J. Soils and Crops 27 (2) 54-60, Dec. 2017

ISSN 0971-2836
NAAS Rating - 4.46
Scientific Journal Impact Factor - 4.338

PROTECTIVE CULTIVATION OF VEGETABLES IN KONKAN REGION OF MAHARASHTRA STATE

U.S.Kadam[1], R.T. Thokal[2], M.S.Mane[3], S.T.Patil[4] and K. Y. Shigawan[5]

ABSTRACT

Three experiments were undertaken under protective cultivation (tunnel type green house (GH-2 type)) for different vegetable crops viz., green capsicum (2007-08 to 2009-10), broccoli (2008-09, 2009-10) and kholrabi (2007-08 to 2009-10) in Hi-Tech Project, Dr. B.S.K.K.V., Dapoli. The results of study suggested that the green capsicum, broccoli and kholrabi can be grown economically under protected cultivation in Konkan region with drip irrigation and fertigation. Capsicum and broccoli could fetch more returns under protected cultivation than growing in open field condition with tradition method. These vegetables responded well to alternate day irrigation and weekly split applications of water soluble fertilizers (WSF). Study inferred that irrigation requirement for capsicum, broccoli and kohlrabi was 54.4, 29.8 and 31.0 cm when grown under drip irrigation. The water saving for all three vegetables was observed in the range of 39 to 50 per cent over ridges and furrows method of irrigation. Vicinity of megacities and availability of transport facilities are the strengths of this region, which can be used for transforming the agricultural economy of this region by cultivating these commercial important vegetable crops under protective cultivation.

(Key words: Protected cultivation, green capsicum, broccoli, kholrabi, drip irrigation, fertigation)

INTRODUCTION

The Konkan region is bestowed with rich biodiversity. High annual rainfall of 2500 to 3500 mm, lateritic soils having high infiltration rate, sloppy terrain are some of the peculiarities of this region. The water table which is raised up to ground level in rainy season is declined drastically after December month and scarcity of water becomes normal phenomena after the month of March every year. Close vicinity to the megacities like Mumbai and Pune and availability of transport facilities (through road and Konkan railways) are the strengths of this region. However, lateritic soils coupled with sloppy terrain have imposed constraints on the cultivation of vegetables. These crops are generally cultivated in open field with traditional irrigation systems. Looking into the water scarcity problem in the region during *rabi* and summer seasons and demand of these vegetables in mega-cities as well in local markets, the present study was undertaken in the tunnel type green houses (GH-2 type) on different commercially important vegetable crops like green capsicum, color capsicum, broccoli and kholrabi.

Protective cultivation that is cultivation in greenhouse provides potential area for higher production of vegetables and other horticultural produce (Singh *et al.,* 2003) with excellent quality round the year even in adverse climatic conditions (Von, 1999). The protective cover provides favorable climate condition for capsicum for germination (Pathania and Sharma, 2003), growth (Singh *et al.,* 2003 and Brar, 2006) and yield (Thorat *et al.,* 2008). Beneficial effects of drip irrigation on vegetable yields and yield quality have been confirmed in the studies by Podsiadlo *et al*. (2003), and Rolbiecki and Rolbiecki (2005)

The capsicum or bell pepper is vegetable crop and mostly consumed raw in green mature forms in developed countries like Europe and United States etc. It is also consumed in red ripe forms in salads, cooked, mixed and stuffed vegetable. Capsicum performs better in cooler region as well as in winter season under irrigated condition. Capsicum can also be grown in summer season but it's yield is very low due to poor crop growth and fruit set and also severe diseases. Successful crop of bell pepper can be raised only under irrigated condition providing shed to bell peppers through poly or net houses during summer. Capsicum crop needs ideal temperature of 26-28^{0}C in day time and 16-18^{0}C in night time during flowering stage.

