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## **EFFECT OF FERTIGATION AND IRRIGATION SCHEDULING ON GROWTH AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS L.*)**

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**Abstract:** The maximum yield ( $21.67 \text{ t}\cdot\text{ha}^{-1}$  and  $20.85 \text{ t}\cdot\text{ha}^{-1}$ ) was obtained with fertigation level  $F_1$  (80% of R.D) and irrigation level  $I_2$  (0.3PE). The yield was 44.28% and 39% higher in fertigation level  $F_1$  and irrigation level  $I_2$  as compared to conventional method of irrigation. The individual effect of fertigation and irrigation levels showed significant effect on the yield but the interaction effect between fertigation and irrigation levels was found to be non-significant. The maximum water use efficiency (WUE) of  $11.6 \text{ t}\cdot\text{ha}^{-1}\cdot\text{mm}$  and  $10.9 \text{ t}\cdot\text{ha}^{-1}\cdot\text{mm}$  was recorded with  $I_1$  and  $F_1$  while maximum fertilizer use efficiency (FUE) of 135.10 was recorded with  $F_1$ . The total quantity of water applied through drip irrigation and conventional method of irrigation was 16.35 cm and 48.00 cm respectively, indicating 65.93% saving of water in drip irrigation system over conventional method of irrigation. The B:C ratio 1.94 was found maximum in treatment combination  $I_2 F_1$ .

**Key words:** cucumber, irrigation, water use efficiency, fertilizer use efficiency, fertigation, yield, B:C ratio.

### **INTRODUCTION**

Cucumber has high place in the diet as a rich source of carbohydrates, as a breakfast fruit and as an ingredient of salads. Cucumber forms an important and big group of vegetable in our diet due to its high nutritive value (44.5 g of average nutritive value per

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100 g dry matter). It can give cool and refreshing effects in summer. The area and productivity of cucumber is very low in Maharashtra. Hence to increase the production per unit use of water, adequate and timely supply of water is crucial one. The important input which seriously affects the growth and yield of any vegetable is fertilizer application. Thus with Hi-tech irrigation practice like drip irrigation, fertilizer were applied with water directly in the root-zone of crop, thereby avoiding leaching and percolation losses with the economy in the use of fertilizers and water to be applied. The cultural practices coupled with balanced use of fertilizers and optimum use of irrigation water plays an important role in enhancing the productivity of cucumber. Therefore the present study was aimed to work out fertilizer and water requirement, compare yield of cucumber, *WUE* and *FUE* as influenced by drip and surface irrigation method and compute benefit cost ratio.

## MATERIAL AND METHODS

The field experiment was conducted at the Instructional Farm of Department of Irrigation and Drainage Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering, MPKV., Rahuri on clay soil during the period from December 2004 to March 2005. The topography of the experimental field was uniform and leveled. The EC and pH of the experimental plot were  $0.502 \text{ dSm}^{-1}$  and 8.05, respectively. Available N, P and K were observed as  $416.97 \text{ kg}\cdot\text{ha}^{-1}$ ,  $45.824 \text{ kg}\cdot\text{ha}^{-1}$ ,  $728.00 \text{ kg}\cdot\text{ha}^{-1}$ . The quality of water was of class  $C_3S_1$ .

The experiment was carried out in split plot design with three main-plot treatments and four sub-plot treatments with one control treatment each having three replications. The main-plot treatments included  $I_1$  : Irrigation at 0.2PE by drip irrigation method,  $I_2$  : Irrigation at 0.3PE by drip irrigation method,  $I_3$  : Irrigation at 0.4PE by drip irrigation method, Where 0.2, 0.3 and 0.4 were the integrated factors derived from crop coefficient ( $K_c$ ), pan factor ( $K_p$ ) and wetted area ( $W_a$ ). Sub-plot treatments included  $F_1$  : 80% of recommended dose (*RD*) through water soluble fertilizer (*WSF*),  $F_2$  : 100% of recommended dose through water soluble fertilizer,  $F_3$  : 120% of recommended dose through water soluble fertilizer and  $F_4$  : Application of N through drip and P, K by band placement according to recommended dose. The treatments were compared with a suitable control i.e with conventional method of irrigation (ridges and furrows) replicated thrice.

