Environment & Ecology 29 (2A) : 790—795,
 ISSN 0970-0420

Effect of Spacings and Different Levels of Fertilizer Dose on Quality and Nutrient Uptake in Bell Pepper under Shade Net Condition

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Abstract

An experiment was conducted in shade net condition to study the effect of spacings and different levels of fertilizer on quality of bell pepper, nutrient uptake and nutrient availability in soil during *kharif* of 2008. The results revealed that chlorophyll content of leaves and chlorophyll content of fruit was maximum in medium spacing S_2 (45 × 30 cm) and fertilizer level F_6 (150 kg each NPK/ha) + FYM (30 t/ha). Leaf area index was maximum in spacing S_1 (45 × 45 cm) and fertilizer level F_6. The treatment combination S_3 at F_6 recorded higher uptake of nutrients (152.23, 18.93 and 148.89 kg/ha ; N, P and K, respectively). The available nutrient was maximum in treatment combination S_1 at F_1 (208.20, 23.32 and 213.67 kg/ha ; N, P and K, respectively.

Key words : Bell pepper, Fertilizer, Economics, Spacing, Fertilizer dose.

The genus *Capsicum* belongs to the family Solanaceae which is believed to be the native of tropical South America (1). The bell pepper (*Capsicum annum* L. var Grossum Sendt. ; 2n = 24) is commonly known as sweet pepper, bell pepper, *Capsicum* or green pepper. Normally these bell peppers differ from hot peppers in size and shape of the fruits, capsicin content and usage. Bell pepper is one of the highly remunerative vegetables cultivated in most parts of the world especially in temperate regions of Central and South America and European countries. Similarly it is also grown in tropical and sub-tropical regions of Asian continent. In the world, area and production of bell pepper is merged with that of hot pepper (chilli pepper). Hence, the exact statistics related to bell pepper or chilli as whole is given. Holland is the major exporter of bell peppers and it meets the requirements of Indian expatriates in South East Asia, Gulf countries and to some extent in UK. Annual world production of capsicum in 2007 amounted to 27.46 million metric tonnes from an area of 1.72 million hectare (2). India's contribution was estimated to be 50, 500 thousand metric tones from an area of 5, 500 thousand hectares (3).

Methods

The experiment was conducted on the effect of spacings and different levels of fertilizer dose on quality of bell pepper, nutrient uptake and availability of nutrient in soil under shade house condition during *kharif* of 2008 at Horticulture orchard, Raichur which is situated in North Easstern Dry (Zone-2) of Karnataka at $16^0 12'$ N latitude and $77^0 20'$ E longitude with an altitude of 389 meters above the mean sea level. Eighteen treatment combinations comprising different levels of fertilizer were allotted in main plots S_1 (45 × 45 cm), S_2 (45 × 30 cm) and S_3 (30 × 30 cm) and different levels of fertilizer in sub-plots (F_1 : FYM alone, F_2 : Vermicompost alone (15 t/ha), F_3 : 50% FYM + 50% vermicompost, F_4 : 50% FYM + 50% RDF, F_5 : 50% vermicompost + 50% RDF and F_6 : RDF + FYM). The experiment was laid out in split-plot design with three replications. The experimental field was clayey (49.59% clay) in texture with the available nitrogen of 192.12 kg/ha, phosphorus (19.28 kg/ha) and potassium (203.63 kg/ha) with organic carbon content of (0.61%). The seeds of cv Indra were sown during the first week of the August 2008.

Results and Discussion

The response of different level of nutrient was reflected in leaf area index. Maximum leaf area index was noticed in F_6 (RDF + FYM) at all stages of crop growth. Leaf area index was measured by instrument

Table 1. Effect of spacings and different levels of fertilizer on leaf area index (LAI cepto meter) of capsicum in shade net. DAT : Days after transplanting, NS : Non-significant. Main plot Spacing : S_1 45 cm × 45 cm, S_2 45 cm × 30 cm, S_3 30 cm × 30 cm. Sub-plot fertilizer combination : F_1 FYM alone, F_2 Vermicompost alone, F_3 50% + FYM + 50% vermicompost, F_4 50% FYM + 50% RDF, F_5 50% vermicompost + 50% RDF, F_6 RDF + FYM.

