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RESPONSE OF GREEN CAPSICUM TO DIFFERENT IRRIGATION AND FERTIGATION SCENARIO UNDER PROTECTIVE CULTIVATION

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Abstract: *An experiment was carried out at Hi-Tech project, Central Campus of the University on sandy loam soil for three years (2007 to 2010) under protective cover i.e. shed net house. The study concluded that green capsicum crop showed positive response to higher levels of irrigation and exponential response to nutrients levels when these inputs were individually applied. But when irrigation and nutrients were associated and applied with higher levels, the crop responded and yield increase. The economic analysis concluded that the returns and net income were influenced by productivity and the B: C ratio for all treatments was more than one, under protective cultivation, which showed that the capsicum crop was found more economical under protective cultivation.*

Key Words: *Protective cover, Shed net, Net benefits, B:C ratio, capsicum, Drip irrigation.*

Protective cultivation provides the potential vicinity for higher production of vegetables and other horticultural produces (Singh, *et al,* 2003) with excellent quality over the year under adverse climatic conditions. The protective cultivation provides optimum climatic conditions for crop growth and results into higher yield. The green capsicum is one of the important vegetable grown under protective cultivation and it is mostly used in salads and staffed vegetables. The protective cultivation provides optimum climatic conditions for capsicum for germination (Pathania & Sharma, 2003) growth (Atre, *et al*, 2003; Singh *et al*, 2003) and yield (Thorat *et al*, 2008). The capsicum crop also response well to irrigation and fertigation levels. The split application of nutrients to crop improves the growth and yield of capsicum (Khurana *et al*, 2006; Tumbare *et al* 2007).

These results verified that capsicum crop needs favorable climatic conditions and proper irrigation and fertigation management practices for enhancing the better growth and yield. The information regarding irrigation scheduling, irrigation depth, fertigation levels and split application, combine results of irrigation and fertigation levels on growth and yield of capsicum is deficient. Therefore an attempt was made to determine the individual and combine effect of irrigation and fertigation on capsicum crop under protective cultivation in terms of water use efficiency, nutrient use efficiency, yield and benefits obtained

Material and Methods

The experiment was carried out at Hi-Tech project, Central Campus of the University on sandy loam soil for three years (2007 to 2010). The experiment was executed in semi-circular type protective shed having 200 µ UV stabilized film on the roof of the shed to protect the crop from heavy rainfall (>3000 mm) and sides were covered with 50 per cent off white(black and white)over 484 m^2 (44 m x 11m) area. The experiment was carried out in split plot design with three main plot treatments (Irrigation levels, I-1; I-2 and I-3) and three sub plot treatments (Fertigation levels, F-1; F-2 and F-3) along with control. The different treatments (T-1 to T-9) consist of combination of irrigation and

fertigation levels *viz.,* T-1 = (I-1 F-1). The main plot treatment consisted of three irrigation levels with alternate day irrigation through drip irrigation viz. 60 %, 80 % and 100 % of pan evaporation and sub-plot treatments includes three fertigation levels viz. 80 %, 100 % and 120 % of recommended dose of (280: 30:415 NPK kg/ha) through liquid fertilizers of various grades (19:19:19, 0:52:34 and 46:0:0) in thirteen equal split doses. The control treatment consists of 30 mm depth of irrigation water after every 3 days interval through ridge and furrow irrigation method. The recommended dose of fertilizer was applied as per the recommended practices i.e. half nitrogen and full P and K applied at the time of transplanting and half nitrogen at the time of flowering. The healthy seedlings of California Wonder were transplanted at spacing of 0.30 m x 0.45 m on raised bed having dimensions of 40 m x 0.70 m x 0.15 m. The one 16 mm Ø LLDPE lateral with 4 lph in-line drippers irrigated the two rows. After establishment of the seedlings the irrigation and fertigation scenario was implemented.

Results and Discussion

The monthly water requirement of capsicum crop under different irrigation levels is showed in Table. 1. It is seen that water requirement of capsicum was more in the months of February and March in all irrigation levels due to the development stage of the crop and higher rate of evaporation .The total amount of water applied to the crop was 326.2 mm, 434.9 mm and 543.6 mm respectively in irrigation levels I-1, I-2, and I-3. It resulted in watering saving as 63.15 %, 50.86 % and 30.58 % over the control (885 mm). The least amount of water was applied in irrigation level I-1 due to 60% of pan evaporation results in higher water saving, While the maximum amount of water was applied in irrigation level I-3 (100% of pan evaporation) results in lesser water saving.