1. Professor and Head, Deptt. of Irrigation and Drainage Engineering, CAET, Dr.B.S.K.K.V., Dapoli
2. Chief Scientist, AICRP on Irrigation Water Management, C.E.S., Wakawali
3. Assoc. Professor, Deptt. of Irrigation and Drainage Engineering, CAET, Dr.B.S.K.K.V., Dapoli
4. Asstt. Professor, Deptt. of Irrigation and Drainage Engineering, CAET, Dr.B.S.K.K.V., Dapoli
5. Jr. Res. Assistant, Agriculture School, Lanja, Dist. Ratnagiri

MATERIALS 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) for three different crops viz., green capsicum (2007-08 to 2009-10), broccoli (2008-09 to 2009-10) and kohlrabi (2007-08 to 2009-10) crops. An experiment was executed in semi-circular type protective shed having 200 ì 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 experiments were undertaken on capsicum, broccoli and kohlrabi crops under protected condition to study the response of crops to irrigation and fertilizer levels. The experiments were designed in split plot with 9 treatment combinations and these combinations were replicated thrice. The results of response of crops to irrigation and fertigation levels were compared with the results of crops grown under open field condition and with traditional method. The farmers traditionally grow the crops with ridges and furrows method and irrigate crops with 3 cm depth at an interval of 3 days and apply fertilizers by using ring method. The recommended dose of fertilizer application for capsicum is 280:30:45 NPK kg ha^{-1}, for broccoli is 130:20:30 NPK kg ha^{-1} and for kholrabi 100:50:50 NPK kg ha^{-1}. Thus, the experiment was set with irrigation treatments of I_1 (0.6 PE), I_2 (0.8 PE) and I_3 (1.0 PE); where 0.6, 0.8, 1.0 are the integrated factors determined by considering pan factor, crop factor/ coefficient, wetted area etc. The fertigation treatments were 80 % of RD through WSF (F_1), F_2 = 100 % of RD through WSF (F_2) and 120 % of RD through WSF (F_3). The nutrients were applied to crops under treatments through WSF with the combination of urea and 19:19:19 in weekly equal splits. During the study the observations on depth of water applied and yield of ten randomly selected plants in each treatment combination were recorded and reported.

Nursery and transplanting

The plants of capsicum (*Capsicum annum* L.), variety-California wonder; broccoli variety - Ganesh and Kholrabi (*Brassica oleracea* L.) variety- Navalkhol were raised in tray. The media of coco-pit and FYM (Farm Yard Manure) in ratio of 3:1 with 0.5 kg of SSP (Single Super Phosphate) was mixed with media. After placing seed in tray, light watering was done to provide sufficient moisture in tray for germination of seeds. The necessary temperature required for germination was maintained in trays by putting the tray in sequential manner and covering those with poly film for two days. The healthy 30 days seedlings of crops were transplanted on bed with spacing of 0.30 m x 0.45 m. Before transplanting 250 gm Single Super Phosphate was applied on each bed measuring 0.70 m x 20.5 m. The beds were irrigated to its field capacity before transplanting; so that seedlings got favorable moisture conditions for establishment. After transplanting, the drenching operation was done with help of Bavistine solution at the rate of 2 g l^{-1} to protect the seedlings from fungal infection.

Poly-house details

The plants of crops transplanted in semi circular type poly house with black and white coloured shed nets of 50 % openings for side ventilation. The dimensions of the structures were 44m (Length) X 11m (Width) X 4m (Height) with span of 4m. The foundation size was 0.45 m x 0.30 m x 0.30 m and the poly house was covered with the UV stabilized poly film of 200 µ thickness.

RESULTS AND DISCUSSION

Water application

Monthly water application to crops under experimentation and water saving in drip irrigation treatments as compared to ridges and furrow irrigation are tabulated in table 1. It is revealed that water delivered to capsicum was in the range of 54.36 to 32.62cm under drip irrigation and 88.5cm under ridges and furrow method. The water saving under drip irrigation was observed in the range of 38.6 to 63.2 per cent. Roma Kumari and Kaushal (2014) also found about 40 per cent water saving with drip irrigation while growing sweet pepper. Water delivered to broccoli was in the range of 17.87 to 29.18cm under drip irrigation and 55.5cm under ridges and furrow method. The water saving under drip irrigation was observed in the range of 46.3 to 67.8 per cent. Also water delivered to kholrabi was in the range of 18.58 to 30.98cm under drip irrigation and 61.5cm under ridges and furrow method. The water saving under drip irrigation was observed in the range of 69.6 to 69.8 per cent. The maximum water was required to grow capsicum as compared to other two crops, it was due to enhanced growing period of capsicum as well as this crop was grown during dry *rabi* season, whereas, broccoli was grown during recession of monsoon season to take an advantage of climatic condition as well as to catch market during winter season. Growing period of Kholrabi was about 85 days as well as it was grown during winter season, thus, this crop also required nearly same amount of water as that of broccoli.

