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Short communication

Effect of plant geometry and fertigation on growth and yield of cherry tomato (*Solanum lycopersicon* var. *cerasiforme*) under zero energy polyhouse conditions

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ABSTRACT

An experiment consisting of twelve treatment combinations of four plant geometries and three levels of fertigation with three replications in Factorial Completely Randomized Design was conducted at Udaipur under zero energy polyhouse conditions. Among the different plant geometries and fertigation levels adopted, S_4 (75 cm × 60 cm) and F_3 (NPK @ 250:125:125 kgha^{-1}) were found statistically superior to enhance plant height (284.78 cm), stem girth (1.33 and 1.22 cm), number of branches per plant (18.17 and 18.13), leaf area (337.84 and 327.99 cm^2), number of flower clusters per plant (50.93 and 51.26) , fruit set (77.44 and 73.04%), fruits per cluster (12.45 and 11.56), number of fruits per plant (461.74 and 417.80), average fruit weight (5.95 and 5.57 g) and yield per plant (2.75 and 2.34 kg). Maximum fruit yield per unit area was observed at spacing of 45 cm × 45 cm (S_1) with F_3 fertigation level due to greater crop biomass.

Key words: Cherry tomato, fertigation, growth, plant geometry, polyhouse.

The tomato is one of the most popular and widely grown Solanaceous fruit vegetable in the world. Among different forms of tomato, Cherry tomato (*Solanum lycopersicon* var. *cerasiforme*) have recently gained in popularity among consumers because they can be eaten without being cut, they are deep red in colour, and their flavour is intense and pleasant. It is gaining popularity in private sector in Rajasthan state of India. Cherry tomato is very small in size and the average fruit weight is 12-20 g depending on variety. Cherry tomato has high TSS ranging from 6.8-7.0% and therefore ideal for salad purpose. Thus, there is a need to increase the production and productivity of cherry tomato in the country. Greenhouse cultivation could be resorted to increase the productivity of cherry tomato. Tomato crops grown under polyhouse conditions were early to flower and had higher yield than those raised under field (Nagalakshmi *et al.*, 6).

Protected cultivation actually achieves higher water and nutrient use efficiencies. It requires careful planning and suitable production technology like spacing, water and nutrient management and cultivars to produce economic yield. Among the various factors responsible for low production, crop geometry and fertilizer application are important factors for production and productivity.

Cherry tomato yield could be increased through suitable spacing with appropriate fertigation levels. Fertigation is the process wherein fertilizer is applied through an efficient irrigation system like drip. In fertigation, nutrient use efficiency could be as high as 90 percent as compared to 40-60 percent in conventional methods (Olaimalai *et al.*, 7). Fertigation improved nutrient availability, enhanced nutrient uptake, reduced fertilizer application rate and water requirements, minimized nutrient losses through leaching and prevents salt injuries to root and foliage. Fertigation enables accurate supply of water and nutrients to the individual plant. Considering these aspects, the present study was undertaken to know the response of plant density and different levels of fertigation on growth and yield of cherry tomato under polyhouse conditions.

The experiment was conducted during 2011-12 at the Hi-Tech Horticulture Unit, Department of Horticulture, RCA, Udaipur. The experiment was laid out using factorial Completely Randomized Design with three replications and comprised of total twelve treatment combinations of four plant geometries, *i.e.*, 45 cm × 45 cm (S_1), 60 cm × 45 cm (S_2), 60 cm× 60 cm (S_3) and 75 cm × 60 cm (S_4) and three levels of fertigation, *viz.*, NPK @ 150:75:75 kgha^{-1} (F_1), NPK @ 200:100:100 kgha^{-1} (F_2) and NPK @ 250:125:125 kgha^{-1} (F_3). The F_1 hybrid BS.834 cherry tomato was taken for evaluation of treatments. In fertigation, nitrogen, phosphorus and potassium were applied through irrigation water as source of NPK mixture (19: 19:19) and urea twice in a week as per different level

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of fertigation. The plant were trained on single stem, first hoeing and weeding was done after 20 days of transplanting and second was repeated after 20 days to keep the beds weed free. The crop was protected from leaf minor attack by spraying Pro-Rin @ 40 ml/15 l of water. Alternate sprays of copper oxichloride and mancozeb 0.2% were done to keep the crop disease-free. Calcium chloride @ 0.5% at fruit development stage was applied to overcome blossom end rot. For recording the growth, yield and yield contributing characters, five plants were randomly selected in each plot and were tagged.

