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ESTIMATION OF WUE AND FUE FOR DIFFERENT IRRIGATION AND FERTIGATION LEVELS IN SUMMER CHILLI (*Capsicum annuum* L.)

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ABSTRACT

A field experiment entitled "Impact of Irrigation and Fertigation Levels on Growth, Yield and Quality of *Summer* Chilli (*Capsicum annuum* L.)" was carried out during *summer* season for two years, in split plot design having main plot treatments as drip irrigation levels *viz*. I_1: at 0.7 ETc, I_2: at0.8 ETc,I_3: at 0.9 ETc, I_4: at 1.0 ETc, and I_5: at 1.1 ETc and Sub-plot treatments as fertigation levels *viz*. F_1= 60 per cent of RDF, F_2= 80 per cent of RDF and F_3= 100 per cent of RDF with fifteen treatment combinations, replicated thrice. Results of the study indicates that for different drip irrigation levels, the treatment drip irrigation level at 0.8 ETc recorded highest water use efficiency of 30.48 q ha^{-1} cm^{-1}, whereas lowest water use efficiency of 21.68 q ha^{-1} cm^{-1} was noted under drip irrigation level at 1.1 ETc in pooled results. Thus, drip irrigation level at 0.8 of crop evapotranspiration was found to be superior among the tested treatments. For fertilizer use efficiency non-significant differences were found, when crop received drip irrigation levels between 80 to 100 per cent of crop evapotranspiration. Whereas in different fertigation levels, treatment 60 per cent of RDF recorded highest fertilizer use efficiency of 41.05 kg kg^{-1} which was found statistically at par with 80 per cent RDF having 37.36 kg kg^{-1} in pooled results. Lowest fertilizer use efficiency of 32.35 kg kg^{-1} was recorded under treatment fertigation with 100 per cent RDF. The interaction effect on fertilizer use efficiency by different drip irrigation and fertigation levels did not differ significantly.

Index Items: Drip Irrigation, Fertigation, WUE, FUE, summer chilli

I. INTRODUCTION

Water is the vital source for crop production and is the most limiting factor in Indian agricultural scenario. Though India has the largest irrigation network and even if the full irrigation potential is exploited, about 50 per cent of the country's cultivated area will still remain unirrigated, due to the current level of irrigation efficiency not exceeding 40 per cent. Conventional and traditional irrigation systems such as basin irrigation and wild flooding apply comparatively larger quantity of water per irrigation contributing to huge loss of water in the form of surface runoff, evaporation and deep percolation. India has to enhance the current irrigation potential of 91 m ha to 140 m ha. to achieve required food and fibre production with ever increasing population.

In view of worsening water scarcity and raising water demand, the available water resources should be very effectively utilized through water saving irrigation technologies. The need of the hour is, therefore, to maximize the production per unit of water. Hence, further expansion of irrigation may depend upon the adoption of new systems such as pressurized irrigation methods with the limited water resources. Amongst those pressurized irrigation methods, drip irrigation has proved its superiority over other methods of irrigation due to high efficiency and the direct application of water and nutrients in the vicinity of root zone, matching the crop water needs. Because of reduced water loss and uniform water application in precise quantity drip system has higher irrigation efficiency of more than 90 per cent.

Fertilizer is the costliest input after water, in agriculture. Apart from the economics consideration it is also well known that the adverse effect of injudicious use of water and fertilizer on the environment can have far reaching implications. There is, therefore, a need for technological options, which will help in sustaining the precious resources and maximizing crop production without any detrimental impact on the environment. Fertigation opened up new possibilities for controlling water and nutrient supplies to the crops. By introducing fertigation, it is possible to save the water and fertilizers about 45-50 per cent and 30 per cent with increasing the productivity about 40 per cent respectively (Sivanappan and Ranghaswami, 2005).