Table 1. Water application to crops under different treatments and water saving

Month	Water applied to capsicum, cm (2007-08 to 2009-2010)				Water applied to broccoli, cm (2008-09 to 2009-2010)				Water applied to kholrabi, cm (2007-08 to 2009-2010)			
	I_1	I_2	I_3	Control	I_1	I_2	I_3	Control	I_1	I_2	I_3	Control
Aug	---	---	---	---	0.88	1.17	1.47	3.00	---	---	---	---
Sept	---	---	---	---	5.95	7.93	9.92	21.00	---	---	---	---
Oct	---	---	---	---	7.17	9.56	11.95	24.00	---	---	---	---
Nov	---	---	---	---	3.87	5.16	6.45	7.50	---	---	---	---
Dec	6.34	8.46	10.57	21.00	---	---	---	---	5.95	7.93	9.92	21.00
Jan	7.36	9.81	12.27	24.00	---	---	---	---	7.35	9.80	12.26	24.00
Feb	8.47	11.29	14.11	18.00	---	---	---	---	5.28	7.04	8.80	16.50
March	10.43	13.91	17.38	25.50	---	---	---	---	---	---	---	---
Total	**32.62**	**43.49**	**54.36**	**88.50**	**17.87**	**23.79**	**29.78**	**55.50**	**18.58**	**24.77**	**30.98**	**61.50**
Water saving (%) over control	63.20	50.90	38.60		67.80	57.10	46.30		69.80	59.70	49.60	

Yield of capsicum

The influence of irrigation and fertigation levels was evaluated on capsicum yield and the pooled results are iterated in table 2. The results indicated that irrigation and fertigation amounts could influence the capsicum yield independently and combinely.

Effect of irrigation levels on yield

The results pointed out that the capsicum yield increased with the increase in amount of irrigation water through drip irrigation and water application @ 1.0PE (I_3) had produced significantly highest yield of 4.78 kg/m^2 (Table 2) followed by 4.41 and 4.09 kg/m^2 in water application @ 0.8PE (I_2) and 0.6PE (I_1). Capsicum yield was found to be least in control treatment (0.13 kg/m^2). The comparison of water application and yield under these treatment I_3 and control treatment suggested that the capsicum yield can be increased by about 37 folds as compared to traditional method of cultivation in open field condition with the water saving of about 39 per cent. Lodhi *et al.* (2014) conducted an experiment on drip and furrow irrigation methods and their effects on growth and yields of the sweet pepper were observed using split plot design. The irrigation treatments were, drip irrigation with IW/CPE ratio of 0.60 (I_1), drip irrigation with IW/CPE ratio of 0.75 (I_2), drip irrigation with IW/CPE ratio of 0.90 (I_3), furrow irrigation with paired row planting (I_4) and furrow irrigation with single row planting (I_5). Best drip irrigated treatment I_2 gave an increase of 30.67% over I_4 and an increase of 33.74% over I_5. The percentage of water saving for drip irrigation treatment I_1, I_2 and I_3 were 51.01%, 39.72% and 28.73% respectively, over the furrow irrigation treatment. Irrigation treatment I_2 gives maximum yield and highest WUE.

In the present study, the comparison among irrigation levels through drip irrigation system could reveal that in case of water scarcity, one can go for either 20% to 40% water saving, however, capsicum yield may be reduced by 7.7 to 14.4%.

Effect of fertilizer levels on yield

The results also revealed that the capsicum yield increased with the increase in fertigation up to 100%RD and thereafter further increase in fertigation amount decreased the capsicum yield. Fertigation application @ 100%RD (F_2) produced significantly highest yield of 4.76 kg/m^2 (Table 2) and was at par with 120%RD (F_3). The fertigation also increased capsicum yield significantly over traditional way of fertilizer application. This must be due to the fact that the application of fertilizers in soluble form could be more effective in absorption of nutrients as compared to the traditional way of fertilizer application. The comparitive study of yield results pointed out that one can go for 80%RD fertigation, however, he may fetch about 14% less yield as compared to 100%RD fertigation.