Data presented in Tables 1 & 2 indicated that various plant geometries and fertigation levels and their interaction had significant influence on growth parameters of cherry tomato under zero energy polyhouse conditions. Plant geometry significantly affected the plant height and stem girth of cherry tomato crop. The plant density (60 cm × 60 cm) gave maximum plant height (281.58 cm) than closer spacing (45 cm × 45 cm). The maximum stem girth (1.33 cm) was obtained at wider planting density (75 cm × 60 cm) than closer spacings, which might be due to more vegetative growth, more leaf area,

Table 1. Effect of plant geometry and fertigation on growth of cherry tomato under zero energy polyhouse conditions.

Treatment	Plant height (cm)	No. of branches per plant	Leaf area (cm^2)	Stem girth (cm)	No. of flower clusters per plant
(a) Geometry					
S_1 (45 cm × 45 cm)	262.87	14.13	284.55	1.06	43.11
S_2 (60 cm × 45 cm)	273.72	17.07	307.85	1.14	47.17
S_3 (60 cm × 60 cm)	281.58	17.67	325.89	1.25	50.67
S_4 (75 cm × 60 cm)	280.80	18.17	337.84	1.33	50.93
CD at 5%	11.098	0.660	7.393	0.025	2.218
(b) Fertigation					
F_1 (NPK 150:75:75 $kgha^{-1}$)	266.18	15.09	300.84	1.16	44.25
F_2 (NPK 200:100:100 $kgha^{-1}$)	273.28	17.06	313.27	1.21	48.40
F_3 (NPK 250:125:125 $kgha^{-1}$)	284.78	18.13	327.99	1.22	51.26
CD at 5%	9.611	0.571	6.402	0.022	1.920

Table 2. Interaction effect of plant geometry and fertigation on growth parameters of cherry tomato under zero energy polyhouse conditions.

Treatment	Plant height (cm)	No. of branches per plant	Leaf area (cm^2)	Stem girth (cm)	No. of flower clusters per plant
S_1F_1	254.85	13.43	275.25	0.99	39.33
S_1F_2	262.72	14.20	279.21	1.09	43.33
S_1F_3	271.05	14.77	299.18	1.11	46.67
S_2F_1	267.72	14.97	278.47	1.09	46.67
S_2F_2	271.63	17.82	323.03	1.15	47.00
S_2F_3	281.82	18.43	322.04	1.19	47.83
S_3F_1	271.38	15.82	314.21	1.23	46.22
S_3F_2	279.13	18.00	315.28	1.25	52.26
S_3F_3	294.22	19.18	348.18	1.27	53.52
S_4F_1	270.75	16.12	335.45	1.33	44.78
S_4F_2	279.63	18.24	335.53	1.35	51.00
S_4F_3	292.02	20.15	342.55	1.32	57.00
CD at 5%	NS	1.143	12.805	0.0434	3.841

NS = Non-significant

ample sun light and aeration under wider spacing. Significant linear increase of main plant height and stem girth was reported with increased plant spacing. Similar results were reported by Mohamed (5) in tomato.

Among the various fertigation levels, F_3 (NPK 250:125:125 kgha^{-1}) treatment on cherry tomato crop adequately sustained favourable vegetative and reproductive growth as compared to F_1 (NPK 150:75:75 kgha^{-1}) treatment due to optimum concentration of fertilizer. Thus, F_3 gave maximum plant height (284.78 cm) and stem girth (1.22 cm) than F_1 treatment. Present results are supported by Singh *et al.* (8) that plant height and stem thickness was highest with the application of 500:300:350 kg NPK/ha in tomato. Interaction effect of plant geometry and fertigation influenced stem girth of cherry tomato significantly (Table 2). The maximum stem girth (1.35 cm) was reported for combined treatment S_4F_2 (75 cm × 60 cm + NPK 200:100:100 kgha^{-1}) followed by S_4F_3 (1.32 cm), whereas, these interactions, non-significantly influenced the plant height of cherry tomato.

