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Effect of Planting Geometry and Fertigation Levels on Growth, Yield and Quality of Chilli

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ABSTRACT

The present study entitled was carried at University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2014-15 and 2015-16. The experiment was laid out in Factorial Randomized Block Design with nine treatment combination and each treatment was replicated thrice. The treatments comprised of three planting geometry (S) *viz.*, S_1 (90 x 90 cm), S_2 (90 x 60 cm) and S_3 (90 x 45 cm) and three fertigation levels (F) *viz.*, F_1 (RDF@150:50:50 NPK kg/ha through soil application), F_2 (100% RDF through fertigation) and F_3 (80% RDF through fertigation). The pooled data reveal that, for planting geometry, the treatment S_3 (90 cm × 45 cm) and for fertigation levels F_3 (80% RDF through fertigation) was found to be the best treatment in respect to maximum increased the growth parameters *viz.,* plant height, stem diameter, plant spread and leaf area. Similarly, the same treatment was found best in respect of yield and yield contributing and quality parameters *viz.,* fruit length, diameter of fruit, number of fruits per plant, average fresh weight of fruit per plant (g), green and dry fruits yield per plant (kg), yield (q/ha), ascorbic acid, chlorophyll and crude protein contents. Similarly, the quality parameters *viz*., ascorbic acid, chlorophyll and crude protein content were also found maximum in same treatment. The interaction effect between planting geometry and fertigation levels *i.e*., S_3F_3 (90 cm × 45 cm + 80% RDF through fertigation) was found superior for obtaining maximum growth, yield and better quality of chilli

Key Words: Planting geometry, fertigation, yield, growth, quality, RDF

INTRODUCTION

Chilli (*Capsicum annum* L.) belongs to the family solanaceae and is also called as red pepper/ hot pepper. According to Hakkim (2014) chillies are indispensable ingredient used in every Indian diet due to its pungency, spicy taste and appealing colour and flavour. It has two important qualities, the pungency due to a crystalline acrid volatile alkaloid called Capsaicin and captivating red colour due to the pigment Capsanthin. The production share of chillies among the major spices in India is 25-26per cent. Andhra Pradesh ranks first in both area and production of chillies. In Maharashtra it is cultivated on an area about 30.99 thousand hectare with annual production of 359.77 thousand metric tonnes (Anon, 2017). There is vast scope to increase production per unit area by adopting latest and improved scientific agro techniques, including the use of high yielding hybrid varieties, suitable planting geometry and fertigation.

At present, use of water soluble fertilizers is increasing day by day, but up till now there is no basic knowledge regarding the scheduling of fertigation in vegetable crops. Some progressive farmers are using water soluble fertilizer in tentative splits *viz*., weekly, fortnightly, monthly in different proportion, but there is lack of technical know-how regarding time of application and appropriate use of recommended dose of fertilizer through water soluble fertilizer. Fertigation system saves water and fertilizers improve growth, higher yield and maximum benefits in comparison with normal practices of irrigation and fertilizer application.

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In views of this the present investigation was undertaken to find out optimum spacing and appropriate fertigation levels to boost the production potential and productivity in chilli.

MATERIALS AND METHODS

The present investigation was carried during *Rabi* season of 2014-15 and 2015-16. The experiment was laid out in Factorial Randomized Block Design with nine treatment combination and each treatment was replicated thrice. The treatments comprised of three planting geometry (S) *viz.*, S_1 (90 x 90 cm), S_2 (90 x 60 cm) and S_3 (90 x 45 cm) and three fertigation levels (F) *viz.*, F_1 (RDF@150:50:50 NPK kg/ha through soil application), F_2 (100% RDF through fertigation) and F_3 (80% RDF through fertigation). The soil of the experimental field was medium black, rich in potash with good water holding capacity and fairly good drainage. The raised beds were prepared of 1.2 m wider with 15 cm height. Entire dose of recommended nitrogen, phosphorus and potassium were applied in the form of urea, single superphosphate and muriate of potash, i.e., RDF @ 150:50:50 NPK kg/ha through soil application and were mix with FYM @ 25 t/ha and applied on prepared bed before mulching in the control plot. Immediately after fertilization drip irrigation were supplied to the crop to avoid and protect from burning the seedling respectively. Fertigation was done at every 10 days intervals into eight (8) equal split doses. Recommended dose of fertilizers at different levels were applied by using water-soluble fertilizers 19:19:19 and urea (46% N) through fertigation using drip irrigation system. Nutrient concentration in irrigation water was well within the prescribed limits. Online drip line spread over the bed and covered with Silver black polythene film having thickness of 40 microns. The 30 days old seedling of chilli F_1 Hybrid (Sitara) were transplanted according to allotted plant spacing in randomized block of 4.5 m × 3.6 m.