Treatments	30 DAT				60 DAT				90 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
F_1	0.72	0.79	0.45	0.65	0.82	0.84	0.65	0.87	1.09	0.88	0.87	0.95
F_2	0.81	0.75	0.41	0.66	0.94	0.95	0.61	0.87	1.07	1.09	0.87	1.01
F_3	0.83	0.76	0.62	0.74	0.97	0.82	0.78	0.97	1.15	1.01	0.97	1.04
F_4	0.85	0.65	0.62	0.74	1.04	0.79	0.93	0.99	1.16	1.03	0.99	1.06
F_5	1.01	0.95	0.72	0.89	0.93	1.08	0.77	1.11	1.12	1.17	1.11	1.13
F_6	1.35	0.89	0.62	0.96	1.09	1.01	0.89	1.01	1.28	1.25	1.01	1.18
Mean	0.95	0.80	0.57	0.77	0.96	0.92	0.77	0.97	1.14	1.07	0.97	1.06
	SE ±		CD at 5%		SE ±		CD at 5%		SE ±		CD at 5%	
Spacing (S)	0.04		0.15		0.02		0.08		0.02		0.06	
Fertilizer (F)	0.06		0.18		0.03		0.09		0.03		0.08	
F at same S	0.11		NS		0.05		0.16		0.05		0.14	
S at same or different F	0.11		NS		0.05		0.16		0.05		0.13	

Table 1. Continued.

Treatments	120 DAT				150 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
F_1	1.04	0.84	0.63	0.84	0.69	0.72	0.48	0.63
F_2	0.90	0.92	0.62	0.82	0.67	0.69	0.47	0.61
F_3	0.93	0.84	0.67	0.81	0.79	0.62	0.65	0.69
F_4	0.90	0.72	0.84	0.82	0.76	0.63	0.59	0.66
F_5	0.89	0.96	0.88	0.91	0.72	0.77	0.71	0.73
F_6	1.17	1.12	0.80	1.03	0.93	0.83	0.73	0.83
Mean	0.97	0.90	0.74	0.87	0.76	0.71	0.61	0.69
	SE ±		CD at 5%		SE ±		CD at 5%	
Spacing (S)	0.02		0.08		0.02		0.08	
Fertilizer (F)	0.05		0.14		0.03		0.07	
F at same S	0.08		NS		0.04		0.13	
S at same or	0.08		NS		0.04		0.13	

ceptometer (4). There was gradual increase in leaf area index with advancing age of crop and reached the highest value at 90 DAT. The leaf area index declined at final harvest due to senescence and leaf fall. The highest level of N and P resulted in the highest LAI at all stages of F_6 treatment. The effect of nitrogen on protein syntheses and meristematic growth through hormonal synthesis could have helped leaf production and expansion. A similar trend was observed by Maya et al. (5) in bell pepper under shade net condition.

Chlorphyll content in bell pepper cv Indra leaves were maximum in medium spacing S_2 (45 × 30 cm) followed by closer spacing S_3 (30 × 30 cm) at all stages of crop growth. The chlorophyll concentration in the leaves was measured by using the instrument SPAD chlorophyll meter (Spad 502, Konica minolta sensing inc. Japan) following the method of Peterson et al. (4). SPAD chlorophyll meter readings were recorded at 30, 60, 120 and 150 days after transplanting on third fully expanded leaf from top.