The experiment was laid out with twelve treatment combinations arranged randomly on a field of 40 m x 22 m size with spacing of 1.0 m x 0.5 m while with conventional method of irrigation on a field of 40 m x 1 m size with a spacing of 0.5 m x 1.0 m. The buffer of 1m was left between two successive treatment plots in order to avoid lateral movement of water from one treatment plot to another. One lateral commanded two rows of cucumber plants. The seeds of cucumber (var. Himangi) were dibbled on 29<sup>th</sup> December 2004 at the rate of  $1.50 \text{ kg}\cdot\text{ha}^{-1}$ .

Water-soluble fertilizer (Ultrasol) of grade (19:19:19) and urea was used for treatments with fertigation levels from  $F_1$  to  $F_3$  while urea (46% N), single super phosphate (16%  $\text{P}_2\text{O}_5$ ), murate of potash (60%  $\text{K}_2\text{O}$ ) were used for treatment with fertigation level  $F_4$  and conventional method of irrigation. The recommended dose of fertilizer (NPK) for the cucumber crop is  $100:50:50 \text{ kg}\cdot\text{ha}^{-1}$ . Water soluble fertilizers

(Ultrazol) were applied weekly as per different treatments. The basal dose was divided into four splits as 10%, 30%, 30% and 30% respectively and was applied weekly after sowing, whereas the dose for top dressing was divided into four equal splits as 12.5% and was applied weekly in the next month.

In case of control, solid fertilizers were used in which half dose of N and full dose of P and K were given at the time of sowing and remaining half dose of N was given one month after sowing.

The effect of fertigation and irrigation levels on growth and yield contributing parameters viz., length of vine, diameter of fruit, weight of fruit, length of fruit, number of fruit, compactness of fruit and yield of fruit were observed.

## RESULTS AND DISCUSSION

It was observed that the maximum 480.00 mm depth of irrigation water was applied to cucumber crop in control treatment followed by 227.04, 195.28 and 163.52 mm as in irrigation level  $I_3$ ,  $I_2$ ,  $I_1$  that was 237.04 mm respectively through drip irrigation system. The maximum saving (65.58%) of water in  $I_1$  was achieved with drip irrigation system over control.

It was also observed that the yield per hectare of cucumber differed significantly due to irrigation levels. The maximum average yield of 20.83 t·ha<sup>-1</sup> was reported for treatment  $I_2$  (0.3PE) and was found significantly superior over rest of treatments ( $I_1$  and  $I_3$ ). This might be due to the favorable moisture status in the rootzone of crop produced by treatment with irrigation level  $I_2$  during the growth period as compared to treatment with  $I_1$  (0.2PE) and  $I_3$  (0.4PE), which resulted in reduced average yield of fruit. The treatments  $I_1$  and  $I_3$  were at par with each other. The minimum yield of 17.79 t·ha<sup>-1</sup> was observed in irrigation level of  $I_3$ . Similarly, it was revealed that the average yield per hectare of cucumber varied significantly due to fertigation levels. The maximum average yield of 21.62 t·ha<sup>-1</sup> was obtained in treatment  $F_1$  (80% R.D) and was significantly superior over  $F_3$  and  $F_4$ . The treatment  $F_1$  and  $F_2$  were at par with each other. However the average yield obtained in  $F_2$  was significantly superior to that obtained by  $F_4$  (N through drip and P, K by band placement) and was also at par with  $F_3$ . It was also reported that average yield obtained in treatment  $F_3$  was at par with  $F_4$ . The interaction effect between irrigation levels and fertigation levels was observed to be non-significant in respect of average yield per hectare. In control treatment, the minimum average yield of 14.98 t·ha<sup>-1</sup> was registered, this decrease in yield in case of control treatment might be caused due to deep percolation and conveyance losses of fertilizers during application.