The observations recorded were plant height, stem diameter, plant spread and leaf area, yield and yield attributing parameters *viz*., days to flower initiation, days to 50 per cent flowering fruit length, diameter of fruit, number of fruits per plant, average fresh and dry weight of fruit per plant (g), green and dry chilli yield per plant (kg). Biochemical parameters *viz*., ascorbic acid, capsaicin, carotenoids, chlorophyll and crude protein content was recorded on five randomly selected plants in each plot. The data of various observations were subjected to statistical analysis as method suggested by Fisher's (1963).

RESULTS AND DISCUSSION

Growth attributes

The data (Table 1) revealed that, the maximum vegetative growth in terms of plant height, stem diameter, plant spread at 120 DAT and leaf area was recorded under the closer spacing treatment S_3 (90 × 45 cm) and 80% RDF through fertigation F_3. While, wider spacing treatment (S_1) and 100% RDF through soil application (F_1) showed minimum values in all above parameters. Similarly, interaction of planting geometry and fertigation levels the treatment combination S_3F_3 showed best performance in respect of plant height, stem diameter, plant spread leaf area. There was a significant increase in plant growth parameters due to application of varying levels of fertigation and spacing. This increase might be due to highest absorption of nutrient which promotes the auxiliary buds into new shoots. The results were in agreement with Hazim and Manohar (2010) in okra.

The nutrients element nitrogen promotes vegetative growth and enhances cell division and elongation as well as responsible for greater chlorophyll synthesis and thus increased activity of leaf formation and development in chilli. Leaves are the principle site of photosynthesis which accumulates more carbohydrates to further increase their numbers and area. The close spacing highly responses to the availability of ample amount of macronutrients (NPK) resulted in a better vegetative growth of the crop and thereby higher dry matter production per unit area. Similar results

Table 1. Planting geometry and fertigation levels influenced the growth parameters.

Treatment	Pooled (2014-15 and 2015-16)			
	Plant height (cm)	Stem diameter (cm)	Plant spread (cm)	Leaf area (cm^2)
Planting geometry (S)				
S_1	81.53	3.23	72.46	119.97
S_2	85.25	3.48	77.63	124.48
S_3	86.74	3.56	77.58	126.83
'F' test	Sig	Sig	S	Sig
SE(m) ±	0.85	0.04	1.07	0.87
CD @ 5%	2.56	0.12	3.20	2.61
Fertigation levels (F)				
F_1	73.88	3.02	63.88	85.66
F_2	87.21	3.44	80.68	124.32
F_3	92.43	3.81	83.12	161.30
'F' test	Sig	Sig	S	Sig
SE(m) ±	0.85	0.04	1.07	0.87
CD @ 5%	2.56	0.12	3.20	2.61
Interaction effect (S × F)				
$S_1 F_1$	78.97	2.98	66.91	89.49
$S_1 F_2$	80.16	3.19	73.17	115.03
$S_1 F_3$	85.46	3.53	77.30	155.40
$S_2 F_1$	72.51	3.02	64.08	83.19
$S_2 F_2$	90.68	3.61	88.82	127.63
$S_2 F_3$	92.55	3.81	79.99	162.61
$S_3 F_1$	70.17	3.05	60.64	84.29
$S_3 F_2$	90.78	3.53	80.05	130.30
$S_3 F_3$	99.27	4.09	92.05	165.89
'F' test	Sig	Sig	Sig	Sig
SE(m) ±	1.48	0.07	1.85	1.50
CD @ 5%	4.43	0.21	5.54	4.50

were reported by Ayare *et al* (2012), Sollapur and Hiremath (2017) in Brinjal, Bhattarai *et al* (2015) and Ganjare *et al* (2013) in capsicum.

Yield and yield attributing characters

The data (Table 2) regarding the yield and yield contributing characters *viz.,* fruit length, diameter of fruit, number of fruits per plant was recorded significantly maximum under the closer spacing S_3 (90 × 45 cm) and 80% RDF through fertigation (F_3). While the wider spacing (S_1) and 100% RDF through soil application (F_1) recorded lowest values for all the characters. The treatment combination S_3F_3 showed best performance for all the characters and it was found on par with the treatment S_2F_3 and S_2F_2 with each other.