The maximum number of branches per plant (18.17) and leaf area (337.84 cm^2) was recorded in wider spacing (75 cm × 60 cm) over other plant densities. Similarly, fertigation treatments had significant effect on number of branches per plant and leaf area of cherry tomato. Maximum number of branches (18.13) and leaf area (327.99 cm^2) was noticed in F_3 (NPK 250:125: 125 kgha^{-1}). This might be due to increased fertilizer use efficiency by using adequate dose of NPK through fertigation. Further, interaction effect of plant geometry and fertigation as depicted in Table 2, which showed significant effect on number of branches per plant and leaf area, which might be due to more growth at wider spacing accompanied with higher level of fertilizers. The results of the present investigation are in agreement with the results of Moccia and Katcherian (4).

Data revealed that various crop geometry and fertigation treatments had significant effect on number of flower clusters per plant. The maximum number of flower clusters per plant (50.93 and 51.26) was noticed in S_4 (75 cm × 60 cm) and F_3 (NPK 250:125: 125 kgha^{-1}. The number of flower clusters per plant was significantly affected by interaction effect of geometry and fertigation (Table 2). The greater flower clusters were because of the more branches with greater flower production. The number of flower clusters per plant was highest with the application of 500:300:350 kg NPK/ha in tomato as compared to other treatments (Singh *et al.*, 8). The data related to effect of plant geometry and fertigation and their combinations on fruit set of cherry tomato differed significantly (Tables 3 & 4). It is clearly indicated that wider geometry 75 cm × 60 cm and fertigation level F_3 (NPK 250:125: 125 kgha^{-1}) exhibited higher fruit set 77.44 and 73.04%, respectively. Moreover, the percentage of fruit set was significantly higher due to the wider spacing and optimum dose of NPK, where number of flowers per clusters and clusters per plant were high. The maximum fruit set (79.33%) was recorded in S_4F_3 followed by (78.42%) in S_3F_3 combination than other treatment combinations. Effect of plant geometry and fertigation and their interaction effects on number of fruits per cluster showed significant increase. Maximum number of fruits per cluster (12.45) and (11.56) was recorded in wider geometry S_4 (75 cm ×

Table 3. Effect of plant geometry and fertigation on yield and yield attributing characteristics of cherry tomato under zero-energy polyhouse conditions.

Treatment	Fruit set (%)	Fruits/ cluster	No. of fruits /plant	Fruit wt. (g)	Fruit yield (kg/plant)	Fruit yield (t/ha)
(a) Geometry						
S_1 (45 cm × 45 cm)	62.04	9.49	343.93	5.00	1.72	79.12
S_2 (60 cm × 45 cm)	66.46	10.79	351.79	5.16	1.83	52.33
S_3 (60 cm × 60 cm)	76.96	11.19	393.66	5.39	2.12	37.77
S_4 (75 cm × 60 cm)	77.44	12.45	461.74	5.95	2.75	35.04
CD at 5%	0.980	0.543	22.346	0.132	0.136	1.379
(b) Fertigation						
F_1 (NPK 150:75:75 kgha^{-1})	68.42	10.49	345.60	5.26	1.84	44.70
F_2 (NPK 200:100:100 kgha^{-1})	70.71	10.89	399.93	5.29	2.14	51.53
F_3 (NPK 250:125:125 kgha^{-1})	73.04	11.56	417.80	5.57	2.34	56.97
CD at 5%	0.849	0.470	19.353	0.114	0.118	1.194

Table 4. Interaction effect of plant geometry and fertigation on yield and yield attributing characteristics of cherry tomato under zero energy polyhouse conditions.

Treatment	Fruit set (%)	Fruits/ cluster	No. of fruits/ plant	Fruit wt. (g)	Fruit yield (kg/plant)	Fruit yield (t/ha)
S_1F_1	57.67	8.55	328.83	4.89	1.61	73.25
S_1F_2	63.33	9.05	332.95	4.89	1.63	78.40
S_1F_3	65.13	10.88	370.00	5.22	1.93	85.72
S_2F_1	64.41	10.33	272.67	4.88	1.33	43.06
S_2F_2	65.67	10.55	385.71	4.97	1.91	52.56
S_2F_3	69.29	11.50	397.00	5.63	2.24	61.37
S_3F_1	75.95	10.94	343.36	5.50	1.89	29.95
S_3F_2	76.50	11.27	412.73	5.31	2.19	40.91
S_3F_3	78.42	11.35	424.89	5.35	2.28	42.45
S_4F_1	75.67	12.15	437.54	5.78	2.53	32.55
S_4F_2	77.33	12.70	468.33	6.01	2.81	34.24
S_4F_3	79.33	12.50	479.33	6.05	2.90	38.34
CD at 5%	1.698	0.940	38.705	0.229	0.236	2.388

