Int.J.Curr.Microbiol.App.Sci (2017) *6*(6): 1242-1249

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 6 (2017) pp. 1242-1249**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.606.145

Effect of Cow Urine and Bio-Fertilizers based Fertigation Schedule at Varying Levels of Drip Irrigation on Yield, Growth, Quality Parameters and Economics of Cucumber under Protected Condition

Sunil Kumar*, Naveen Datt, S.K. Sandal and Sanjay K. Sharma

Department of Soil Science, CSK Himachal Pradesh Agricultural University, Palampur, India
**Corresponding author*

Keywords

Cucumber, fertigation, Azotobacter, Drip irrigation, polyhouse.

Article Info

Accepted:
19 May 2017
Available Online:
10 June 2017

A B S T R A C T

The effect of cow-urine and bio-fertilizers based fertigation schedule was studied at varying levels of drip irrigation on various cucumber parameters in a naturally ventilated polyhouse during summer season. The experiment was conducted in a randomized block design with 11 treatments and 3 replication comprising of two drip irrigation levels *viz.*, I_2(IW/CPE= 0.4) and I_4 (IW/CPE = 0.8), five fertigation levels and one farmers' practice. The total soluble solids (TSS) were numerically higher in irrigation level I_2 than in I_4. The yield was statistically higher in different treatments compared to farmers' practice (4.47 kg m^{-2}). The gross return and B: C ratio were highest in treatment F_2I_4 (where F_2 is 100 % of recommended NPK doses (1/3rd N and full P, K applied as basal and 2/3rdN through fertigation + *Azotobacter* + PSB) and 5% cow-urine) and were lowest under farmers' practice. However, the irrigation levels didn't influence the marketable yield. The overall results indicated that combined application of bio-fertilizers and fertilizers has positive effect on yield, growth and quality parameter due to addition of nutrients and saving of at least 50 % of water and hence can be exploited as a sustainable approach under integrated nutrient management.

Introduction

A native to India, cucumber (*Cucumis sativus* L.) is commonly grown in all parts of the country, mainly for its immature fruits. It is a good source of vitamins B and is a low calorie diet. It has 95% water content, making it a diuretic vegetable crop, which keeps the body hydrated and helps in cleansing of body toxins. It also reduces the risk of cancer, eliminates uric acid and its fiber-rich skin and high levels of potassium and magnesium helps to regulate blood pressure and promote nutrient functions. However, it is a frost susceptible species, and being a warm season vegetable, it is thermophilic and grows best under condition of high light, humidity, moisture, fertilizer and temperature (above 20 °C). Hence, growing cucumber during autumn - winter and spring - summer season can give off season supply to the nearby market in plains. Parthenocarpic fruits are common cucumber hybrids that can be grown in off season under protected conditions due to their ability to set fruit without pollination or fertilization even at low temperatures

(Monisha *et al.,* 2014) making efficient utilization of the land, water, nutrient and other resources. Protected cultivation, also known as 'Controlled Environment Agriculture (CEA)' is highly productive, environment protective and water and land conservative cultivation practice (Jensen, 2002). This technology can be utilized for year round production of high value vegetable crops with high yield. Increasing photosynthetic efficiency and reduction in transpiratory losses are added advantages of protected cultivation. Both of these factors are of vital importance for healthy and luxuriant growth of crop plants. In spite of having the largest irrigation network in the world, the irrigation efficiency in India is not more than 40% (Imamsaheb *et al.,* 2014), hence more efficient irrigation methods need to be studied upon and applied.The optimum soil moisture content for adequate cucumber growth and fruiting is 80-85% of field capacity. Its high requirements of soil water can be attributed to its bulky and vigorous above-ground portion which evaporates large quantity of water and its poorly developed root system characterized by low absorbing capacity and heavy leaching losses of fertilizers. Drip irrigation system is one of the advanced methods of irrigation, in which water is applied drop by drop on continuous basis through closed network of plastic pipes at frequent intervals near to the root zone for consumptive use of the crop. It minimizes conventional losses of water by deep percolation, evaporation and run off. It can save water up to 40 to 70% as well as increase the crop production to the extent of 20 to 100% (Reddy and Reddy, 2003).