From Tab. 1. it was revealed that the  $WUE$  ranged from 3.12 t·ha<sup>-1</sup>-mm to 11.6 t·ha<sup>-1</sup>-mm due to different treatments. It was revealed that maximum  $WUE$  was reported in treatment with irrigation level  $I_1$  (0.2PE) and with fertigation level  $F_1$  (80% RD). The increase in  $WUE$  was largely due to reduction in total water used. It was also noted that through drip system maximum  $WUE$  was achieved than with conventional method of irrigation. The saving in irrigation water was to the extent of 63.12% and 59.32% [2] in case of irrigation level  $I_1$  (0.2PE) and  $I_2$  (0.3PE) in drip irrigation system as compared with conventional method of irrigation. In other words, within the same quantity of water, about 63.12% and 59.32% additional area could have been brought under irrigation.

Table 1. Water and fertilizer use efficiency as influenced by different treatment

Treatments	Yield [t·ha <sup>-1</sup> ]	Depth of water applied [cm]	Water use efficiency [t·ha <sup>-1</sup> -mm]	Percent saving in water [%]	Quantity of fertilizer applied [kg·ha <sup>-1</sup> ]	Fertilizer use efficiency [%]	Increase in yield [%]
<b>Irrigation levels</b>							
I <sub>1</sub>	18.94	16.35	11.6	65.93	200	94.71	20.91
I <sub>2</sub>	20.83	19.83	10.7	59.32	200	104.13	28.06
I <sub>3</sub>	17.79	23.70	7.5	50.61	200	88.96	15.74
<b>Fertigation levels</b>							
F <sub>1</sub>	21.62	19.86	10.9	58.62	160	135.10	30.69
F <sub>2</sub>	19.86	19.86	10.0	58.62	200	99.30	24.56
F <sub>3</sub>	18.44	19.86	9.3	58.62	240	76.81	18.73
F <sub>4</sub>	16.84	19.86	8.5	58.62	200	84.18	11.02
Control	14.98	48.00	3.1	-	200	74.91	-
<b>SE ±</b>							
	Irrigation levels			Fertigation levels		Interaction (I x F)	
	2.29			6.78			
<b>CD at 5%</b>							
	9.02			20.14		N.S.	

The maximum value of FUE (135.10%) was observed in Tab. 1 for fertigation level with F<sub>1</sub> (80% RD) followed by F<sub>2</sub> (100% RD), F<sub>3</sub> (120% RD) and F<sub>4</sub> (N through drip and P, K by band placement) whereas in case of irrigation levels FUE was observed maximum (104.17%) in I<sub>2</sub> (0.3PE) followed by I<sub>1</sub> (0.2PE) and I<sub>3</sub> (0.4PE). The drip irrigation treatment registered maximum values of FUE as compared to those obtained with conventional method of irrigation. It was revealed that there was 30.69% increase in yield and 20% saving in fertilizers over control.

Table 2. Cost economics of fertigation for different treatments

Items	I <sub>1</sub> F <sub>4</sub>	I <sub>1</sub> F <sub>2</sub>	I <sub>1</sub> F <sub>1</sub>	I <sub>1</sub> F <sub>3</sub>	I <sub>2</sub> F <sub>2</sub>	I <sub>2</sub> F <sub>3</sub>	I <sub>2</sub> F <sub>1</sub>	I <sub>2</sub> F <sub>4</sub>	I <sub>3</sub> F <sub>3</sub>	I <sub>3</sub> F <sub>1</sub>	I <sub>3</sub> F <sub>4</sub>	I <sub>3</sub> F <sub>2</sub>	Control
Cost of production [Rs·ha <sup>-1</sup> ]	40257	49881	47420	52293	49881	52293	47420	40257	52293	47420	40257	49882	33727
Gross monetary return [Rs]	65600	80000	86400	70400	62700	82800	92000	74400	67600	80400	61600	74400	59600
Net income [Rs]	25343	30119	38980	18107	12819	30507	44580	34143	15307	32980	21343	24518	25873
B:C Ratio	1.63	1.60	1.82	1.35	1.28	1.58	1.94	1.85	1.29	1.70	1.53	1.49	1.76

The maximum B:C ratio was observed in treatment combination  $I_2F_1$  (1.94) and the least value was found in treatment combination  $I_2F_2$  (1.28) for drip irrigation system whereas it was 1.76 in control (Tab. 2).

