

Original Research Article

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## Interactive Impact of Irrigation and Fertigation Level on Growth and Yield Attributes of Cucumber under Naturally Ventilated Polyhouse

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### ABSTRACT

The field experimental study was carried out under naturally ventilated polyhouse during winter season at plasticulture farm of CTAE, Udaipur to study the influence of irrigation and fertigation level on growth & yield attributes of cucumber. The experiment consisted of 9 treatment combination with 3 replication in randomized block design. The treatments include 3 irrigation levels viz. 100 %, 80% and 60 % ET through drip and 3 levels of fertilizer application viz. 125%, 100%, 75% RDF of N,P,K through fertigation. The effects of different treatments recorded the significant effect on growth and yield attributes of cucumber. Maximum average plant height (399.27 cm), days to 50% flowering (30.67), days to first harvest (42.67), average length of fruit (15.92cm), average diameter of fruit (3.98 cm) were reported in treatment T<sub>5</sub> (drip irrigation with 80% ETc and fertigation at 100% RDF) as compared to other treatments. However maximum individual weight of fruit (133.03 gm), number of fruit per plant (34.80), Maximum yield of fruit (132.62tonne/ha) were observed in T<sub>5</sub> treatment respectively. Also higher O: I ratio (2.65:1) was observed in T<sub>5</sub> treatment and minimum (1.6:1) under T<sub>9</sub> treatment. By considering all the aspects treatment T<sub>5</sub> was observed best among all other treatments.

#### Keywords

Naturally ventilated polyhouse, cucumber, irrigation and fertigation level, growth, yield attributes

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### Introduction

Vegetables impart not only nutritional security but also play a main role in economic viability and fit well into predominant intensive cropping system prevailing in different part of our country. More than 60 kinds of vegetables are cultivated in India produced 162.19 million tonnes of vegetables and vegetables export from our country was worth ₹ 5462.93 crores. Though India's share in global market is only about 1%, there is increasing of

horticultural products from our country is necessary. (Anonymous, 2014). Cucumber (*Cucumis sativus L*) is mostly preferred vegetables from cucurbitaceae family. In our country, Cucumber is cultivated in 71 thousand's ha with production of 1.202 lakh MT and productivity of 16.929 thousand's MT/ha in 2015-16 year (Anonymous, 2017). The nutritive value of 100 g of edible cucumber is calcium (14 mg), magnesium (15 mg), potassium (127 mg), vitamin C (12mg), Niacin (0.3 g), protein (0.6 g), dietary fiber

(0.5 g), carbohydrate (2.2-3.6 mg) (Anonymous, 2018). It contains more than 90 % water content, which making cucumber an ideal hydrating and cooling food. It is a very good source of potassium, vitamin K and some unique anti-oxidants, which are good for brains, heart and urinary system of human body (Sikarwar and Hardaha, 2016). Generally Cucumber is warm season crop. But due to polyhouse technique it can be grown winter season also for provide more profit to farmers.

In looking at the future scenario, water scarcity is considered as the largest water problem worldwide (Jury and Vaux 2005). It is obvious then that the solution to this problem lies mostly on improving the efficiency of water use for food production. Polyhouse techniques achieves higher water and nutrient use efficiencies (Bhattarai *et al.*, 2015). In polyhouse technique yield of crop increased but proper water and fertiliser management will be necessary.

Fertigation is the application of water soluble solid fertiliser applied through drip irrigation directly to the root zone plant. It increases the fertilizer efficiency by saving fertilizer. In polyhouse technique yield of crop increased but proper water and fertiliser management will be necessary. The present work was conducted to study the effect of irrigation and fertigation levels on growth and yield of cucumber crop under NVP in order to find out best combination of water and fertilizer treatment.

## Materials and Methods

The present research work was conducted inside the naturally ventilated polyhouse during winter season of 2017-18 at plasticulture farm of CTAE, Maharana Pratap University of Agriculture and Technology, Udaipur. Nine treatments combination were

applied in Randomized Block Design with three replications. The treatments consist of 3 levels of irrigation. viz. 100 %  $ET_C$  ( $I_1$ ), 80% $ET_C$  ( $I_2$ ), 60% $ET_C$  ( $I_3$ ), through drip irrigation and 3 level of fertigation, 125% RDF ( $F_1$ ), 100% RDF( $F_2$ ), 75% RDF( $F_3$ ) through drip.