Effect of interaction on capsicum yield

The interaction effect of irrigation and fertigation levels was also significant on capsicum yield (Table 2). The results were consistent and significant for three years. The highest and significant capsicum yield of 5.62 kg/m^2 was produced with 1.0 PE and fertigation at 120 % RD through WSF (I_3F_3) treatment combination. This might be due to the optimum moisture content to the crop during its all growth stages, while fertigation at this level of water application has made more nutrients available to the crops in the soluble form and thus, more nutrients might be used by the crop.

Yield of broccoli

The influence of irrigation and fertigation levels was evaluated on yield of broccoli and the pooled results are given in table 3. The results illustrated that irrigation

Table 2. Pooled average of capsicum yield (kg/m^2) as influenced by irrigation and fertigation treatments (2007-08 to 2009-2010)

Table 2. Pooled average of capsicum yield (kg/m^2) as influenced by irrigation and fertigation treatments (2007-08 to 2009-2010)

Treatments	F_1 (80 % RD)	F_2 (100 % RD)	F_3 (120 % RD)	Mean
I_1 (0.6 PE)	4.02	4.74	3.52	4.09
I_2 (0.8 PE)	4.48	4.71	4.04	4.41
I_3 (1.0 PE)	3.90	4.83	5.62	4.78
Mean	4.10	4.76	4.39	
	Irrigation levels	Fertilizer Levels	Interaction	
S.E. ±	0.091	0.123	0.218	
CD at 5 %	0.317	0.393	0.671	
Control				0.13

produced very less yield and thus it should not be cultivated in the open field condition. Thompson *et al.* (2002a) advocated the positive response of brocolli to drip irrigation and weekly fertigation. They also iterated that market yield of broccoli was significantly affected by fertigation and soil water tension under subsurface drip irrigation.

Effect of irrigation levels on yield

The results pointed out that the broccoli yield produced significantly highest yield of 1.14 kg/m^2 with water application of 0.8PE through drip irrigation (Table 3) and was at par with treatment I_3 i.e. water application @ 1.0PE. The comparison of water application levels indicated that water application less than 0.8PE produced very less yield confirming that the crop was under moisture stress throughout its growth period with this treatment. Water application @ 0.6PE resulted in yield reduction by about 37% as compared to 0.8PE water application. Pasakdee *et al.* (2006) conducted a three-year field study and examined effects of different irrigation application rates on leaf, stem, and floret yields, volumetric soil water content *(Pv)*, and crop water use efficiency (WUE) in organically-grown broccoli *(Brassica oleracea* L.) in two regions of California; Santa Cruz (UCSC farm) and Five Points (Harris farm). A greater *Py* was measured from the 0-15, 15-45, and 45-90 cm depths when treated at 150, 100, and 80% crop

the results, it appears that irrigation at either 80 or 100% ETc on the UCSC farm, and at 100% ETc on the Harris farm achieves the highest level of WUE.

Effect of fertilizer levels on yield

The results also revealed that the broccoli yield increased with the increase in fertigation. Fertigation application @ 120%RD (F_3) produced significantly highest yield of 1.18 kg/m^2 (Table 3). The fertigation also increased broccoli yield significantly over traditional way of fertilizer application. The comparision of yield results pointed out that one can go for 100%RD fertigation, however, he may fetch about 14% less yield as compared to 120%RD fertigation.

Effect of interaction on broccoli yield

The interaction effect of irrigation and fertigation levels was also significant on broccoli yield (Table 3). The results were consistent and significant for three years. The highest and significant broccoli yield of 1.34 kg/m^2 produced with 1.0 PE and fertigation at 120 % RD through WSF (I_3F_3) treatment combination and was non-significant with treatment 0.8 PE and fertigation at 120 % RD through WSF (I_2F_3).