60 cm) and F_3 (NPK 250:125: 125 kgha^{-1}) fertigation practices. This might be due to wider spacing for growth of plant along with higher level of fertilizers, which resulted in increased leaf area and fruit setting consequently more number of fruits per cluster. These results are supported by the reports of Sortino *et al.* (9) in tomato.

Significant increase in number of fruits per plant and fruit weight was observed with various levels of spacing and irrigation. Highest number of fruits per plant (461.74) and maximum average weight (5.95 g) were recorded in treatment S_4 (75 cm × 60 cm). This was due to availability of more space, which favours plant growth and more photosynthesis. The same trend having more No. of fruits and weight of fruit in tomato have also been observed by Charlo *et al.* (3). In fertigation treatments, the maximum value for fruits per plant (417.80) and fruit weight (5.57 g) were observed in treatment F_3 (NPK 250:125:125 kg ha^{-1}) where highest fertilizer doses were applied. It shows that tomato is fertilizer responsive crop and yield can be increased by increase in fruit number and weight. This increment was chiefly due to easy availability of nutrients. These findings are in confirmation with results of Adjanohoun *et al.* (1). Interaction effects of plant geometry and fertigation levels on number of fruits per plant and fruit weight were also significant and maximum values were registered for treatment combination S_4F_3 (75 cm × 60 cm along with NPK 250:125:125125 kg ha^{-1}). Yield per plant was significantly affected by different crop geometry and various fertigation treatments. The data showed that maximum yield per plant (2.75 and 2.34 kg) was noticed in S_4 (75 cm × 60 cm) and F_3 fertigation level, respectively. The results of the present study are in the close conformity with Bahadur and Singh (2) in tomato. However, the maximum yield per plant (2.90 kg) was observed for S_4F_3 followed by S_4F_2 (2.81 kg). The fruit yield per hectare (Table 3) was also significantly influenced by various plant geometry and fertigation treatments. The data showed that the highest fruit yield per hectare (79.12 t) was recorded in narrow spacing S_1 (45 cm × 45 cm), while the lowest yield (35.04 t) in wider spacing S_4 (75 cm × 60 cm). This is because of maximum number of plants per unit area lead to increased yield per hectare. Closer spacing of 80 cm × 30 cm and 60 cm × 45 cm gave the higher total as well as marketable fruit yield than the wider spacing of 100 cm × 30 cm in tomato (Tesfaye, 10). F_3 (NPK 250:125: 125 kgha^{-1}) resulted highest fruit yield (56.97 t) due to optimum dose of NPK in fertigation levels helped positively the yield attributing characters. The present result confirmed the earlier reports of Singh *et al.* (8). The highest fruit yield per hectare (85.72 t) was obtained in S_1F_3 followed by S_1F_2 (78.40 t) as compared to minimum (29.95 t) with treatment S_3F_1 followed by S_4F_1 (32.55 t).

From the above discussion, it is clear that the plant geometry S_4 (75 cm × 60 cm) with fertigation level F_3 (NPK @ 250:125:125 kgha^{-1}), *i.e.* S_4F_3 enhanced vegetative growth parameters such as plant height, number of branches per plant, stem girth resulted into maximum number of flower clusters with maximum fruit set per plant as well as yield attributing characteristics such as maximum number of fruits per plant, weight of fruit, which ultimately increased the fruit yield per plant. Based on the above findings, it could be recommended that cherry tomato should be grown at a spacing of 75 cm × 60 cm along with F_3 (NPK @ 250:125:125 kg ha^{-1}) fertigation practices for sustaining the higher fruit yield and quality under zero energy polyhouse conditions. Whereas, on the basis of total fruit yield per unit area, it could be recommended that cherry tomato cultivar BS.834 should be grown at a spacing of S_1 (45 cm × 45 cm) along with F_3 fertgation level for attaining the maximum production.

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