In India, the nutrient consumption per hectare and fertilizer use efficiency is very low in spite of it being the third largest producer and consumer of fertilizer in the world (Sathya *et al.,* 2008). The main reasons for low efficiency are the types of fertilizers used and the methods of application adopted by Indian farmers. Use of both the inorganic and organic type of fertilizers in a balanced proportion and incorporating fertilizer application in the drip irrigation system (fertigation) not only optimizes the water use but also increases the nutrient use efficiency. The fertigation method gives higher nutrient use efficiency (90%) then the conventional methods (40 to 60%) by Solaimalai *et al.,* (2005).The excessive uses of inorganic fertilizers have some deleterious effects on fruit quality in addition of having adverse effects on soil and its biological dynamics, water and environmental conditions. Under these conditions, bio-fertilizers have emerged as potential nutrient suppliers or mobilizers in various horticultural crops to meet the day by day increasing requirements of the growing population. Incorporation of microbial inoculants not only reduces the requirement of inorganic fertilizers but also has other added advantage such as consistent and slow release of nutrients, maintaining ideal C: N ratio, improvement in water holding capacity and microbial biomass of soil profile, without having any adverse residual effects.

The cow urine contains 95% water, 2.5 % urea, minerals, hormones, salts and enzymes can be used as bio-fertilizers for increasing soil fertility. The cow urine application as different concentration can increase the enzymatic activity and alleviate micro nutrient deficiency in the soil.

Considering the scope of the crop growth behavior of cucumber under differential moisture regimes and fertigation levels, many accounts of effect of irrigation amount, intervals and frequencies have been found (Moujabber *et al.,* 2002; Yuan *et al.,* 2006; Wang *et al.,* 2009). However, an effect of incorporation of cow urine and bio-fertilizers in fertigation scheduling has not been studied so far. Hence the objective of present paper is to study the effects of cow urine and bio-fertilizers based fertigation schedule at varying levels of drip irrigation on yield, growth, quality parameters and economics of cucumber under protected condition.

Materials and Methods

The present study was conducted at experimental farm of CSK HPKV, Palampur (32°6’ N latitude and 76°3’ E longitude) situated at an elevation of 1290 m above mean sea level in Kangra district of Himachal Pradesh and represents the mid hills sub humid agro climatic zone of Himachal Pradesh in North Western Himalayas, during summer 2015 in naturally ventilated polyhouse. The cucumber cv. Hilton was transplanted on March 21, 2015. Raised strips were laid out as per plan before transplanting and were made with dimensions of 3.0 m length and 0.4 m width. The soil was clay loam and rich in clay content with accumulation of sesquioxide, pH 5.50 and organic carbon 11.40 g kg^{-1}. At the initial stage available nitrogen, phosphorus and potassium status of soil was 209.5, 42.50 and 278.3 kg ha^{-1} at 0-0.15 m and 201.4, 39.10 and 270.6 kg ha^{-1} at 0.15 to 0.30 m, respectively. The mean air temperature varies from 2 °C in January to around 36 °C during the months of May-June. Soil temperature drops as low as 2 °C and frost incidences are common. The relative humidity varies from 46 to 84% and average annual rainfall of the place is about 2500 mm.