Table 3. Pooled average of brocolli yield (kg/m ^{2}) as influenced by irrigation and fertigation treatments (2008-09 to 2009-2010)

Treatments	F_1 (80 % RD)	F_2 (100 % RD)	F_3 (120 % RD)	Mean
I_1 (0.6 PE)	0.45	0.79	0.92	0.72
I_2 (0.8 PE)	1.01	1.12	1.28	1.14
I_3 (1.0 PE)	0.92	1.16	1.34	1.14
Mean	0.79	1.02	1.18	
	Irrigation levels	Fertilizer Levels	Interaction	
S.E. ±	0.008	0.012	0.021	
CD at 5 %	0.029	0.036	0.063	
Control				0.0011

Yield of kholrabi

The influence of irrigation and fertigation levels was evaluated on yield of kholrabi and the pooled results are given in table 4. The results illustrated that irrigation and fertigation amounts influenced the kholrabi yield independently and combinely.

Effect of irrigation levels on yield

The results pointed out that the kholrabi yield produced significantly highest yield of 3.01 kg/m^2 with treatment I_3 i.e. water application of 1.0PE through drip irrigation (Table 4). The results also indicated that kholrabi cultivated in open field with traditional method produced less yield (1.59 kg/m^2). The results confirmed that kholrabi yield increased by about 89 per cent as well as about 50 per cent irrigation water can be saved as compared to traditional way of cultivation. Interestingly, it was seen that the yield of kholrabi was very less (1.29 kg/m^2) with water application of 0.6PE through drip irrigation and was even less than that in control treatment. This confirmed that the crop was under very much moisture stress throughout its growth period with this treatment.

Effect of fertigation levels on yield

The results also revealed that the kholrabi yield could be increased with the increase in fertigation. Fertigation application @ 120%RD (F_3) gave significantly highest yield of 2.60 kg/m^2 (Table 4) and was at par with fertigation @ 100%RD (F_2). The fertigation also could increase kholrabi yield significantly over traditional way of fertilizer application. The comparision of yield results pointed out that one may go for 100%RD fertigation, however, there may be just about 5% less yield as compared to 120%RD fertigation.

Effect of interaction on kholrabi yield

The interaction effect of irrigation and fertigation levels was also significant on kholrabi yield (Table 4). The results were consistent and significant for three years. The highest and significant kholrabi yield of 3.76 kg/m^2 could be produced with 1.0 PE and fertigation at 100 % RD through WSF (I_3F_2) treatment combination and was non-significant with treatment 1.0 PE and fertigation at 120 % RD through WSF (I_3F_3). Thus, it can be concluded that kholrabi yield can be increased with water application of 1.0PE through drip irrigation and fertigation @ 100%RD through water soluble fertilizers.

Table 4. Pooled average of kholrabi yield (kg/m^2) as influenced by irrigation and fertigation treatments (2007-08 to 2009-2010)

Treatments	F_1 (80 % RD)	F_2 (100 % RD)	F_3 (120 % RD)	Mean
I_1 (0.6 PE)	0.92	1.21	1.73	1.29
I_2 (0.8 PE)	1.90	2.41	2.77	2.36
I_3 (1.0 PE)	1.96	3.76	3.29	3.01
Mean	1.59	2.46	2.60	
	Irrigation levels	Fertilizer Levels	Interaction	
S.E. ±	0.13	0.125	0.21	
CD at 5 %	0.465	0.382	0.67	
Control				1.59

Water use efficiency (WUE) and fertilizer use efficiency (FUE)

It is also essential to study the returns from the crop (may be in terms of yield or monetary) unit^{-1} of water and fertilizer consumption. Thus, the water use efficiency (WUE) and fertilizer use efficiency (FUE) play a very important role. The WUE and FUE were determined for all vegetables under study and are tabulated in table 5.