Cost of production (Rs·ha<sup>-1</sup>) = seasonal fixed cost Rs.8890/-, Variable and fertilizer cost, rental value Rs. 1000·ha<sup>-1</sup> and interest on working capital 10%, selling price Rs. 400·q<sup>-1</sup>. The study revealed that there was 30.69% increase in yield and 20% saving in fertilizers over control. The highest water use efficiency (11.58 t·ha<sup>-1</sup>·mm) was found in treatment with irrigation level  $I_1$  (0.2PE) whereas in case of fertigation level highest value of WUE (10.9 t·ha<sup>-1</sup>·mm) was recorded in  $F_1$  (80% RD). The fertilizer use efficiency was recorded highest (104.13%) in irrigation level  $I_2$  (0.3PE) whereas in case of fertigation level highest value (135.10%) was recorded for  $F_1$  (80% RD). The maximum B:C ratio (1.94) was found in treatment combination  $I_2F_1$  which was the combination of treatments with irrigation level  $I_2$  (0.3PE) and fertigation level  $F_1$  (80% RD) with the maximum net income of 44,580 Rs·ha<sup>-1</sup>.

## CONCLUSIONS

From the present study it was concluded that though the effect of interaction between irrigation and fertigation level was found statistically non-significant but the individual effects of irrigation and fertigation levels gave significant results. Thus, it was concluded that cucumber irrigated with 0.3PE grown in clay soil with irrigation scheduled on the alternate day, and with 80% of RD through WSF showed better results in respect of yield under Rahuri conditions.

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## UTICAJ RASPOREDA FERTIRIGACIJE I NAVODNJAVANJA NA PORAST I PRINOS KRSTAVCA (*CUCUMIS SATIVUS L.*)

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**Sažetak:** Maksimalni prinos (21.67 t·ha<sup>-1</sup> i 20.85 t·ha<sup>-1</sup>) je postignut sa nivoom fertirigacije  $F_1$  (80% R.D) i nivoom navodnjavanja  $I_2$  (0.3PE). Prinos je bio 44.28% i

39% viši sa nivoom fertirigacije  $F_1$  i nivoom navodnjavanja  $I_2$  u poređenju sa konvencionalnom metodom navodnjavanja. Pojedinačni efekti nivoa fertirigacije i navodnjavanja pokazali su značajan uticaj na prinos, ali efekat interakcije nivoa fertirigacije i navodnjavanja nije bio značajan. Maksimalna efikasnost navodnjavanja ( $WUE$ ) od  $11.6 \text{ t}\cdot\text{ha}^{-1}\cdot\text{mm}$  i  $10.9 \text{ t}\cdot\text{ha}^{-1}\cdot\text{mm}$  je postignuta sa  $I_1$  i  $F_1$  dok je maksimalna efikasnost đubrenja ( $FUE$ ) od 135.10 postignuta sa  $F_1$ . Ukupna količina vode koja je upotrebljena za navodnjavanje kap po kap i konvencionalni metod navodnjavanja bila je 16.35 cm i 48.00 cm, redom, pokazujući uštedu vode od 65.93% pri navodnjavanju kap po kap u odnosu na konvencionalni metod navodnjavanja. Odnos B:C od 1.94 je bio maksimalan u tretmanu kombinacijom nivoa  $I_2 F_1$ .

**Ključne reči:** krastavac, navodnjavanje, efikasnost navodnjavanja, efikasnost đubrenja, fertirigacija, prinos, odnos B:C

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