The drip irrigation system was installed in a naturally ventilated polyhouse of 15 x 7 m size. A total of 33 raised strips each of 3 x 0.4 m size were prepared. The average discharge rate from each dripper was 3 l h^{-1}. A fertigation tank system of 30 litre capacity was provided near the electric pumping unit for fertigation. The FYM @ 1 kg m^{-2} was applied to all the treatments. In conventional method, urea, single super phosphate and muriate of potash were used whereas, in fertigation treatments, water soluble fertilizers such as 19:19:19, 0:0:50, 12:61:0 and urea were applied through drip irrigation system. The experiment was laid out in Completely Randomized Design with three replications of two irrigation and fertigation treatment combinations. The irrigation and fertigation treatments consisted of two irrigation levels (I_2 and I_4 designated as 2 l m^{-2} and 4 l m^{-2} daily, respectively) and five fertigation levels; (F_1) 50 % of recommended NPK doses 1/3rd N and full P, K applied as basal and 2/3rd N through fertigation+ *Azotobacter* (Azo)+PSB and 5 % cow-urine, (F_2) 100 % of recommended NPK doses 1/3rd N and full P, K applied as basal and 2/3rd N through fertigation+ *Azotobacter* (Azo)+ PSB and 5 %cow-urine, (F_3) 50 % of recommended NPK doses 1/4th N, P and K applied as basal and 3/4th NPK through fertigation+ *Azotobacter* (Azo)+PSB and 5 %cow-urine, (F_4) 100 % of recommended NPK doses 1/4th N, P and K applied as basal and 3/4th NPK through fertigation+ *Azotobacter* (Azo)+ PSB and 5 %cow-urine, (F_5) 100 % of recommended NPK doses of fertilizer applied through water soluble fertilizers(RDF= 100:50:60) and Farmers’ practice (FYM @ 1 kg m^{-2} + 10 g m^{-2} IFFCO(12:32:16) + 2g lt^{-1} of 19:19:19 at 15 days intervals and drip irrigation applied at rates 2 l m^{-2} daily).There were 11 treatment combinations. The treatment combinations were as follows:

T_1 - F_1I_2, T_2 - F_1I_4, T_3 - F_2I_2, T_4 - F_2I_4, T_5 - F_3I_2, T_6- F_3I_4, T_7- F_4I_2, T_8 - F_4I_4, T_9- F_5I_2, T_{10}- F_5I_4, T_{11} - Farmers’ Practice. The concentration of nitrogen, phosphorus and potassium content in di-acid digest of plant samples were estimated by modified Kjeldhal’s method, vanadomolybdate yellow colour method with the help of spectrophotometer at 470 nm and flame photometer, respectively (Jackson 1973). Total soluble solids were determined by means of hand refractometer. The observations on growth, yield and quality parameters were recorded and analyzed.

Results and Discussion

Soil water content during crop growth

The soil water content (θ) determined at regular interval throughout the growth period is shown in table 1. The 'θ' determined at early crop growth stages (25 DAT) was 0.26 and 0.28 $m^3 m^{-3}$ in I_2; 0.28 and 0.31 $m^3 m^{-3}$ in I_4 at 0.0-0.15 and 0.15-0.30 m soil depths between two drippers, respectively and the soil water content was 0.27 and 0.26 $m^3 m^{-3}$ in I_2; 0.29 and 0.28 $m^3 m^{-3}$ in I_4 at 0.0-0.15 and 0.15-0.30 m soil depths near drippers, respectively. The soil water content showed an increasing trend from I_2 to I_4 at 0.0-0.15 and 0.15-0.30 m in both cases. The soil water content was higher both in surface (0.0-0.15 m) as well as subsurface (0.15-0.30 m) layers in I_4 then I_2. But the soil water content was higher at surface layer (0.0-0.15 m) than subsurface layer (0.15-0.30 m) near drippers and vice-versa between two drippers.

The higher 'θ' in I_4 may be attributed to higher quantity of water application**.** The soil water content determined at different stages like 40 DAT, 55 DAT, 70 DAT, 85 DAT and 100 DAT followed same trend as shown in table 1. The 'θ' increased with increasing depths in all the treatments between two drippers and vice-versa near drippers. Soil water content increased with increasing depth in I_2 and vice-versa in I_4.

This may be due to uniform coverage of moisture in whole cropped area under closer lateral spacing as compare to wider lateral spacing by Chouhan *et al.*, (2015).