The results in table 5 revealed that when the crops are grown under drip irrigation, the WUE for capsicum, broccoli and kohlrabi ranged between 7.17 kg/m^2 m and 14.53 kg/m^2 m, 2.50 kg/m^2 m and 5.37 kg/m^2 m and 6.33 kg/m^2 m and 12.14 kg/m^2 m, respectively. Ayas *et al.* (2011) concluded that WUE for broccoli could be achieved to 6.71 kg/m^2 in unheated greenhouse condition. The FUE for capsicum, broccoli and kohlrabi were in the range between 40.46 and 77.24, 31.07 and 70.14 and 57.64 and 188.14. This indicated that capsicum can produce highest unit^{-1} of water consumption as compared to kholrabi and broccoli. However, the yield returns of kohlrabi were found more unit^{-1} of fertilizer consumption as compared to broccoli and capsicum. The WUE and FUE for all crops were very less when crops are irrigated and fertilized with traditional methods and grown in open field. The results also showed that these vegetables respond the water application and fertigation when they are grown in protected condition and irrigated with drip irrigation by delivering proper amounts of water and fertilized through fertigation.

Table 5. Water use efficiency (WUE) and fertilizer use efficiency (FUE) of capsicum, broccoli and kohlrabi

Treatments	Water use efficiency (WUE), kg/m^2.m			Fertilizer use efficiency (FUE)		
	Capsicum	Broccoli	Kholrabi	Capsicum	Broccoli	Kholrabi
I_1F_1	12.32	2.50	4.95	69.31	31.07	57.64
I_1F_2	14.53	4.43	6.57	65.38	43.97	60.82
I_1F_3	10.79	5.12	9.26	40.46	42.39	71.75
I_2F_1	10.30	4.24	7.67	77.24	70.14	118.72
I_2F_2	10.83	4.70	9.73	64.97	62.22	120.34
I_2F_3	9.29	5.37	11.18	46.44	59.17	115.32
I_3F_1	7.17	3.06	6.33	67.24	63.34	122.69
I_3F_2	8.88	3.90	12.14	66.62	64.50	188.14
I_3F_3	10.96	4.48	10.62	68.51	61.80	137.12
Control	0.15	0.0021	2.59	1.79	0.063	79.55

Cost economics

The economic analysis of various treatment combinations for capsicum, broccoli and kohlrabi was done and is presented in table 6. The cost of production of broccoli was found less among all the crops under study as well as the highest net returns and thereby the B:C ratio of broccoli were achieved highest among all vegetables under study. Capsicum and broccoli were not found economically viable when these crops were grown with traditional method and in the open fields. Kholrabi was exception and its B:C ratio was quite high with traditional method. The results also indicated that kholrabi can be grown with traditional method in open field with very low investment as compared to drip with fertigation. However, its cultivation can be made more beneficial with adoption of drip and fertigation. Thompson *et al*. (2002b) observed results for broccoli indicated that with management of water and nitrogen inputs, including maintaining an appropriate soil water tension, subsurface drip-irrigated broccoli production can result in outcomes that are acceptable to growers, and result in minimal environmental impact.

Ayare *et al*. (2012) revealed that adoption of micro-sprinkler irrigation to green chilli production could fetch benefit : cost ratio up to 3.0 with higher water use efficiency of 272 kg/ha-cm.

The treatment wise cost analysis showed that the maximum benefit : cost ratio was achieved from broccoli and capsicum by applying irrigation water @ 1.0PE and fertigation @ 120%RD. Whereas kohlrabi cultivation can be made more profitable by applying irrigation water @ 1.0PE and fertigation @ 100% RD.

Table 6. Cost of production, net returns and benefit : cost ratio of crops under study

Treatments	Production cost (Rs./m^2)	Net returns (Rs./m^2)	B:C ratio	Productio n cost (Rs./m^2)	Net returns	B:C ratio (Rs./m^2)	Productio n cost (Rs./m^2)	Net returns (Rs./m^2)	B:C ratio
	Capsicum			**Broccoli**			**Kholrabi**		
I_1F_1	29.85	70.65	2.37	19.26	70.74	3.67	20.75	-6.95	-0.33
I_1F_2	32.71	85.79	2.62	19.69	138.34	7.02	21.63	-3.33	-0.15
I_1F_3	35.57	52.43	1.47	20.13	163.87	8.14	22.51	3.29	0.15
I_2F_1	29.98	82.02	2.74	19.33	182.67	9.45	20.82	7.68	0.37
I_2F_2	32.84	84.91	2.59	19.77	204.23	10.33	21.70	14.45	0.67
I_2F_3	35.71	65.29	1.83	20.20	235.80	11.67	22.58	18.97	0.84
I_3F_1	30.12	67.38	2.24	19.41	162.59	8.38	20.90	8.50	0.41
I_3F_2	32.98	87.77	2.66	19.84	212.16	10.69	21.78	34.62	1.59
I_3F_3	35.84	113.16	3.16	20.27	245.73	12.12	22.66	26.69	1.18
Control	20.69	-17.44	-0.84	7.44	-7.22	-0.97	10.64	13.21	1.24

