	16.33	102.37	3.443	4.06	20.05	0.960	3.55	95.73
V ₃ S ₂	20.06	99.73	17.23	105.62	3.490	3.02	14.91	0.943	3.53	95.54
V ₃ S ₃	21.66	103.0	16.76	108.77	3.413	2.62	12.97	0.950	3.58	95.47
V ₄ S ₁	25.53	97.46	15.80	102.31	3.510	3.36	16.59	0.950	3.59	95.24
V ₄ S ₂	29.66	96.00	16.63	100.89	3.487	3.35	17.31	0.953	3.55	95.51
V ₄ S ₃	34.06	105.3	17.60	111.08	3.447	2.47	13.53	0.950	3.62	95.11
V ₅ S ₁	26.20	98.00	15.53	105.47	3.420	4.30	15.95	0.930	3.58	95.60
V ₅ S ₂	29.40	99.60	16.60	104.79	3.377	3.76	13.95	0.950	3.82	95.24
V ₅ S ₃	31.73	105.6	17.30	112.63	3.417	2.64	9.77	0.937	3.50	95.33
V ₆ S ₁	15.66	96.20	14.36	102.83	3.133	4.24	15.70	0.937	3.60	95.21
V ₆ S ₂	18.93	98.07	15.23	103.63	3.100	3.48	12.91	0.947	3.61	95.34
V ₆ S ₃	21.66	102.8	15.33	108.27	3.193	2.62	9.73	0.950	3.54	95.24
SEm±	0.883	1.129	0.337	1.460	0.082	0.014	0.684	0.005	0.090	0.156
CD at 5%	2.548	3.148	NS	4.208	0.237	0.418	1.971	0.016	NS	NS

Conclusion

On the basis of these findings it could be concluded that cultivar Nun-3134 was found best as it gave maximum yield per vine as well as per square meter and plants should be accommodated at the spacing of 45 cm x 30 cm for getting maximum yield per unit area. Among the treatment combinations maximum yield per unit effective area was recorded for Nun-3134 + 45 cm x 30 cm.

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