Plant growth and TSS parameters

The data pertaining to the effects of bio-fertilizer, cow urine, drip irrigation and fertigation on plant height and TSS at 90 DAT are given in table 2.

Plant height

The plant height recorded at 90 DAT indicated that the plant height in I_4 (4 l m^{-2} daily) was numerically higher than that in I_2 (2 l m^{-2} daily), except in treatment T_3, T_4 and T_8 being statistically at par with each other. The higher plant height in irrigation level 4 l m^{-2} daily may be attributed to the higher quantity of irrigation applied throughout the crop growth period. The similar results are reported by Pires *et al.*, (2011) where the high irrigation frequency favored the vegetative growth. Similar results are also reported by Acharya *et al.*, (2013) and Yaghi *et al.*, (2013). The treatment T_3 and T_4 differed significantly with all treatments but statistically at par with T_8. This could be attributed to the prevailing favourable microclimate inside the greenhouse which helped the plants in better utilization of solar radiation, nutrients and water for the photosynthesis and also the prevailing higher temperature inside the green house might have helped in faster multiplication of cells and cellular elongation resulting in better growth of roots and shoots which helped better vegetative growth including plant height and plant spread. The results obtained are in agreement with Nagalakshmi *et al.*, (2001), Krishnamanohar (2002) and Srivastava *et al.*, (1993). Drip fertigation of cucumber adequately sustain favourable vegetative and reproductive growth as compare to conventional method of fertilizer application. These results are in accordance with the findings of Al- Jaloud *et al.*, (1999) and Choudhari and More (2002) in gynoecious cucumber hybrids.

Total soluble solids

The total soluble solid (TSS) contents are shown in table 2. The TSS was numerically highest in treatment T_7 (2.9 °Brix) followed by treatment T_4 (2.8 °Brix) and T_3 (2.8 ° Brix) which were statistically at par with each other. The TSS was recorded numerically higher in all the treatment with irrigation level I_2 than that with irrigation level I_4 but statistically at par with all treatments of I_4 irrigation level. The TSS content of fruit was increased in the treatments T_1 to T_8which included combined application of organic and inorganic fertilizers along with the bio-fertilizers (*Azotobacter*, PSB and cow urine) than in the treatments without application of organic and bio-fertilizers (T_9 and T_{10}).

This suggest that uptake of NPK nutrients including micronutrients is better in treatments T_1 to T_8 which in turn influence the quality traits in cucumber. The results are in conformity with the findings of Grimst and (1990), Koodzeij and Kostecka (1994) and Asano (1994) in cucumber.

Table.1 Effect of drip irrigation scheduling on volumetric soil water content (m^3m^{-3}) during crop growth

Drip based irrigation	Soil depth (m)	Days after transplanting					
		25	40	55	70	85	100
Between two drippers							
I_2	0-0.15	0.26	0.22	0.24	0.21	0.22	0.25
	0.15-0.30	0.28	0.26	0.27	0.30	0.26	0.32
I_4	0-0.15	0.28	0.23	0.24	0.25	0.24	0.24
	0.15-0.30	0.31	0.27	0.31	0.33	0.32	0.33
Near drippers							
I_2	0-0.15	0.27	0.23	0.25	0.23	0.24	0.26
	0.15-0.30	0.26	0.22	0.23	0.22	0.23	0.25
I_4	0-0.15	0.29	0.26	0.28	0.30	0.31	0.31
	0.15-0.30	0.28	0.24	0.25	0.23	0.24	0.25

Table.2 Effects of bio-fertilizer, cow urine, drip irrigation and fertigation on plant height, TSS (°Brix), relative leaf water content (RLWC) during crop growth and on marketable yield of crop.