Chilli (*Capsicum annuum* L.) belongs to the *Solanaceae* family, has its unique place in the diet as a vegetable cum spice crop. Chilli is an indispensable spice due to its pungency, taste, appealing colour and flavor. It is the second largest commodity after black pepper (*Piper nigrum* L.) in the international spice trade. *Capsicum* spp. contain a range of essential nutrients and bioactive compounds which are known to exhibit antioxidant, antimicrobial, antiviral, anti-inflammatory and anticancer properties (Khan *et al.*, 2014). It is pre-dominantly popular for its green pungent fruits, which is used for culinary purpose. The nutritive value of chilli is excellent with different types of protein, vitamin and ascorbic acid contents and has of medicinal potential of especially anti-cancerous and instant pain relief.

India is the largest producer, consumer and exporter of chilli, which contribute to 25per cent of total world's production. In India, chilli is grown in almost all the states across the length and breadth of the country. Chilli being a long duration crop, it responds to split application of nutrients *i.e.,* nitrogen, phosphorus and potassium. It responds well to fertigation with 11 to 22 applications in terms of increased growth and yield properties besides, higher water and fertilizer use efficiencies compared to conventional methods of fertigation. Pungency and colour are two important characters liked by consumers. Some nutrients are known to play an important role in maintaining these characters. Nitrogen is an essential component of nucleic acid and has been suggested to improve the development of vegetative structures and thereby yield (Glass, 1989). Potassium is well known for its role in improving quality. Potassium improves colour, glossiness and dry matter accumulation in fruits (Subhani *et al.*, 1990). Since, chilli is a spice crop with tremendous export potential, the yield and quality are the important factors to be considered which can be achieved only through optimum nutrient application.

II MATERIALS AND METHODS

The field experiment entitled **"**Impact of Irrigation and Fertigation Levels on Growth, Yield and Quality of *Summer* Chilli (*Capsicum annuum* L.)**"** was undertaken during *summer* season of year 2017-18 and 2018-19 at Experimental farm, College of Agriculture, Badnapur, VNMKV, Parbhani.

2.1 Experimental details

The experimental field was laid out as per plan after preparatory operations. The layout consistedof fifteen treatments arranged randomly, in split plot design with three replications in a field of 40 m x 36 m size. The gross length and width of each main plot treatment *i.e.* drip irrigation level was 7 x 36 m, divided into three sub plot treatment *i.e*. fertigation levels with each of size 7 x 12 m. Net plot size for each treatment combination was 6 x 3.6 m. A space of 1.0 m was provided between two treatments as a buffer strip to avoid lateral movement of water from treatment to treatment.

2.2 Irrigation Scheduling

To assess the influence of infield variability irrigation levels on chilli, crop was irrigated with five drip irrigation levels as per the treatments. Irrigations were applied at an alternate day on the basis fraction of crop evapotranspiration (ETc) as per the treatments *i.e.* I_1: at 0.7ETc, I_2: at 0.8 ETc, I_3: at 0.9 ETc, I_4: at 1.0 ETc, and I_5: at 1.1 ETc, throughout the complete crop period of chilli.

The ETc was computed as given by equation (3.1)

$$ETc = ETr \times Kc \quad .... (3.1)$$

Where,

ETc = Crop evapotranspiration (mm/day)

ETr = Reference crop evapotranspiration (mm/day)

Kc = Crop coefficient

The FAO Penman-Monteith method was used to estimate ETr as given by equation (3.2)

$$ETr = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u(e_s - e_a)}{\Delta + \gamma (1+0.34u_2)} \quad ....(3.2)$$

Where,

ETr = Potential evapotranspiration (mm/day)

ssRn = Net radiation at the crop surface (MJ/m/day)

G =Soil heat flux density (MJ/m/day)

T =Mean daily air temperature at 2 m height (°C)

u2 =Wind speed at 2 m height (m/s)

es =Saturation vapours pressure (kPa)

ea = Actual vapour pressure (kPa)

es – ea = Saturation vapour pressure deficit (kPa)

Δ =Slope vapour pressure curve (kPa/°C)

γ =Psychometric constant (kPa/°C)

ETr values were computed by “Phule Jal App” developed by Gorantiwar and Palkar. It calculates the ETr values by different standard methods automatically by fetching the real time data from the weather service provider and estimate the evapotranspiration at the specified location. It has provision to fill up the input data manually also.