REFERENCES

Ayare, B. L., R. T. Thokal, M. S. Mane, T. N. Thorat and D. J. Dabke, 2012. Effect of micro-irrigation systems and fertilizer levels on growth and yield of green chilli (*Capsicum annum*). Int. J. Agril. Engg. **5**(2): 220-224.

Ayas, S., H. Orta and S. Yazgan, 2011. Deficit irrigation effects on broccoli (*Brassica oleracea* L. Var. Monet) yield in unheated greenhouse condition. Bulgarian J. Agril. Sci. **17**(4): 551-559.

Brar, G. S., M. C. Varshneya, R. N. Sabale, S. S. Salunke and A. K. Hazari, 2006. Influence of irrigation and light levels on transpiration in capsicum under poly house. J. Agrometeorology. **8**(2):192-196.

Lodhi, A. S., A. Kaushal and K. G. Singh, 2014. Impact of irrigation regimes on growth, yield and water use efficiency of sweet pepper. Indian J. Sci. and Technol. **7**(6): 790-794.

Pasakdee, S., G. Banuelos, C. Shennan and W. Cheng, 2006. Organic N fertilizers and irrigation influence on organic broccoli production in two regions of California. J. Vegetable Sci. **12**(4): 27-46.

Pathania, P. and V. Sharma, 2003. Comparative performance of nursery of tomato (*Lycopersicon esculentum Mill.*) and capsicum (*Capsicum annum* L.) in low cost *Ladakhi* polyhouse and in open conditions under cold desert areas of Himachal Pradesh. All India Seminar on Prospects for Protective Cultivation held on December 12-13, 2003 at Ahmednagar (MS): pp. 162-164.

Podsiadlo, C., S. Karczmarczyk, R. Biczak and E. Rumasz-Rudnicka, 2003. Reakcja pomidora gruntowego na nawadnianie kroplowe i nawozenie mineralne. Fol. Hort. Supl. **2**:331-333.

Rolbiecki, R. and S. Rolbiecki, 2005. Mozliwosci uprawy patisona (*Cucurbita pepo* var. Patissonia Greb.) w warunkach nawadniania kroplowego na glebie bardzo lekkiej. Zesz. Nauk. AR Wroclaw, Rolnictwo. **86**: 447-453.

Roma Kumari and A. Kaushal, 2014. Drip fertigation in sweet pepper: A review. International J. Engg. Research and Applications. **4**(8): 144-149.

Singh, R., R. Asrey and D. D. Nangave, 2003. Studies on the performance of tomato and capsicum under medium cost greenhouse. All India seminar on Potential and Prospects for Protective Cultivation held on December, 12-13, 2003 at Ahmednagar (MS): 158-161.

Thompson, T. L., T. A. Doerge and R. E. Godin, 2002a. Subsurface drip irrigation and fertigation of broccoli: I. Yield, quality and nitrogen uptake. Soil Sci. Soc. Am. J. **66**: 186-192.

Thompson, T. L., T. A. Doerge and R. E. Godin, 2002b. Subsurface drip irrigation and fertigation of broccoli: II. Agronomic, economic and environmental outcomes. Soil Sci. Soc. Am. J. **66**: 178-185.

Thorat, P. V., A. D. Balwan and D. D. Ahire, 2008. Effect of protective cover (shed net) with different levels of fertilizers and irrigation on growth and yield of capsicum *(Capsicum annum L.)*. Unpublished B. Tech. thesis, Dr. BSKKV, Dapoli, Ratnagiri (MS).

Von, Z., 1999. Greenhouse structures. Ecosystem of the World's 20 Greenhouse. Elsevier, Amsterdam.

Rec. on 2.09.2016 & Acc. on 7.10.2016