Chlorophyll content of leaves increased up to 90 days then decreased at 120 and 150 DAT because of production of carotenoid pigment at later stage of plant growth which leads to decrease in chlorophyll content of leaves. Similar findings were reported by Maya et al. (5) in capasicum. At different levels of treatment, F_6 receiving (RDF + FYM) has shown the maximum chlorophyll content of leaves. Chlorophyll and other pigments did not exist singly within the chloroplast but always associated with proteins, forming complex structures. The formation of chlorophyll

Table 2. Effect of spacings and different levels of fertilizer on chlorophyll content of leaves (SPAD) of capsicum in shade net. DAT : Days after transplanting, NS : Non-significant. Main plot spacing : S_1 45 cm × 45 cm, S_2 45 cm × 30 cm, S_3 30 cm × cm. Sub-plot fertilizer combination : F_1 FYM alone, F_2 Vermicompost alone, F_3 50% FYM + 50% Vermicompost, F_4 50% FYM + 50% RDF, F_5 50% Vermicompost + 50% RDF, F_6 RDF + FYM.

Treatment	30 DAT				60 DAT				90 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
F_1	59.21	61.32	62.60	61.04	62.65	65.81	60.97	63.14	52.56	72.15	74.96	66.56
F_2	60.67	63.38	59.53	61.19	56.53	67.08	64.15	62.59	54.35	76.90	71.97	67.74
F_3	61.95	64.39	58.67	61.67	53.33	82.67	55.33	63.78	58.08	74.73	66.55	66.45
F_4	54.00	63.01	64.17	60.04	67.00	54.41	68.78	63.40	61.07	75.57	65.67	67.44
F_5	62.01	66.57	65.33	64.64	60.67	73.92	73.67	69.42	64.85	79.99	77.05	73.96
F_6	65.77	69.15	67.89	67.60	68.00	76.15	77.17	73.87	76.03	78.83	67.89	74.25
Mean	66.60	64.64	63.03	62.76	61.41	70.01	68.68	66.03	61.16	76.36	70.68	69.40
	SE ±		CD at 5%		SE ±		CD at 5%		SE ±		CD at 5%	
Spacing (G)	1.34		NS		1.64		6.44		1.69		6.64	
Fertilizer (F)	1.64		4.75		2.66		7.67		2.14		6.19	
F at same S	2.85		NS		4.60		13.29		3.71		10.73	
S at same or	2.92		NS		4.51		13.03		3.79		10.94	

Table 2. Continued.

Treatments	120 DAT				150 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
F_1	50.54	74.72	63.77	63.01	57.44	53.27	51.53	54.08
F_2	51.31	77.52	67.29	65.37	58.12	60.18	54.89	57.73
F_3	56.08	68.33	69.59	64.67	55.10	64.00	57.06	58.72
F_4	57.86	71.23	66.42	65.17	58.21	56.12	56.92	57.41
F_5	61.24	70.41	72.50	68.05	55.45	65.73	57.98	59.72
F_6	65.30	73.77	72.98	70.68	52.73	71.57	64.18	62.83
Mean	57.05	72.66	68.76	66.16	56.18	61.98	57.09	58.42
	SE ±		CD at 5%		SE ±		CD at 5%	
Spacing (S)	1.03		4.03		0.89		3.50	
Fertilizer (F)	1.60		4.63		1.74		5.02	
F at same S	2.78		8.02		3.01		8.69	
S at same or different F	2.74		7.90		2.89		8.34	

complex is a necessary condition for chlorphyll biosynthesis. This accounts for the positive relationship between chlorophyll and N present in RDF and FYM. Similar findings were noticed by Maya et al. (5) in bell pepper.

Chlorophyll content of fruit was maximum in medium spacing S_2 (45 × 30 cm) followed by closer spacing S_3 (30 × 30 cm). In different levels of fertilizer treatment F_6 (RDF + FYM) has maximum chlorophyll content of fruit at all stages of crop growth. The estimation of chlorophyll content in fresh fruit was carried out following standard (6). For this purpose 500 mg of fresh fruit sample was collected individually from five fruits of each treatment. Fifteen ml of dimethyl sulfoxide (DMSO) taken into test tubes containing fruit pieces and incubated overnight. The colored solution was then decanted into measuring cylinder. The OD values were recorded at 645 and 663 nm using a spectrophotometer model UV 200. The total chlorophyll was calculated by using the formulae and expressed in mg per g fresh weight.