2.3 Fertigation: Water soluble 19:19:19 and Urea (46 % N) was used as a source of NPK. The recommended dose of fertilizer (NPK) for chilli crop is 120:80:80 kg/ha. To assess the influence of different fertigation levels *i.e.*F_1 at 60 per cent, F_2 at 80 per cent and F_3 at 100 per cent of RDF fertilizers were applied in eleven splits during the critical growth stages of chilli (Establishment stage, Vegetative growth, Flowering and fruiting and Fruit maturity to harvest: 02,03,03 and 03 splits, respectively).

2.4 Water use efficiency

The water use efficiency of different treatments was estimated from the chilli yield data and the total depth of water applied, using equation (3.3)

$$WUE = \frac{\sum Y}{WR} \text{ .... (3.3)}$$

Where,

WUE = Water use efficiency (t ha^{-1} mm^{-1})

Y = Yield of Chilli (t ha^{-1})

WR = Irrigation water applied (mm)

2.5 Fertilizer use efficiency

The fertilizer use efficiency was computed for different treatments from the chilli yield data and the quantity of fertilizer applied using equation (3.4),

$$FUE = \frac{\text{Yield of chilli (q ha}^{-1}\text{)}}{\text{Quantity of fertilizer applied (q ha}^{-1}\text{)}} \text{ ....(3.4)}$$

Where,

FUE = Fertilizer use efficiency

2.6 Yield: Yield of the total fruits of the chillies harvested in different pickings (Four potential) from the sample plants in each treatment was recorded and averages was worked out to estimate yield in tonnes per hectare.

III RESULT AND DISCUSSION

3.1 Irrigation scheduling

Irrigations were scheduled at an alternate day on the basis of different treatments of chilli crop evapotranspiration over the whole crop period of chilli crop. Amount of irrigation water to be given was varied according to the treatment which is based on crop evapotranspiration.

Table 1. Number of irrigations and gross depth of irrigation water applied for different treatments during 2018 and 2019

Treatment	Number of irrigations	Total depth of irrigation water applied (mm)	
		2018	2019
I_1 = Drip irrigation at 0.7 ETc	55	417	457
I_2 = Drip irrigation at 0.8 ETc	55	477	522
I_3=Drip irrigation at 0.9 ETc	55	536	587
I_4=Drip irrigation at 1.0 ETc	55	596	653
I_5=Drip irrigation at 1.1 ETc	55	655	718

3.2 Water use efficiency

The data pertaining to water use efficiency (q ha^{-1} cm^{-1}) as influenced by drip irrigation and fertigation levels and their interactions recorded are presented in Table 4.2.

In pooled analysis, data indicates that the drip irrigation and fertigation levels significantly influenced the water use efficiency. In main plot treatment with different drip irrigation levels, significantly highest water use efficiency was recorded under the treatment I_2 (30.48 q ha^{-1} cm^{-1}), followed by the treatment I_1 (29.26 q ha^{-1} cm^{-1}) and these treatments were found at par with each other. The next best treatment was I_3 (27.54 q ha^{-1} cm^{-1}) followed by treatment I_4 (24.61 q ha^{-1} cm^{-1}). Water use efficiency was found lowest under the treatment I_5 (21.68 q ha^{-1} cm^{-1}). Antony and Singandhupe (2004) in their studies also found that the maximum water use efficiency of 59.9 kg ha^{-1} mm^{-1} was recorded in drip irrigation at 0.8 ET as compared to drip irrigation at 1.0 ET (54.7 kg ha^{-1} mm^{-1}) and 1.2 ET (59.0 kg ha^{-1} mm^{-1}) in capsicum. Similarly, Gupta *et al.* (2015) also opined that that drip irrigation levels had a favorable and significant influence on water use efficiency in tomato var. SHTH-1. Drip irrigation at 80 per cent and 60 per cent ET were at par and found significantly superior to drip irrigation at 100 per cent ET drip and surface irrigation with the water use efficiency (45.1q ha^{-1} cm^{-1} and 50.25 q ha^{-1} cm^{-1}).