From Table 2, it is observed that the production of green capsicum per unit area was more in irrigation level I-3 (100 % PE) followed by I-2 (80 % PE). The productivity per unit depth of water applied was less in irrigation level I-3 followed by I-2. The maximum water use efficiency was observed in I-1(60% PE). The water use efficiency for different irrigation levels was ranges from 9.00 gm/lit to 12.53 gm/lit. The yield obtained in irrigation level I-3 (100 % PE) was more as compared to other levels but the water use efficiency was less. The low productivity in irrigation level I-3 due to more application of water (543.6 mm) than other levels. While in irrigation level I-1 (60 % PE) the yield was less (4.09 gm/m^2) and application of water was also less which results in higher water use efficiency. These results indicated that the green capsicum response well to higher level of irrigation in terms of water use efficiency.

From Table 2, it is observed that the water productivity was maximum in irrigation level I-1 and minimum in irrigation level I-3. These results indicated that water productivity is directly proportional to the net income obtained. The maximum net come was observed in irrigation level I-3 followed by I-2. The water productivity for different fertigation levels was ranges from 0.17 to 0.18. The maximum water productivity was found in fertigation level F-2 (100% RD) due to maximum yield and net income. These results indicated that under or over application of fertilizers along with less water (60%PE) will not influence the yield of the crop as well as net income.

The nutrient use efficiency was maximum in fertigation level F-1 (80 % RD) followed by F-2 (100 % RD). The production of the green capsicum was maximum in fertigation level F-2 (4.76 kg/m^2) followed by fertigation level F-3 (4.51 kg/m^2). These results indicated that capsicum crop response well to recommended dose of fertilizers. These results also indicated that the increase or decrease in fertilizer level by 20 per cent, the reduction in yield was 5.5 per cent to 24.2 % respectively. It is also observed that the yield of capsicum was more in irrigation I-3(100 % PE) when the fertigation levels were constants, similarly for fertigation level F-2 (100 % RD) yield was more (4.76 kg/m^2) when irrigation levels were constant. These results indicate that the capsicum crop showed positive response to higher level of irrigation and exponential response to fertigation levels. These results indicated that under limited water supply increase in fertigation level will not

supportive to yield. Therefore the response of capsicum under different combination of irrigation and fertigation levels was also studied and results are depicted in Table. 3.

The combine effect of different irrigation and fertigation levels showed that the yield of capsicum was ranges from 3.52 kg/m^2 to 5.96 kg/m^2. These results indicated that for combine application of higher levels of irrigation and fertigation the capsicum crop responses well. In treatment T-3, it was observed the yield was decreased due to limited water application I-1 (60 % PE) and increase in fertigation level (120 % RD). Similar results were also observed in treatment T-6. The water use efficiency was ranges from 14.53 gm/lit to 7.17 gm/lit for various treatments.

The nutrient use efficiency for various treatments was ranges from 40.46 to 77.24. The minimum nutrient use efficiency was observed in treatment T-3 (60 % PE, 120 % RD). These results showed that under limited water application the nutrients availability to capsicum was not proper or might be due to high concentration of nutrients which affect the uptake of nutrients. The maximum nutrient use efficiency was found in treatment T-4 (80 % PE, 80 % RD). The maximum nutrient use efficiency was achieved due to appropriate use of nutrients with irrigation water.

From Table 3, it is also observed the maximum cost of production of Rs. 35.84/m^2 was found in treatment T-9 (100% PE, 120% RD) due to more application of water and higher dose of nutrients and minimum in treatment T-1 (100% PE, 120% RD) due to lower level of irrigation and fertigation. The cost of irrigation in treatments T-2, T-5 and T-8 was fewer and hence the cost of production in treatment T-2, T-5 and T-8 was found at par. The returns obtained in various treatments were ranged from Rs. 88/m^2 to Rs. 149/m^2. The minimum returns Rs. 88/m^2 was recorded in treatment T-3 (60% PE, 120% RD) due less yields obtained (3.52 kg/m^2) and higher level of fertigation. While treatment T-9 recorded maximum returns (Rs. 149/m^2) due to maximum yield (5.96 kg/m^2).. The maximum net income was obtained in treatment T-9 followed by T-8. The minimum net income was recorded in treatment T-3.