## Estimation of Reference Crop Evapotranspiration ( $ET_0$ )

The daily reference crop evapotranspiration was estimated by using the standard method i.e. FAO Penman-Monteith (Allen *et al.*, 1998)

## Crop evapotranspiration

The daily crop evapotranspiration was estimated using Equation as shown below:

$$ET_c = K_c \times ET_0 \dots (11.2)$$

Where,  $ET_c$  = crop evapotranspiration, (mm/day),  $K_c$  = crop coefficient,  $ET_0$  = Reference Crop Evapotranspiration, (mm/day)

The volume of water required under drip irrigation system was computed by following formula.

$$W_r = \frac{\text{Croparea} \times ET_0 \times K_c \times W_a}{E_u}$$

Where,  $W_r$  = peak water requirement, (lit/day/plant), Crop area = row to row spacing (m)  $\times$  plant to plant spacing (m) of the crop,  $ET_0$  = reference evapotranspiration, (mm/day),  $K_c$  = crop coefficient,  $W_a$  = wetted area, (%).

Mini Angel F1 hybrid cucumber was sown under naturally ventilated polyhouse on 4<sup>th</sup> Oct 2017 with 2 rows per plot consisting of 64 plants/plot. Keeping row to row, plant to plant distance 50 cm $\times$ 50 cm respectively. Total 27

lateral was used for experimental set up. Each lateral served one row with in-line emitter distance at 30 cm and discharge rate of 2 lit per hour.

Irrigation scheduling has been decided before growing of the crop by using the last five year data i.e. 2012-13 to 2016-17 for the months Oct to February. Available capacity of tank was 5000 lit, so for convenient basis, water was supplied after total depletion of 5000 lit water. Mean water was applied with 5 to 7 days interval according to the treatments. Scheduling of fertilizer was done by Full dose of P, half dose of N and K applied as basal dose and remaining half dose of N, K was applied through fertigation after 30 DAS in 5 day interval into 3 fertigation levels 125% RDF, 100% RDF, 75% RDF.

All other packages, input sources and practices were adopted same to all treatment as recommended for the region.

The water use efficiency was determined by following equation:

$$WUE = \frac{Y}{WR}$$

Where, WUE = Water Use Efficiency, ( $\text{kg}/\text{m}^3$ ), Y=Crop yield, ( $\text{kg}/\text{ha}$ ), WR = water requirement, ( $\text{m}^3/\text{ha}$ ).

The fertilizer use efficiency was computed by the following equation.

$$UE = \frac{\text{Crop Yield } (\frac{\text{kg}}{\text{ha}})}{\text{Total quantity of nutrient applied } (\text{kg}/\text{ha})}$$

Statistical analysis of data was performed using a randomized block design with three replication. 5% level of significance was considered in ANOVA to test the influence of different irrigation and fertigation levels on growth and yield attributes of cucumber.

## Results and Discussion

The performance evaluation of drip irrigation system was studied before conducting the experiment. The drip system performed at emission uniformity of 85.93 % with 1.76 lph average discharge rate indicating the good performance of the system. Physio-chemical properties of soil was also determined.

Actual water required for cucumber crop was determined by penman Monteith equation using daily climatic data under NVPH during season 2017-18. According to this total 21 times 5000 lit of irrigation water was supplied to crop as per the different treatments i.e. 100 %  $ET_C$ , 80 %  $ET_C$  and 60 %  $ET_C$ . Total water requirement of cucumber crop under NPVH at 100 %  $ET_C$  (i.e.  $T_1, T_2, T_3$ ), 80 %  $ET_C$  (i.e.  $T_3, T_4, T_5$ ) and 60 %  $ET_C$  (i.e.  $T_6, T_7, T_8$ ) was 269.98 mm, 215.98 mm and 156.93 mm respectively.