In the sub plot treatment, the different levels of fertigation had showed significant effect on water use efficiency. Due to the effect of fertigation levels, significantly maximum water use efficiency was observed in treatment F_3 (29.69 q ha^{-1} cm^{-1}), followed by treatment F_2 (27.69 q ha^{-1} cm^{-1}) and both the treatments were found at par with each other. Water use efficiency was found minimum in treatment F_1 (23.00 q ha^{-1} cm^{-1}). Present results regarding water use efficiency was found in conformity with most of the earlier findings reported by Singh *et al.* (2017), Kumar *et al.* (2016), Kumari *et al.* (2014), Monte *et al*. (2013) and Gupta *et al.* (2010).

The interaction effect of drip irrigation and fertigation levels was noticed non-significant on the water use efficiency for chilli

Table 2 Impact of different drip irrigation and fertigation levels on water use efficiency of chilli

Treatments	**Water use efficiency (q ha^{-1} cm^{-1})**		
	2018	**2019**	**Pooled**
A) Main Plot (Irrigation levels)			
I_1= Drip irrigation at 0.7 ETc	32.65	25.88	29.26
I_2= Drip irrigation at 0.8 ETc	33.99	26.98	30.48
I_3= Drip irrigation at 0.9 ETc	30.71	24.36	27.54
I_4= Drip irrigation at 1.0 ETc	26.58	22.64	24.61
I_5= Drip irrigation at 1.1 ETc	24.19	19.17	21.68
S.E. ±	**0.632**	**0.511**	**0.41**
C.D. at (P=0.05)	**1.86**	**1.50**	**1.21**
B) Sub Plot (Fertigation levels)			
F_1= 60% of RDF	25.90	20.10	23.00
F_2= 80% of RDF	31.04	24.35	27.69
F_3= 100% of RDF	32.63	26.75	29.69
S.E. ±	**1.30**	**0.964**	**0.765**
C.D. at (P=0.05)	**3.84**	**2.84**	**2.25**
C) Interaction (I X F)			
S.E. ±	**2.91**	**2.15**	**1.71**
C.D. at (P=0.05)	**NS**	**NS**	**NS**
General Mean	**29.85**	**23.74**	**26.80**

3.3 Fertilizer use efficiency

The data pertaining to fertilizer use efficiency (kg kg^{-1}) as influenced by drip irrigation and fertigation levels and their interactions recorded are presented in Table 4.3.

In pooled analysis, the data indicates that, the drip irrigation and fertigation levels significantly influenced the fertilizer use efficiency In the main plot treatment with different drip irrigation levels, significantly highest fertilizer use efficiency was recorded under the treatment I_4 (39.79 kg kg^{-1}), followed by the treatment I_3 (38.35 kg kg^{-1}) and treatment I_2 (37.89 kg kg^{-1}) and these treatments were found at par with each other. The fertilizer use efficiency was lowest under the treatment I_1 (31.58 kg kg^{-1}).

In the sub plot treatment, the different levels of fertigation had showed significant effect on fertilizer use efficiency. Due to the effect of fertigation levels, significantly maximum fertilizer use efficiency was observed in treatment F_1 (41.05 kg kg^{-1}), followed by treatment F_2 (37.36 kg kg^{-1}) and both the treatments were found at par with each other. The fertilizer use efficiency was found minimum in treatment F_3 (32.35 kg kg^{-1}). It can be concluded from the results obtained that increase in fertilizer use efficiency with decrease in fertilizer application were in accordance with crop demand and the efficiency with which the applied fertilizer utilized was increased. As the fertilizer levels decreased, the fertilizer use efficiency increased

when there was less yield difference. Similar findings regarding fertilizer use efficiency are well documented earlier by Veeranna *et al*. (2001), Singhandhupe *et al*. (2003), Hongal and Nooli (2007), Badr and Abou Ei - Yaized (2007), Gupta *et al.* (2010), Ughade *et al.* (2014) and Gupta *et al*. (2015).

The interaction effect of drip irrigation and fertigation levels was noticed non-significant on the fertilizer use efficiency.