Chlorophyll content was recorded highest at 90 day after transplanting. Later there was a gradual decline in chlorophyll content in the fruit. Carotenoid increases with attainment of maturity of chilli. It may be said that along with fruit development in chilli, chloroplast is transformed into chromoplast and the same time carotenoid synthesis begins. These results are in accordance with the results obtained by Saga (7) in capsicum.

Table 3. Effect of spacings and different levels of fertilizer on total chlorophyll content of fruit (mg/g) of capsicum in shade net. DAT : Days after transplanting, NS : Non-significant. Main plot spacing : S_1 45 cm × 45 cm, S_2 45 cm × 30 cm, S_3 30 cm × 30 cm. Sub plot fertilizer combination : F_1— FYM alone, F_2— Vermicompost alone, F_3 50% FYM + 50% Vermicompost, F_4 —50% FYM + 50% RDF, F_5 —50% Vermicompost + 50% RDF, F_6—RDF + FYM.

Treatments	60 DAT				90 DAT				120 DAT				150 DAT			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
F_1	0.20	0.18	0.21	0.20	0.16	0.23	0.21	0.20	0.22	0.31	0.24	0.26	0.16	0.23	0.20	0.20
F_2	0.14	0.17	0.16	0.16	0.16	0.24	0.22	0.21	0.23	0.28	0.31	0.27	0.16	0.24	0.22	0.21
F_3	0.17	0.15	0.20	0.17	0.16	0.28	0.21	0.22	0.20	0.32	0.28	0.27	0.16	0.24	0.21	0.2
F_4	0.16	0.18	0.16	0.17	0.21	0.24	0.23	0.22	0.22	0.31	0.24	0.26	0.16	0.24	0.23	0.21
F_5	0.18	0.25	0.17	0.20	0.17	0.3	0.25	0.24	0.17	0.33	0.29	0.27	0.17	0.29	0.37	0.28
F_6	0.18	0.28	0.19	0.22	0.26	0.42	0.23	0.30	0.30	0.42	0.32	0.35	0.21	0.44	0.23	0.29
Mean	0.17	0.20	0.18	0.19	0.19	0.28	0.23	0.23	0.22	0.33	0.28	0.28	0.17	0.28	0.24	0.23
	SE ±		CD at 5%		SE ±		CD at 5%		SE ±		CD at 5%		SE ±		CD at 5%	
Spacing (S)	0.005		0.02		0.01		0.03		0.01		0.03		0.02		0.08	
Fertilizer (F)	0.01		0.04		0.01		0.03		0.01		0.03		0.02		0.06	
F at same S	0.02		0.06		0.02		0.06		0.02		0.06		0.04		NS	
S at same or different F	0.02		0.06		0.02		0.06		0.02		0.06		0.04		NS	

Higher plant density under closer sapacing (30 × 30 cm) was found to utilize more amount of nutrients, which resulted in significant increase in uptake of nitrogen (140.40 kg/ha), phosphorus (15.22 kg/ha) and potassium (137.30 kg/ha) by capsicum crop compared to the wider spacing of 45 × 45 cm. It is due to more number of plant per unit area. Kacha et al. (8) in chilli also reported similar results. In spacings, available nitrogen, phosphorus and potassium in the soil estimated after the harvest of the crop found to be significant in available phosphorus. With respect to fertilizer dose available nutrient was maximum in treatment F_1(203.67, 20.91 and 210.33 kg/ha nitrogen phosphorus and potassium respectively).

Interaction Effect of Spacing and Fertilizers

Interaction also produced significant effects on LAI values except on 30 and 120 DAT. F_6 fertilizer level recorded maximum leaf area index at all stages of

Table 4. Uptake and available nitrogen, phosphors and potassium in plant after the final harvest of capsicum as in influenced by spacings and different levels of fertilizer in shade net.