The observations were recorded on WUE, FUE, various growth parameters, yield parameters of cucumber and were subjected to statistical analysis. The results regarding to this are discussed as follows:

### Water use efficiency

Water use efficiency was significantly improved by interactive effect of different irrigation and fertigation level (Fig.1). The result of study indicated that water use efficiency increased by reduction in irrigation water applied through drip with higher level of fertigation. Highest WUE ( $62.33\text{kg}/\text{m}^3$ ) was realized for  $T_7$  treatment (drip irrigation with 60%  $ET_C$  and fertigation at 125 % RDF) because this treatment consumed less water with higher level of fertigation. Lowest WUE ( $38.88\text{ kg}/\text{m}^3$ ) was obtained under  $T_1$  treatment (drip irrigation with 60%  $ET_C$  and fertigation at 125 % RDF) due to more water applied as compare to other treatments. But at

T<sub>5</sub> treatment, WUE (61.40kg/m<sup>3</sup>) was observed with comparatively higher yield. This results are also agreement with (Dunage *et al.*, 2008), (Soni 2013), (Joshi 2014) and (Rajak 2015). (Rahil and Qanadillo (2015) was reported that 70% ET<sub>C</sub> treatments has higher WUE (33 kg/m<sup>3</sup>) of cucumber crop than under F1, T1 and ET<sub>C</sub> treatments under greenhouse cultivation. (Wang and Xing 2016) researcher reported that in tomato crop highest WUE is obtained in the W3F1 (W3-50 % ET<sub>C</sub>, F1-N-240-P<sub>2</sub>O<sub>5</sub> -120-K<sub>2</sub>O-150 kg·ha<sup>-1</sup>) treatment in tomato crop and was 45 kg·m<sup>-3</sup> and 47.7 kg·m<sup>-3</sup> in 2012 and 2013, respectively.

### **Fertilizer use efficiency**

The fertilizer use efficiency as influenced by irrigation and fertilizer levels was depicted in Fig.2. The FUE has decreased with increase in level of fertilizer in all the treatment.

It is seen from the Fig.2 that the highest fertilizer use efficiency recorded was 579.27kg of yield/kg of nutrients applied in Treatment T<sub>6</sub>(drip irrigation with 80% ET<sub>C</sub> and fertigation at 75 % RDF). It might be attributed to reduction in quantity of nutrient applied in this treatment and no leaching of nutrients in the form of runoff. Also might be due to efficient use of water (80 % ET<sub>C</sub>) increase nutrient uptake by the plant, corresponded with lower fertilizer applied. The researcher (Soni 2013), (Rajak 2015), (Joshi 2014) stated that at Low level of fertigation FUE is higher.

### **Growth parameters of cucumber crop**

#### **Plant height**

At 30 DAS and 60 DAS, plant height was observed maximum (133.8 cm and 295.27 cm) in T<sub>4</sub> treatment followed by T<sub>5</sub> (130.93 and 295.07cm), which is significantly higher than

other 8 treatments and lower with T<sub>9</sub> (104.00 and 202.53 cm) respectively. At 90 DAS and last harvest, plant height was obtained maximum (381.13cm and 399.27 cm) under T<sub>5</sub> treatment followed by T<sub>4</sub> (373.00 and 398.67cm). This might be due to optimum availability of nutrients and moisture. Result showed that there is less significant difference between T<sub>4</sub> and T<sub>5</sub> treatment. The minimum plant height (253.73 and 271.47) was recorded in T<sub>9</sub> treatment at 90 DAS and at last harvest respectively.

Plant height of cucumber reported by Gupta *et al.*, (2014) was 248.41cm (8.15 ft) at treatment combination of 80% ET through drip + 80 % recommended NPK through fertigations. Imamsaheb *et al.*, (2011) revealed that the application of 100 per cent fertilizers through water soluble fertilizer through drip at 80 per cent evaporation resulted in higher plant height (96.70 cm) in tomato crop.

#### **Days to 50 % flowering and days to first harvest**

Days to 50 % flowering was significantly influenced by effect of irrigation and fertigation level as shown in Table 1. Minimum days required for 50 % flowering was reported in treatment T<sub>5</sub> (30.67) followed by treatment T<sub>4</sub> (31.67). Maximum days required for 50 % flowering was reported in T<sub>9</sub> (36.67). Treatment T<sub>9</sub> (drip irrigation with 60% ET<sub>C</sub> and fertigation at 75 % RDF) prolonged the vegetative growth so that late flowering occurred at T<sub>9</sub>.

Minimum days required for first harvest was reported in treatment T<sub>5</sub> (42.67) at par with treatment T<sub>4</sub> (43.33) and superior to all other treatments. This might be due to very favorable combination of irrigation (80% ET<sub>C</sub>) and fertigation level (100% RDF of NPK). Maximum days required for first harvest was reported in T<sub>9</sub>(48.33).