Table 3 Impact of different drip irrigation and fertigation levels on fertilizer use efficiency of chilli

Treatments	Fertilizer use efficiency (kg kg^{-1})		
	2018	2019	Pooled
A) Main Plot (Irrigation levels)			
I_1= Drip irrigation at 0.7 ETc	33.84	29.33	31.58
I_2= Drip irrigation at 0.8 ETc	40.83	34.94	37.89
I_3= Drip irrigation at 0.9 ETc	41.12	35.59	38.35
I_4= Drip irrigation at 1.0 ETc	42.67	36.90	39.79
I_5= Drip irrigation at 1.1 ETc	39.33	34.38	36.86
S.E. ±	**1.07**	**0.743**	**0.657**
C.D. at (P=0.05)	**3.17**	**2.19**	**1.93**
B) Sub Plot (Fertigation levels)			
F_1= 60% of RDF	44.58	37.52	41.05
F_2= 80% of RDF	39.99	34.73	37.36
F_3= 100% of RDF	34.22	30.48	32.35
S.E. ±	**1.74**	**1.45**	**1.06**
C.D. at (P=0.05)	**5.14**	**4.29**	**3.82**
C) Interaction (I X F)			
S.E. ±	**3.90**	**3.26**	**2.37**
C.D. at (P=0.05)	**NS**	**NS**	**NS**
General Mean	**39.5**	**34.2**	**36.9**

3.4. Yield of chilli

The data pertaining to yield of chilli (tonnes ha^{-1}) as influenced by drip irrigation and fertigation levels and their interactions recorded are presented in Table 4.4.

In pooled analysis, the drip irrigation and fertigation levels significantly influenced the yield per ha of chilli. In the main plot treatment with different drip irrigation levels, significantly highest yield per ha of chilli was recorded under the treatment I_4 (15.90 tonnes ha^{-1}), followed by the treatment I_3 (15.38 tonnes ha^{-1}) and treatment I_2 (15.15 tonnes ha^{-1}) and these treatments were found at par with each other. The yield of chilli per ha was lowest under the treatment I_1 (12.72 tonnes ha^{-1}).

Tedeschi and Zerbi (1984) who showed that total and marketable yields per plant were linearly related to actual evapotranspiration and that yield dependent on number of fruits per plant and mean fruit weight rather than on the number of flowers which was less important because abscission of flowers and young fruits was always high. Similar results are reported by Abou-Hussein *et al.* (1984) who stated that the yield of chilli increased with the increase in FC per cent (9 to 54 per cent) and then decreased with increase in FC per cent (54 to 90 per cent) except that there was no statistical difference in yield between 54 and 90 per cent. Nagalakshmi *et al.* (2002) also reported that the higher amount of growth and yield might be due to increased availability of soil moisture with more frequent irrigations. These results are also well supported by Monte *et al.* (2013) and Nadiya *et al*. (2013).

In the sub plot treatment, the different levels of fertigation had showed significant effect on yield per ha of chilli. Due to the effect of fertigation levels, significantly maximum yield per ha was observed in treatment F_3 (16.36 tonnes ha^{-1}), followed by treatment F_2 (15.20 tonnes ha^{-1}) and both the treatments were found at par with each other. The yield of chilli per ha was found minimum in treatment F_1 (12.80 tonnes ha^{-1}). It might be due to optimum replenishment of water and nutrients in the effective root zone during critical periods of nutrient demand, which improve the physiological and photosynthetic activities enhancing the vegetative and productive growth of plants. The increased yield under drip irrigation might have resulted due to better water utilization (Manfrinato, 1974); higher uptake of nutrients (Bafna *et al*., 1993) and excellent soil-water relationship with higher oxygen concentration in the root zone (Gornet *et al*., 1973). The results of present study are in conformity with earlier reports of Veeranna *et al.* (2001), Tumbare and Bhoite (2002), Takele *et al.* (2009), Gupta *et al.* (2010), Singh *et al*. (2011), Nadiya *et al.* (2013) and Kumar *et al*. (2016) who concluded that there were significant positive correlations ($P < 0.01$) between fruit number, fruit weight and fruit yield. Increase in fruit number was the most important factor representing yield increase.