Treatments	Irrigation level	Plant height(m)	TSS (°Brix)	RLWC (%)			Yield (kg m^{-2})
				35 DAT	65 DAT	90DAT	
T_1	F_1I_2	3.2	2.5	84.9	81.7	73.6	5.64
T_2	F_1I_4	3.4	2.4	86.6	83.6	75.0	6.12
T_3	F_2I_2	4.1	2.8	86.4	83.1	74.3	6.94
T_4	F_2I_4	4.1	2.8	88.9	85.1	76.4	7.61
T_5	F_3I_2	3.1	2.7	83.7	81.5	73.0	4.90
T_6	F_3I_4	3.4	2.5	86.7	83.5	74.0	5.10
T_7	F_4I_2	3.6	2.9	86.0	83.1	73.4	6.20
T_8	F_4I_4	3.9	2.5	88.3	85.4	75.4	6.83
T_9	F_5I_2	3.1	2.3	84.4	81.2	72.1	5.43
T_{10}	F_5I_4	3.3	2.2	85.6	84.7	74.1	5.90
T_{11}	FP	2.7	2.1	83.9	82.1	73.7	4.47
	SE(m±)	0.1	0.1	0.9	0.8	0.8	0.2
	CD(P=0.05)	0.3	0.3	2.6	2.4	2.4	0.73

Table.3 Effect of drip irrigation and fertigation on returns and B: C ratio.

Treatment		Yield (kg m^{-2})	Gross return (Rs)	Cost of cultivation (Rs m^{-2})			Net return (Rs)	B: C ratio
				Fertilizer cost	Other cost	Total cost		
T_1	F_1I_2	5.64	112.80	1.19	40	41.19	71.61	1.74
T_2	F_1I_4	6.12	122.40	1.19	40	41.19	81.21	1.97
T_3	F_2I_2	6.94	138.80	1.38	40	41.38	97.42	2.35
T_4	F_2I_4	7.61	152.20	1.38	40	41.38	110.82	2.68
T_5	F_3I_2	4.90	98.00	1.19	40	41.19	56.81	1.38
T_6	F_3I_4	5.10	102.00	1.19	40	41.19	60.81	1.48
T_7	F_4I_2	6.20	124.00	1.38	40	41.38	82.62	2.00
T_8	F_4I_4	6.83	136.60	1.38	40	41.38	95.22	2.30
T_9	F_5I_2	5.43	108.60	1.38	40	41.38	67.22	1.62
T_{10}	F_5I_4	5.90	118.00	1.38	40	41.38	76.62	1.85
T_{11}	FP	4.47	89.40	1.50	40	41.50	47.90	1.15

(Other costs: Seedlings + spray materials + labour cost + interest & depreciation on drip system**)**

Cost of cucumber seed: @Rs6/seed = Rs.360/100 m^2 ;Cost of labour : Rs 12/100 m^2 (for 48 hours @ Rs. 25/hour) ; Cost on spray and electricity : Rs. 60/100 m^2; Cost of fertilizers : Urea – @ 255.50/50 kg, SSP– @ 347/50 kg , MOP – @ 252.75/50 kg , 19:19:19 – @ 150/ kg and 0:0:50 – @150/ kg ;FYM Rs 100/q; fruit rate Rs 20/ kg; Interest on drip irrigation system @ 8% per annum – Rs 20/100 m^2, Depreciation cost on drip system – Rs 15/100 m^2.

Relative leaf water content

The relative leaf water content (RLWC) determined at 35, 65 and 90 DAT during cucumber growth period are shown in table 2. A significant increase in RLWC was recorded with increasing quantity of irrigation. The RLWC at 35, 65 and 90 DAT was higher under I_4 (T_2, T_4, T_6, T_8 and T_{10}) compared to I_2 (T_1, T_3, T_5, T_7 and T_9). This might be due to more quantum of water application in I_4. However, this increase from I_2 to I_4 was non-significant at same level of fertilizer treatments.

Farmers' practice had significantly lowest RLWC (83.9, 82.1 and 73.7%) than fertigation recorded at 35, 65 and 90 DAT, respectively. The RLWC values at 35, 65 and 90 DAT was highest for treatment T_4 (88.9, 85.1 and 76.4%) closely followed by treatment T_3 (86.4, 83.1 and 74.3%), respectively. The treatment T_4 was statistically at par with treatment T_3 and significantly different with all other treatments.