The water productivity is the ratio returns obtained to the depth of water applied. From Table 3, it is observed that the water productivity was ranges from 0.12 to 0.26 Rs/mm. The water productivity was more in T-2 due to less application of water (60% PE). While minimum water productivity was in T-7 due to more application of water (100% PE). These results showed that the water productivity was directly affected by the net returns. The net returns were influenced by the yield of the crop.

These results showed that the returns and net income were influenced by yield of the capsicum. The B: C ratio for all treatments was more than one, which showed that under protective cultivation capsicum crop found economical. The maximum B: C ratio of 3.10 was observed in treatment T-9 due to maximum net income obtained. While the minimum B: C ratio of 1.47 was obtained in treatment T-3 (60% PE, 120% RD) due to fewer yields obtained

Conclusions

Based on the above results the three years study concluded that the green capsicum crop showed positive response to higher levels of irrigation and exponential response to nutrients levels when individually applied. But when irrigation and nutrients were associated and applied with higher levels the crop responses very well. The study also indicated that under limited water supply increase in nutrient level will not supportive to yield because the availability of nutrients to capsicum was not proper or might be due to high concentration of nutrients which affect the uptake of nutrients.

The economic analysis concluded that the returns and net income were influenced by yield/production of the capsicum crop. The B: C ratio for all treatments was more than one, under protective cultivation which results that the capsicum crop found economical under protective cultivation.

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Table 1: Monthly pan evaporation and irrigation water applied (mm)

Months	Pan evaporation	I-1 (60%PE)	I-2 (80%PE)	I-3 (100%PE)	Control
December	95.1	63.4	84.6	105.7	210
January	110.4	73.6	98.1	122.7	240
February	127.0	84.7	112.9	141.1	180
March	156.5	104.3	139.1	173.8	255
Total	489.0	326.2	434.9	543.6	885
% saving		63.15	50.86	38.58	

Table 2: Water Use efficiency (gm/lit), Water productivity (Rs/mm), Nutrient Use Efficiency (gm/gm), and Net income (Rs/m²)

Levels	Yield (kg/m²)	Water applied (mm)	Water use efficiency (gm/lit)	Water productivity (Rs/mm)	Nutrient applied (g/m²)	Nutrient Use efficiency (gm/gm)	Net income (Rs/m²)
Irrigation levels							
I-1(60%PE)	4.09	326.2	12.53	0.21	72.5	56.41	69.62
I-2 (80%PE)	4.41	434.9	10.13	0.18	72.5	60.82	77.40
I-3 (100%PE)	4.90	543.6	9.00	0.16	72.5	67.58	89.43
Fertigation levels							
F-1 (80%RD)	4.13	434.9	9.49	0.17	58.0	71.20	73.35
F-2 (100%RD)	4.76	434.9	10.94	0.18	72.5	65.60	79.75
F-3 (120%RD)	4.51	434.9	10.37	0.17	87.0	51.80	76.96
	Irrigation levels		**Fertigation levels**	**Interaction (I X F)**			
SE±	**0.0175**		**0.123**	**0.030**			
CD at 5%	**0.053**		**NS**	**0.087**			

Table 3: Water use efficiency, Nutrient Use Efficiency, Cost economics and B:C ratio for various treatments

Treatment	Yield (kg/m²)	Water use efficiency (gm/lit)	NUE (gm/gm)	Water productivity (Rs/mm)	Cost of production (Rs/m²)	Returns obtained (Rs/m²)	Net income (Rs/m²)	B:C ratio
T-1 = (I-1 F-1)	4.02	12.32	69.31	0.22	29.85	100.50	70.65	2.37
T-2 = (I-1 F-2)	4.74	14.53	65.38	0.26	32.71	118.50	85.79	2.62
T-3 = (I-1 F-3)	3.52	10.79	40.46	0.16	35.57	88.00	52.43	1.47
T-4 = (I-2 F-1)	4.48	10.30	77.24	0.19	29.98	112.0	82.02	2.74
T-5 = (I-2 F-2)	4.71	10.83	64.97	0.20	32.84	117.7	84.91	2.59
T-6 = (I-2 F-3)	4.04	9.28	46.44	0.15	35.71	101.0	65.29	1.83
T-7 = (I-3 F-1)	3.90	7.17	67.24	0.12	30.12	97.5	67.38	2.24
T-8 = (I-3 F-2)	4.83	8.88	66.62	0.16	32.98	120.7	87.77	2.66
T-9 = (I-3 F-3)	5.96	10.96	68.51	0.21	35.84	149.0	113.16	3.10