The interaction effect of drip irrigation and fertigation levels was noticed non-significant on the yield of chilli.

Table 4 Effect of different drip irrigation and fertigation levels on yield of chilli

Treatments	**Yield of chilli (tonnes ha^{-1})**		
	2018	**2019**	**Pooled**
A) Main Plot (Irrigation levels)			
I_1= Drip irrigation at 0.7 ETc	13.61	11.83	12.72
I_2= Drip irrigation at 0.8 ETc	16.21	14.08	15.15
I_3= Drip irrigation at 0.9 ETc	16.46	14.30	15.38
I_4= Drip irrigation at 1.0 ETc	17.02	14.78	15.90
I_5= Drip irrigation at 1.1 ETc	15.84	13.76	14.80
S.E. ±	**0.37**	**0.30**	**0.28**
C.D. at (P=0.05)	**1.09**	**0.90**	**0.84**
B) Sub Plot (Fertigation levels)			
F_1= 60% of RDF	13.91	11.70	12.80
F_2= 80% of RDF	16.27	14.13	15.20
F_3= 100% of RDF	17.31	15.42	16.36
S.E. ±	**0.69**	**0.57**	**0.42**
C.D. at (P=0.05)	**2.04**	**1.69**	**1.25**
C) Interaction (I X F)			
S.E. ±	**1.55**	**1.28**	**0.94**
C.D. at (P=0.05)	**NS**	**NS**	**NS**
General Mean	**15.83**	**13.75**	**14.79**

IV CONCLUSION

The highest water use efficiency was obtained when chilli was irrigated with drip irrigation at 0.8 of crop evapotranspiration at an alternate day. Water use efficiency increased with decrease in the depth of irrigation water applied. In order to have higher water use efficiency, drip irrigation should be scheduled at an alternate day with 0.8 ETc depth of irrigation. For better yields and high water use efficiency of chilli, application of drip irrigation at 0.8 ETc and fertigation with 80 % of RDF were found to be better.

Fertilizer use efficiency increased with decrease in quantity of fertilizer applied. In order to have higher fertilizer use efficiency, fetigation with 80 per cent of RDF was found to be optimum. Higher fertilizer use efficiency was achieved by fertigation with 80 per cent RDF in eleven splits (Establishment stage: 02, Vegetative growth: 03, Flowering and fruiting: 03 and Fruit maturity to harvest: 03 splits, respectively of equal days interval).

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REFERENCES

Abou-Hussein, M. R., El-Berragy, M. S., El-Bettagy, A. S., Khalil, S., MakSoud, M. and Abdel-Halim, S. M. 1984. Effect of soil water availabilityon growth, flowering and fruiting of pepper plant. *Egyptian Journal*, 74**:** 556561.

Antony E. and Singandhupe R.B. 2004.Impact of drip and surface irrigation on growth, yield and WUE of capsicum (*Capsicum annuum* L.). *Agricultural Water Management* 65:121-132.

Badr, M. A and Abou El-Yazied A. A. (2007). Effect of fertigation frequency from subsurface drip irrigation on tomato yield grown on sandy soil. *Australian Journal of Basic and Applied Sciences*, 1(3): 279-285.

Bafna A.M, Daftardar S.Y., Khade K.K., Patel P.V. and Dhotre R.S. (1993). Utilization of nitrogen and water by tomato under drip irrigation system. *Journal of Water Manage*.1(1): 1-5.

Gornat B., Goldberg D., Rimon D., Asher B.J.1973. The physiological effect of water quality and method of application on tomato, cucmber and pepper. *Journal Am. Soc. Hort. Sci.* 98(2): 202-5.

Gupta, A.J., Feza Ahmad M. and Bhat F.N. (2010). Studies on yield, quality, water and fertilizer use efficiency of capsicum under drip irrigation and fertigation. *Indian Journal of Horticulture*.67 (2)**:** 213-218.

Gupta A.J., Chattoo M A and Lal Singh (2015). Drip irrigation and fertigation technology for improved yield, quality, water and fertilizer use efficiency in hybrid tomato. *Journal of Agri. Search* 2(2): 94-99.