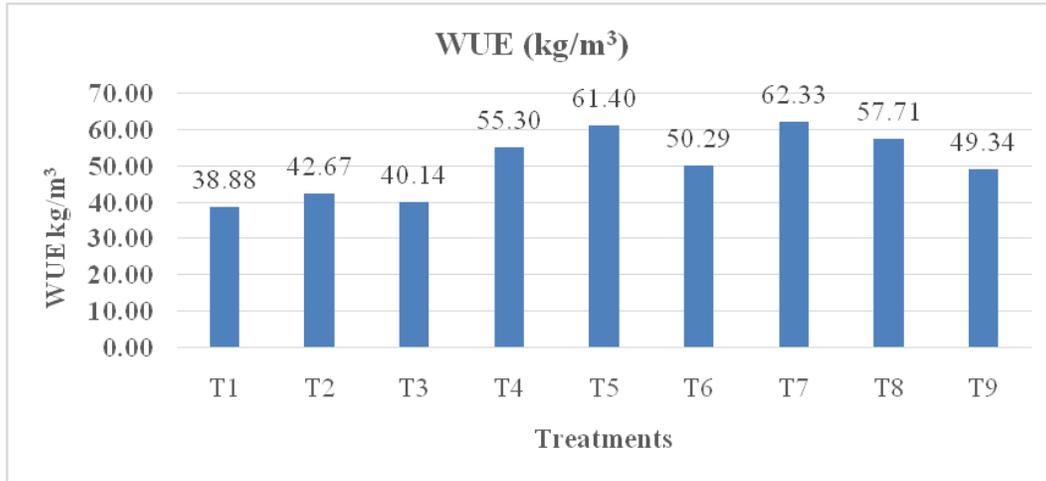
**Table.1** Effect of different irrigation and fertigation levels on growth Parameter of cucumber plant

Treatment		Plant height (cm)				Days for 50 % flowering	Days to first harvest	Length of fruit (cm)	Dia. of fruit (cm)
		30 DAS	60 DAS	90 DAS	At harvest				
T <sub>1</sub>	I <sub>1</sub> F <sub>1</sub>	124.00	259.73	324.00	339.93	32	44.67	14.12	3.42
T <sub>2</sub>	I <sub>1</sub> F <sub>2</sub>	128.20	272.60	340.27	357.87	31.67	45.33	14.37	3.51
T <sub>3</sub>	I <sub>1</sub> F <sub>3</sub>	118.00	249.93	322.33	338.27	34.33	47.00	13.55	3.35
T <sub>4</sub>	I <sub>2</sub> F <sub>1</sub>	<b>133.80</b>	<b>295.27</b>	373.00	398.67	31.67	43.33	14.77	3.68
T <sub>5</sub>	I <sub>2</sub> F <sub>2</sub>	130.93	295.07	<b>381.13</b>	<b>399.27</b>	<b>30.67</b>	<b>42.67</b>	<b>15.92</b>	<b>3.98</b>
T <sub>6</sub>	I <sub>2</sub> F <sub>3</sub>	117.80	233.87	305.27	322.20	34.33	46.67	13.00	3.42
T <sub>7</sub>	I <sub>3</sub> F <sub>1</sub>	113.00	223.73	285.20	303.80	35.33	46.67	12.15	3.11
T <sub>8</sub>	I <sub>3</sub> F <sub>2</sub>	113.53	219.47	272.40	289.93	36.00	48.00	12.87	3.06
T <sub>9</sub>	I <sub>3</sub> F <sub>3</sub>	104.00	202.53	253.73	271.47	36.67	48.33	12.09	3.00
SEm ±		<b>4.88</b>	<b>6.83</b>	<b>8.78</b>	<b>8.81</b>	<b>0.48</b>	<b>0.46</b>	<b>0.23</b>	<b>0.07</b>
CD at 5		<b>14.63</b>	<b>20.49</b>	<b>26.3</b>	<b>26.43</b>	<b>1.44</b>	<b>1.38</b>	<b>0.69</b>	<b>0.22</b>