Similarly, the highest average fresh weight of fruit per plant (g), green chilli yield per plant (kg),

Table 2. Yield and yields attributing parameters influenced by planting geometry and fertigation levels.

Treatment	Pooled (2014-15 and 2015-16)						
	Length of fruit (cm)	Dia. Of fruit (cm)	No. of fruits / plant	Av. fresh weight / fruits plant (g)	Av. dry weight / fruits plant (g)	Green chilli yield /plant (kg)	Total yield (q/ ha)
Planting geometry (S)							
S_1	12.78	1.16	126.49	392.11	46.40	1.57	205.08
S_2	13.35	1.18	155.07	484.37	49.08	1.94	376.95
S_3	13.71	1.19	157.36	488.16	45.85	1.95	504.77
'F' test	Sig	NS	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.11	0.02	4.84	8.19	1.19	0.03	5.58
CD @ 5%	0.33		14.52	24.57	3.57	0.09	16.74
Fertigation levels (F)							
F_1	12.85	1.12	99.10	292.76	34.69	1.17	228.49
F_2	13.38	1.19	160.97	535.44	53.75	2.14	427.29
F_3	13.60	1.22	178.85	536.43	52.89	2.15	431.02
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.11	0.02	4.84	8.19	1.19	0.03	5.58
CD @ 5%	0.33	0.06	14.52	24.57	3.57	0.09	16.74
Interaction effect (S × F)							
$S_1 F_1$	12.74	1.15	103.85	298.78	37.17	1.20	156.71
$S_1 F_2$	13.05	1.16	121.32	446.17	51.93	1.78	233.14
$S_1 F_3$	12.54	1.17	154.29	431.39	50.12	1.73	225.39
$S_2 F_1$	12.57	1.14	97.47	293.20	34.24	1.17	229.86
$S_2 F_2$	13.44	1.21	191.15	583.20	57.36	2.33	453.23
$S_2 F_3$	14.06	1.19	176.59	576.69	55.63	2.31	447.77
$S_3 F_1$	13.24	1.07	95.97	286.31	32.67	1.15	298.91
$S_3 F_2$	13.66	1.19	170.43	576.96	51.97	2.31	595.49
$S_3 F_3$	14.21	1.30	205.66	601.20	52.92	2.40	619.90
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.19	0.03	8.38	14.18	2.07	0.06	9.67
CD @ 5%	0.57	0.09	25.14	42.54	6.21	0.18	29.01

dry chilli yield per plant (kg) green, dry and total yield of chill (q/ha) was recorded under the closer spacing S_3 and 80per cent RDF through fertigation (F_3). While the wider spacing (S_1) and 100% RDF through soil application (F_1) recorded lowest values for all the characters. The treatment combination S_3F_3 recorded significantly maximum for all characters and was found at par with S_3F_2. However, the maximum average dry weight of fruit/plant (g) was recorded in S_2F_2 which were found on par with S_2F_3, S_3F_3 and S_3F_2.

The main focus of cultivating a crop is to have the maximum yield per unit area for better returns. The

Table 3. Quality parameters in chill parameters influenced by planting geometry and fertigation levels.

Treatment	Pooled (2014-15 and 2015-16)					
	Ascorbic acid (mg /100 g fresh weight)	Capsaicin content (mg/ 100 g dry weight)	Chlorophyll content (mg /100 g fresh weight)		Carotenoids content (mg/ 100 g dry weight)	Crude Protein content in fruit (%)
			Leaf	Fruit		
Planting geometry (S)						
S_1	102.45	0.16	16.56	0.71	0.31	16.33
S_2	126.11	0.18	15.82	0.88	0.32	20.81
S_3	126.51	0.17	16.61	0.86	0.32	20.69
'F' test	Sig	NS	Sig	Sig	NS	Sig
SE(m) ±	1.13	0.01	0.16	0.02	0.01	0.25
CD @ 5%	3.39		0.48	0.06		0.75
Fertigation levels (F)						
F_1	81.53	0.13	13.51	0.49	0.29	17.53
F_2	120.97	0.19	17.01	0.98	0.33	19.91
F_3	152.56	0.21	18.47	0.98	0.32	20.40
'F' test	Sig	NS	Sig	Sig	S	Sig
SE(m) ±	1.13	0.04	0.16	0.02	0.01	0.25
CD @ 5%	3.39		0.48	0.06		0.75
Interaction effect (S × F)						
$S_1 F_1$	84.66	0.13	14.43	0.79	0.32	16.20
$S_1 F_2$	107.03	0.18	18.33	0.69	0.32	16.27
$S_1 F_3$	115.68	0.16	16.94	0.64	0.29	16.53
$S_2 F_1$	79.36	0.14	12.97	0.38	0.27	18.01
$S_2 F_2$	131.07	0.21	16.17	1.22	0.34	21.63
$S_2 F_3$	167.87	0.22	18.32	1.04	0.33	22.80
$S_3 F_1$	80.57	0.12	13.13	0.30	0.28	18.39
$S_3 F_2$	124.82	0.19	16.53	1.03	0.33	21.83
$S_3 F_3$	174.12	0.22	20.17	1.27	0.34	21.85
'F' test	Sig	NS	Sig	Sig	-	Sig
SE(m) ±	1.95	0.03	0.28	0.02	0.02	0.44
CD @ 5%	5.85		0.84	0.06		1.32