Marketable yield

The effect of bio-fertilizer, cow urine, drip irrigation and different methods of fertigation on marketable yield of cucumber is given in table 2.

The yield in T_4I_4 (7.61 kg m^{-2}) and T_3I_2 (6.94 kg m^{-2}) was statistically at par. This indicates saving of at least 50 % of applied water with I_2 for attaining the similar marketable yield with I_4. The yield under different fertigation treatments was highest in T_4 (7.61 kg m^{-2}) followed by T_3 (6.94 kg m^{-2}), T_8 (6.83 kg m^{-2}), T_7 (6.20 kg m^{-2}) and T_2 (6.12 kg m^{-2}). Chand (2014) also reported that increasing fertigation levels showed almost equal yield. Similar results are reported by Abdrabbo *et al.*, (2005); Guler *et al.*, (2006); Amer *et al.*, (2009); Kapoor *et al.*, (2013); Feleafel *et al.*, (2014); Liang *et al.*, (2014) and Tekale *et al.*, (2014). The yield in all the treatments was higher as compared to farmers' practice (4.47 kg m^{-2}). The application of cow urine and bio-fertilizers resulted in numerically higher yields. This might be due to the fact that addition of cow urine and bio-fertilizers resulted in narrowing down of C: N ratio showing increased nutrient availability as compared to farmers' practice.

Similar results are reported by

Mtambanengwe *et al.,* (2004); Scott *et al.,* (1996) and Dancer *et al.,* (1973). Sutaliya and Singh (2005) reported that the inoculation of PSB, especially along with FYM significantly increased the maize growth and yield in comparison to control. They also reported that the maize growth and yield parameters increased with increasing NPK levels. Similar results were reported by Balayan and Kumpawat (2008) who found that with the inoculation of *Azotobacter* and phosphate solubilizing bacteria increase in grain yield was recorded over control. Similar results have been reported by Yadav *et al.,* (2009).

Returns and economics

The gross return was highest under treatment T_4 (Rs.152.20/-) followed by T_3 (Rs. 138.80/-) and lowest under farmers' practice (Rs. 89.44/-) with irrigation level I_2 as shown in table 3. The higher gross return in T_4 and T_3 may be due to higher marketable yield. The B: C ratio was highest in T_4 (2.68) and lowest under T_{11} (farmers' practice) (1.16). The B: C ratio was higher in all the treatments which had been applied with irrigation level I_4 than irrigation level of I_2. The higher B: C ratio in T_4 was due to higher yields in comparison to other treatments. Similar results are reported by Patil *et al.,* (2010) who revealed that the treatment combination of 0.60 PE x 80 % resulted into the maximum B: C ratio of 1.59 followed by B: C ratio of 1.57 in 0.40 PE x 80 % RD and 0.60 PE x 100 % RD. Similar results are also reported by Chand (2014) and Tekale *et al.,* (2014).

References

Abdrabbo, M.A., A. Medany, El- Moniem and Abou-Hadid, E.M.A. 2005. Fertigation management of cucumber plants under plastic houses. *Egyptian J. Horticul.,* 32: 1-13.

Acharya, S.K., Y.R. Shukla and Khatik, P.C. 2013. Effect of water regime on growth and yield of lettuce (*Lactuca sativa* L.). *Bioscan,* 8: 201-206.

Al- Jaloud, A., C.T. Ongkingco, S. Al- Sharar and Al-Bashir, W. 1999. Effect of fertigation frequencies on growth and yield of greenhouse grown cucumber. *Saudi J. Biol. Sci.,* 6: 156-166.

Amer, K.H., S.A. Midan and Hatfield, J.L. 2009. Effect of deficit irrigation and fertilization on cucumber. *Agron. J.,* 101(6): 1556-1564.

Asano, J.C. 1994. Effect of organic manures on quality of vegetables. *J. Agri. Res.,* 18: 31-36.