Hongal, M. M and Nooli S. S. (2007). Nutrient movement in fertigation through drip- A review. *Journal of Agric. Rev.*, 28(4): 301-304.

Khan, M.A., M.A. Asghar, J Iqbal, A. Ahmed & Shamsuddin Z.A., 2014. Aflatoxins contamination and prevention in red chillies (*Capsicum annuum* L.) in Pakistan. *Food Additives & Contaminants., Part B* 7 (1): 1-6.

Kumar R., Pal R., Kumar R., Sagar S. and Singh Bist A. (2016). Response of water use efficiency through fertigation on growth and yield of chilli crop. *International journal of engineering sciences & research technology*, 5 (12).

Kumari, R., Kaushal A. and Singh K.G. (2014). Water use efficiency of drip fertigated sweet pepper under the influence of different kinds and levels of fertilizers.

Indian Journal of Science and Technology,7(10):1538–1543

Manifrinato H.A.1974. Effect of drip irrigation on soil water plant relationships. *SecondInternational Drip Irrigation Congress* pp. 446- 451.

Monte, J.A., Carvalho, D.F. de, Medici, L.O., Silva L.D.B. da, and Pimentel C. (2013). Growth analysis and yield of tomato crop under different irrigation depths. *Revista Brasileira de Engenharia Agricola e Ambiental*,17(9): 926-931.

Nadiya, E. K., Kurien, E.K., Mathew and AnuVarughese. 2013. Impact of fertigation and dripsystem layout on performance of chilli (*Capsicum Annuum*). *International Journal of Engineering Research and Development*, **7** (9): 85-88.

Nagalakshmi S., Palanisamy D., Eswaran S.and Sreenarayanan V. V. 2002. Influence of plasticmulching on chilli yield and economics. *South Indian Horticulture* 50 (1-3): 262-265.

Singh, S, R., Sharda P.P., Lubana S. and Singla C. (2011). Economic evaluation of drip irrigation system in bell *peppev (Capsicwnannuum* L. var. *Grossum*). *Progressive Horticulture*, 43(2): 289-293.

Singh Ajeet, Sharma S.K., Rahul Chopra, Virendra Singh, Kaushik R.A., Rathore R.S. and Jain H.K. (2017). Impact of drip fertigation on yield and nutrients uptake by chilli (*Capsicum annuum* L.). *International Journal of Current Microbiology and Applied Sciences*,Vol. 6 Number 8 (2017): 1409-1416.

Singhandhupe, R. B., Rao G. G. S. N., Patil N. G. and Brahmanand P. S. (2003). Fertigation studies and irrigation scheduling in drip irrigation system in tomato crop. *Europe Journal of Agronomy*, 19: 327-340.

Tedeschi, P. and Zebri G. (1984). Flowering and fruiting courses and yield of sweet

pepper plants grown in lysimeter with relation to different water regime (Italy). *Revistadella Ortoflorofruitcultura*, 68(4) : 323-329.

Takele Gadissa and DesalegnChemeda 2009. Effects of drip irrigation levels and plantingmethods on yield and yieldcomponents of green pepper (*Capsicum annuum*, L.) in Bako, Ethiopia. *Agricultural Water Management* 96 (2009) 1673–1678.

Tumbare, A.D. and Bhoite S.U. (2002). Effect of solid soluble fertilizers applied through fertigation on the growth and yield of chilli (*Capsicum annuum* L.). *Indian Journal of Agricultural Sciences*,72(2): 109-111.

Ughade S.R., Ayare B.L., Thorat T.N. and Thokal R.T. (2014). Effect of irrigation and fertigation levels on yield and nutrient uptake of brinjal (*Solanum melongena* L.). *International Journal of Agricultural Engineering*,7(1): 74- 80.

Veeranna H. K., Abdul Kgalak, Faroodhi A. A. and Sujith G. M. (2001). Effect of fertigation with normal and water soluble fertilizers compared to drip andfurrow methods on yield, fertilizer and irrigation water use efficiency in chilli. *Micro Irrigation*, pp. 461-466.