interaction effect of planting geometry and fertigation levels were found significant on the green fruit yield per plant in kilogram. The maximum green fruit yield per plant in chilli was recorded under S_3F_3 and the minimum green fruit yield per plant was recorded by the treatment S_3F_1. The total yield increased with higher planting densities. This was probably due to increase in the number of plants per unit area, which might be contributed to the production of extra yield per unit area leading to high yield (Aminifard *et al,* 2012). Lower planting densities per unit area produces more vigorous crops than at higher population density, but this could not compensate for a reduced number of plants per unit area.

Higher fruit yield per plant in the treatment combination S_3F_3 may be due higher plant population and fertigation of optimum levels of RDF which supplied best amount of fertilizer, thereby increased plant height, increased leaves, increased leaf area, and dry matter production and due to increased length of fruit and fruit girth, which enhanced the yield. The results clearly demonstrated the advantage of fertigation over soil application of N and K fertilizers and irrigation by drip method. The increased chilli yield under drip fertigation can be attributed to the uniform distribution and adequate availability of water around the root zone. The increased yield under fertigation may be due to the efficient use of nutrients at various stages of crop growth and relatively less leaching and runoff loss of nutrients. Also, this might be attributed by highest fertilizer use efficiency of water soluble fertilizers. Similar results were reported in chillies by Sanchita *et al* (2010) in capsicum.

Quality parameters

The data (Table 3) of quality parameters *viz*., ascorbic acid, chlorophyll content in fruit was registered maximum in the closer spacing S_3 and 80% RDF through fertigation (F_3). Highest crude protein content was recorded at moderate plant spacing S_2 (90 × 60 cm and 80% RDF through fertigation (F_3). Significantly the highest amount of ascorbic acid was registered in S_3F_3 The maximum leaf and fruit chlorophyll content was registered by the same treatment combination and it was found on par with S_2F_2 with respect to fruit chlorophyll content**.** The highest crude protein content was registered in S_2F_3 which were found on par with S_3F_3, S_3F_2, S_2F_2. The capsaicin and carotenoids content was significantly not influenced by the levels of planting geometry and fertigation.

Increase in ascorbic acid content (Table 3) might be due to closest spacing, resulted to increase plant competition for nutrients and water, and thus enhanced the vital metabolic activity and production of organic acids. The results of present study were in accordance with the findings of Aminifard *et al* (2012) in capsicum. This might be due to the slow but continuous supply of all major and micro nutrients in F_3 treatment, which might have resulted in the assimilation of carbohydrates and in turn synthesis of ascorbic acid.

Nitrogen is the main constituent of all amino acids in proteins and lipids that act as structural compounds of the chloroplast. The results were in conformity with the findings of Verma and Guhey (2012). The total chlorophyll content, leaf N concentration and shoot dry weight of pepper increased with increasing N fertilization. Amended with 80 and 100 per cent RDF through fertigation proved to accumulate more nitrogen in plant tissues than those with only fertigation. This might be attributed to the enhanced metabolic activity of the plants under frequent fertigation resulting in increased protein synthesis. The positive influence on crude protein content due to potassium was noticed by Rani and Jose (2009).

CONCLUSION

From economic point of view, the individual effect of planting geometry S_3 (90 cm × 45 cm) and 80per cent RDF through fertigation (F_3) were found to be the best treatment. The interaction effect of the treatment combination S_3F_3 were found superior for achieving maximum growth, higher yield per unit area and better quality fruit in chilli, in addition to 20 per cent saving of cost of chemical fertilizers were applied through fertigation.

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