Balayan, J.K., and Kumpawat, B.S. 2008. Nutrient content and their uptake influenced by integrated nutrient management in maize. *Int. J. Agri. Sci.,* 453-456.

Chand, A.J. 2014. Nutrient use efficiency and economics of salad cucumber using drip fertigation in naturally ventilated polyhouses. *J. Agri. Vet. Sci.,* 7(12): 22-25.

Choudhari, S.M., and More, T.A. 2002. Fertigation, fertilizer and spacing requirement of tropical gynocecious cucumber hybrids. *Acta Horticulturae,* 588: 233-240.

Chouhan, S.S., M.K. Awasthi, R.K. Nema and Koshta, L.D. 2015. Soil moisture distribution under different lateral and dripper spacing of surface drip irrigation system in clay loam soil. *Int. J. Agri. Environ. Biotechnol.,* 8(3): 743.

Dancer, W.S., L.A. Peterson and Chesters, G. 1973. Ammonification and nitrification of N as influenced by soil pH and previous N treatments. *Soil Sci. Soc. Am. J.,* 37: 67-69.

Feleafel, N.M., M.M. Zohair and Abdishakur, H.S. 2014. Effect of NPK fertigation rate and starter fertilizer on the growth and yield of cucumber grown in greenhouse. *J. Agri. Sci.,* 6: 81-92.

Grimstand, S.O. 1990. Evaluation trials of greenhouse cucumber. Verdiproving av veksthusagurk, *Garthneryrket,* 80: 16-18.

Guler, S. Ibriki and Buyuk. 2006. Effects of different nitrogen rates on yield and leaf nutrient contents of drip fertigated and greenhouse grown cucumber. *Asian J. Plant Sci.,* 5: 657-662.

Imamsaheb, S.J., Hanchinmani, C.N. and Ravinaik, K. 2014. Impact of drip irrigation and fertigation on growth, yield, quality and economic returns in different vegetable crops. *Asian J. Horticult.,* 9(2): pp.484-491.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice hall inc. Englewood cliffs, New Jersey, USA.

Jensen, M.H. 2002. Controlled environment agriculture in deserts tropics and temperate regions – A world review. *Acta Horticult.,* 578: 19–25

Kapoor, R., S.K. Sandal, S.K. Sharma, A. Kumar and Saroch, K. 2013. Effect of varying drip irrigation levels and NPK fertigation on soil water dynamics, productivity and water use efficiency of cauliflower (*Brassica oleracea* var. Botrytis) in