Treatments	Uptake of nutrient (kg/ha)			Available nutrient (kg/ha)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
Spacings						
S_1	135.08	12.99	136.36	194.58	20.81	205.46
S_2	138.31	13.49	136.75	190.98	19.05	204.46
S3	140.40	15.22	137.30	190.78	17.98	200.97
SE ±	1.06	0.32	1.90	2.49	0.36	1.00
CD at 5%	NS	NS	NS	NS	1.43	NS
Fertilizer Levels						
F_1	124.50	12.41	126.19	203.67	20.91	210.33
F_2	126.68	12.98	126.68	198.51	20.54	203.16
F_3	136.00	13.05	135.12	186.74	18.90	206.80
F_4	142.29	13.82	137.39	188.64	20.00	205.77
F_5	146.55	15.17	142.88	187.58	18.09	197.73
F_6	151.57	15.94	149.34	184.55	17.23	198.00
SE ±	1.74	0.32	2.21	2.55	0.33	1.00
CD at 5%	5.23	NS	6.39	7.38	0.97	NS

Table 4. Continued.

Treatments	Uptake of nutrient (kg/ha) Nitrogen	Phosphorus	Potassium	Available nutrient (kg/ha) Nitrogen	Phosphorus	Potassium
Interaction						
S_1F_1	121.04	11.85	123.55	208.20	23.32	213.67
S_1F_2	127.21	12.09	120.69	206.83	22.39	201.33
S_1F_3	131.81	13.29	131.26	192.90	19.85	208.33
S_1F_4	136.26	12.87	136.36	188.77	21.80	206.67
S_1F_5	141.60	13.40	143.17	188.48	18.91	197.07
S_1F_6	152.58	14.43	163.14	182.92	18.57	205.69
S_2F_1	126.08	11.91	129.03	202.88	21.21	208.33
S_2F_2	127.63	13.34	128.05	190.54	20.27	205.00
S_2F_3	133.55	13.13	134.90	193.39	18.69	213.01
S_2F_4	143.27	13.93	140.55	191.18	19.55	209.67
S_2F_5	149.45	14.16	138.93	184.10	17.75	197.43
S_2F_6	149.90	14.46	149.05	183.80	16.83	193.33
S_3F_1	126.40	13.48	126.00	199.93	18.19	209.00
S_3F_2	125.19	13.50	131.30	198.15	18.96	203.13
S_3F_3	142.63	12.74	129.21	182.93	18.15	199.07
S_3F_4	147.35	14.67	135.26	186.57	18.66	200.97
S_3F_5	148.60	17.97	143.16	190.17	17.60	198.70
S_3F_6	152.23	18.93	148.89	186.93	16.30	194.97
F at the same S						
SE ±	3.02	0.77	3.83	4.42	0.58	3.49
CD at 5%	NS	2.24	NS	NS	NS	10.00
S at same or different F						
SE ±	2.95	0.78	3.98	4.74	0.64	3.34
CD at 5%	NS	2.25	NS	NS	NS	9.65

crop growth. The fertilizer levels F_6 and F_5 significantly possessed the higher LAI values at S_1 spacing. After S_1, the S_2 had significantly the higher LAI values at F_6 level at all stages stages followed by S_3. Similar findings were reported by Sharma and Peshin (9) in capsicum under shade house.

The interaction of chlorophyll content of leaves was non significant at 30 DAT. F_6 has recorded the maximum chlorophyll content of leaves in F_6 followed by F_5. In respect to spacing, maximum chlorophyll content of leaves was noticed in S_2 followed by S_3. In treatment combination S_2 at F_6 level of fertilizer recorded maximum chlorophyll content of leaves at all stages of crop growth.

Interaction effect of spacing and fertilizer level was found to be non significant at 150 DAT. Among fertilizer level F_6 recorded the maximum chlorophyll content of fruit compare to other fertilizer levels. Maximum chlorophyll content of capsicum fruit found in S_2 at F_6 (0.28, 0.42, 0.42 and 0.44) at 60, 90, 120 and 150 DAT, respectively.

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