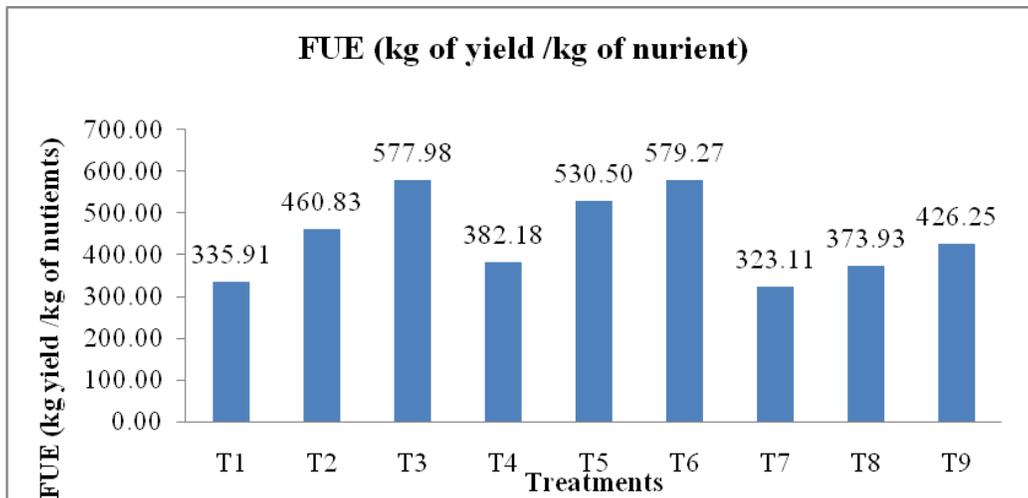
**Table.2** Effect of different irrigation and fertigation levels on yield attributes of cucumber plant

Treatment		Individual weight of fruit (gm)	No. of fruit per plant	Weight of fruits /plant (kg)	Yield / plot (kg)	Yield / sq.m Kg/sq. m	Yield (ton/ha)
T <sub>1</sub>	I <sub>1</sub> F <sub>1</sub>	105.73	30.13	2.62	167.96	10.5	104.972
T <sub>2</sub>	I <sub>1</sub> F <sub>2</sub>	109.91	30.00	2.88	184.33	11.52	115.21
T <sub>3</sub>	I <sub>1</sub> F <sub>3</sub>	88.94	29.67	2.71	173.39	10.84	108.37
T <sub>4</sub>	I <sub>2</sub> F <sub>1</sub>	113.95	31.67	2.99	191.09	11.94	119.43
T <sub>5</sub>	I <sub>2</sub> F <sub>2</sub>	<b>133.03</b>	<b>34.80</b>	<b>3.32</b>	<b>212.20</b>	<b>13.26</b>	<b>132.62</b>
T <sub>6</sub>	I <sub>2</sub> F <sub>3</sub>	86.46	28.40	2.72	173.78	10.86	108.61
T <sub>7</sub>	I <sub>3</sub> F <sub>1</sub>	76.37	28.13	2.52	161.56	10.10	100.97
T <sub>8</sub>	I <sub>3</sub> F <sub>2</sub>	76.45	27.33	2.34	149.57	9.35	93.48
T <sub>9</sub>	I <sub>3</sub> F <sub>3</sub>	74.07	24.93	2.00	127.88	7.99	79.92
SEm ±		<b>5.18</b>	<b>1.86</b>	<b>0.08</b>	<b>14.11</b>	<b>0.88</b>	<b>8.82</b>
CD at 5		<b>15.54</b>	<b>5.58</b>	<b>0.25</b>	<b>42.29</b>	<b>2.64</b>	<b>26.43</b>

**Fig.1** Water use efficiency (WUE) of cucumber in different treatments



**Fig.2** Fertilizer use efficiency (FUE) of cucumber in different treatments



It might be attributed to low level of drip irrigation with low level of fertigation. It prolongs the vegetative growth of cucumber plant and delayed maturity.

**Length and diameter of cucumber**

Maximum average length of fruit and average diameter of the fruit were reported in treatment T<sub>5</sub> (drip irrigation with 80% ETC and fertigation at 100% RDF) i.e. 15.92cm and 3.98 cm and followed by T<sub>4</sub> (14.77 cm and 3.68 cm) respectively (Table.2). Minimum length of fruit and diameter of fruit

was reported in T<sub>9</sub> (12.09cm and 3.00 cm) respectively. It might be due to optimum availability of water and nutrient without loss of fertilizer increases photosynthesis. Also might be due to higher nutrient uptake by plant at drip irrigation with 80% ETC and fertigation at 100% RDF. Patil and Gadge (2016) reported the maximum average diameter of the cucumber fruit was observed with application of 100 per cent N through drip and soil application of P and K i.e. T<sub>2</sub> (3.89 cm). Also Gao *et al.*, (2016) found that 90 % of field capacity was a highest diameter of cucumber fruit.