wet temperate zone of Himachal Pradesh. *Indian J. Soil Conserv.,* 42: 249-254.
Koodzeij, M., and Kostecka, J. 1994. Some quality characteristics in cucumbers and carrots grown on vermicomposts.Zezyty - Naukeme – Akademii - Roluicoz – ej - im- Hugona – Koataja – w - karkowie, *Serja -Naakowa,* 41: 89-93.
Krishnamanohar, R. 2002. Evaluation of capsicum (*Capsicum annuum* L.) hybrids and effects of sources of fertilizers and levels of fertigation on its cultivation under green house condition. Ph.D. Thesis, University of Agricultural Sciences, Bangalore, India.
Liang, X., Y. Gao, X. Zhang, Y. Tian and Zhang, Z. 2014. Effect of optimal daily fertigation on migration of water and salt in soil, root growth and fruit yield of cucumber (*Cucumis sativus* L.) In solar-greenhouse. *PLoS ONE* 9(1): e86975.
Monisha, R., S.K. Maurya, P.K. Singh and Maurya, R. 2014. Screening of improved cultivars of cucumber in naturally ventilated polyhouse under tarai condition of Uttarakhand. *J. Hill Agri.,* 5(1): 72-75.
Moujabber, E.I., Atallah, M. and Darwish, T. 2002. Crop modeling and water useefficiency of protected cucumber. *Int. Atomic Energy Agency Tech. Doc.,* 1266: 61-67.
Mtambanengwe, F., P. Mapfumo and Kirchmann, H. 2004. Decomposition of organic matter in soil as influenced by texture and pore size distribution. Managing nutrient cycles to sustain soil fertility in sub-Saharan Africa p, 261.
Nagalakshmi, S., N. Nandakuma, D. Palaniswamy and Sreenarayana, V.V. 2001. Naturally ventilated polyhouse for vegetable cultivation. *South Indian Horticult.,* 49: 345-346.
Patil, R.V., A.B. Bhosale and Takte, R.L. 2010. Effect of drip irrigation and fertigation levels on growth and yield of gerbera under greenhouse conditions. *Ecol. Environ. Conserv.,* 16: 235-237.
Pires, M. R.C. Furlani., P.R. Ribeiro, B.R.V. Junior, D. Sakai, E. Lourencao and Neto, T.A.L. 2011. Irrigation frequency and substrate volume effects in the growth and yield of tomato plants under greenhouse conditions. *Scientia Agricola*, 68: 400-405.
Reddy and Reddy. 2003. Principles of Agronomy. Kalyani Publication, New Delhi, pp. 319-320.
Sathya, S., Pitchai, G.J., Indirani, R., andKannathasan, M. 2008. Effect of fertigation on availability of nutrients (N, P and K) in soil-a review. *Agri. Rev.,* 29(3): 214-219.
Scott, N.A., C.V. Cole, E.T. Elliott and Huffman, S.A. 1996. Soil textural control on decomposition and soil organic matter dynamics. *Soil Sci. Soc. Am. J.,* 60: 1102-1109.
Solaimalai, A., Baskar, M., Sadasakthi, A. and Subburamu, K. 2005. Fertigation in high value crops. *Agri. Rev.,* 26(1): 1-13.
Srivastava, A.K., J.P. Mishra and Singh, S.P. 1993. Response of different spacing and fertilizer levels on growth and yield of sweet pepper (Capsicum annuum) Cv. Bharath. *Prog. Horticult.,* 25: 94-100.
Sutaliya, R., and Singh, R.N. 2005. Effect of planting time, fertility level and phosphate solubilizing bacteria on growth, yield and yield attributes of winter maize (*Zea mays*) under rice (*Oryza sativa*)-maize cropping system. *Indian J. Agron.,* 50: 173-175.
Tekale, C.D., A.D. Tumbare, G.S. Tekale, N.J. Danawale and Tambe, S.T. 2014. Effect of different fertigation levels and schedules on growth and yield of cucumber under polyhouse conditions. *Int. J. Curr. Res.,* 6: 7353-7355.
Wang, Z., Liu, Z., Zhang, Z. and Liu, X. 2009. Subsurface drip irrigation scheduling for cucumber grown in solar greenhouse based on 20 cm standard pan evaporation in Northeast China. *Scientia Horticulturae,* 123: 51-57
Yadav, S., J. Yadav and Singh, G.S. 2009. Integrated low input nutrient management by bio-fertilizers in wheat-maize cropping system. In: Procceding, Department of Botany, St. Johns College Agra-282002(U.P.) India.
Yaghi, T., A. Arslan and Naoum, F. 2013. Cucumber (*Cucumis sativus* L.) water use efficiency (WUE) under plastic mulch and drip irrigation. *Agri. Water Manage.,* 128: 149-157.
Yuan, B.Z., Sun, J. and Kang, Y. 2006. Response of cucumber to drip irrigation water under a rain shelter Soichi Nishiyama. *Agri. Water Manage.,* 81: 145–158.

How to cite this article:

Sunil Kumar, Naveen Datt, S.K. Sandal and Sanjay K. Sharma. 2017. Effect of Cow Urine and Bio-Fertilizers based Fertigation Schedule at Varying Levels of Drip Irrigation on Yield, Growth, Quality Parameters and Economics of Cucumber under Protected Condition. *Int.J.Curr.Microbiol.App.Sci.* 6(6): 1242-1249. doi: https://doi.org/10.20546/ijcmas.2017.606.145