## **Yield parameter**

### **Individual fruit weight**

The data regarding to individual weight of fruit are presented in Table.2. Individual weight of fruit was affected significantly due to combined effect of irrigation and fertigation levels. The fruit weight plays an important role in increasing the total yield in cucumber. However, the individual fruit weight (133.03 gm) was recorded in treatment T<sub>5</sub> followed by T<sub>4</sub> (113.95 gm) which was significantly superior over the all other treatments. This was largely due to the increased length and diameter of fruit. This could be due to a high uptake of nutrients and build-up of sufficient photosynthesis enabling the increase in size of fruits (length and diameter), resulting in the increased fruit weight and its volume. The lowest individual fruit weight (74.07gm) was recorded in treatment T<sub>9</sub>.

### **No. of fruits per plant**

Maximum no. of fruit per plant was obtained in T<sub>5</sub> (34.80) followed by T<sub>4</sub> treatment (31.67). This result shown that at 80 % ET<sub>C</sub> with 100 % and 125 % RDF of NPK due to favourable condition more aeration, sufficient moisture and high uptake of nutrient as compared to other treatment, enhanced vegetative growth. Plant height obtained in T<sub>5</sub> was higher means higher no. of nodes resulting in higher no. of fruit. Minimum no. of fruit per plant (24.93) was obtained in T<sub>9</sub>. Due to inadequate water and low level of fertigation, less plant height. Gupta *et al.*, (2014) reported that in cucumber crop maximum no. of fruit (22) was obtained in treatment combination of 80% ET through drip + 80 % recommended NPK through fertigations. Also by Imamsaheb *et al.*, (2011) revealed that the application of 100 per cent fertilizers through water soluble fertilizer

through drip at 80 per cent evaporation in tomato crop resulted in significantly higher number of fruits per plant (40.71).

### **Yield of fruit**

The data pertaining to average total weight of fruits per plant and yield of crop as influenced by different irrigation and fertigation levels are presented in Table 4.18. Fruits weight per plant, fruit yield per plant, fruit yield per square meter area and fruit yield per hectare (ton/ha) is represented in Fig. 4.12 Fig. 4.13, Fig. 4.14 and Fig. 4.15 respectively. Maximum weight of fruit per plant, Yield per plot kg, yield per sq.m were observed in T<sub>5</sub> treatment (3.32 kg), (212.20 kg/plot), (13.26kg/sq.m), respectively. Minimum weight of fruit per plant, Yield per plot (kg), yield per sq.m, were observed in T<sub>9</sub> treatment (2.00 kg), (127.80 kg/plot), (7.99kg/sq.m) respectively.

Table 4.18 shown that maximum yield of cucumber per hectare was obtained in T<sub>5</sub> treatment (132.62 tonnes per ha) followed by T<sub>4</sub> treatment (119.43 tonnes per ha). This result might be due to maximum no. of plant, higher individual weight of fruit obtained in T<sub>5</sub> treatment. This might be attributed due to favourable combination of moisture and nutrient available to crop enhanced vegetative and yield growth. Lower yield (79.92 tonnes per ha) was recorded in T<sub>9</sub> treatments due to lesser uptake of nutrient by the crop under low level of irrigation and fertigation level. Gupta *et al.*, (2014) reported that treatment combination of 80 % ET through the drip + 80 % RDF of NPK through fertigation produced maximum yield 144.41 tonne/ha.

The result of study showed that combination of different irrigation and fertigation levels have significant effect on WUE, FUE, growth and yield attributes of cucumber. The result concluded that WUE increased with reduction

in water applied and FUE was enhanced with decreasing quantity of fertilizer applied. There is no significant relation between yield and WUE.

Vegetative growth, was enhanced Due to sufficient moisture availability and higher nutrient uptake by the plant, so increases photosynthesis and cell resulted into more yield. This study concluded that 80% ET<sub>c</sub> significantly increases cucumber yield than 100 % ET<sub>c</sub> at 100% RDF fertigation. By considering all the aspects such as growth and yield parameters, in water scarcity area, treatment T<sub>5</sub>(drip irrigation with 80% ET<sub>c</sub> and fertigation at 100% RDF) is best among all other treatments for cucumber crop under naturally ventilated polyhouse in off season in order to get maximum profit.

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