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Effect of drip irrigation levels and fertigation on cucumber (*Cucumis sativus*) cultivars under protected cultivation

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Abstract

An experiment was conducted during 2010-11 and 2011-12 in poly-house at Niche area excellence farm, Bikaner to study the effect of drip irrigation levels and fertigation levels on plant height, fruit yield and water use of cucumber (*Cucumis sativus*). The treatments consists of three drip irrigation schedules viz. 40, 60 and 80% ETc and three fertigation levels viz. 75%, 100% and 125% recommended dose of fertilizers. The experiment was conducted in randomized block design and replicated thrice. The study indicated that there was increase in plant height, fruit /plant and fruit yield with increase in irrigation levels from 40% to 80% ETc but the water use efficiency decreases from increasing the irrigation levels. Highest fruit yield of 625 q/ha was recorded with 80% ETc, which was at par with 60% ETc (614 q/ha). Similarly, nutrients uptake increases with higher levels of irrigation and highest N, P and K uptake of 112.5, 34.3 and 140.0 kg/ha, respectively was recorded at 80% ETc. However, nutrient use efficiency was higher in 40% ETc and control i.e., surface irrigation. The study further indicated that plant height, fruit /plant, fruit yield and water use efficiency was also increase with increasing the fertigation levels from 75% to 125% recommended dose (RD) of fertilizer. Fertigation with 125% recommended level of fertilizer gave highest N, P, K uptake of 116.8, 35.8 and 148.6 kg/ha, respectively. However, 75% RD recorded the highest nutrient use efficiency.

Key words: *Fertigation, drip irrigation level, cucumber, plant height, fruit yield, water use efficiency*

Introduction

Rajasthan, particularly western region comes under hyper arid zone with very scarce water resource and scanty and erratic rainfall. The arid climate is quite extreme with temperature as high as near about 49^0C and lowest as low as 0^0 C. Cucumber being very sensitive to changing environmental conditions adoption of protected cultivation may prove useful for improving farm income and it is an effective tool for higher and quality production of crops. Summer season vegetables like cucumber could be grown profitably inside the poly house as off-season crop during winter months (Saikia *et al.,* 2001). Drip irrigation maintains moisture content at near about field capacity in one hand and eliminates water losses on other hand. Fertigation with drip irrigation also enhance the water use efficiency as compare to sole application of fertilizers. Choudhary and More (2002), reported that application of fertilizers through drip (fertigation) was superior to sole solid fertilizer application under furrow and drip fertilizer application. Overall growth in terms of height of plant, numbers of leaves per plant inside the green house was more compared to open field in capsicum (Ghosal and Das, 2012). Production of vegetables under protected cultivation system results in effective use of the land resources, beside being able to increase the production of quality vegetables for both the export and domestic markets by offsetting biotic and abiotic stresses to a great extent that otherwise prevalent in open. Cultivation of capsicum in a polyhouse was found to be highly feasible as reflected in higher values of net present value (NPV), B:C ratio and internal rate of return with payback period of less than two year (Murthy *et al*, 2009).

Materials and Methods

An experiment was conducted during 2010-11 and 2011-12 in poly-house at Niche Area Excellence Farm, S K Rajasthan Agricultural University, Bikaner situated in arid western hyper arid zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.7%, PWP 2%, bulk density 1.52 g /cc, pH (1:2) 8.2, electrical conductivity (1:2) 0.2 dS/m. The soil is very low in organic matter (0.11%) and medium in available P (34 kg/ ha) and high in available K (351 kg/ ha). The experiment was laid out in randomized block design with three replications. The treatments consist of three irrigation levels (40%, 60% and 80% ETc) and three

fertigation levels (75%, 100% and 125%). The total irrigation water provided was 339.71, 509.59 and 679.42 mm at 40%, 60% and 80% ETc, respectively (Table 1). Ground water was below 10 m throughout the growth period. Cucumber variety "Hasan" was sown at 30 cm plant to plant and 60 cm row to row spacing on July 15, and tomato fruits were harvested 13 times started from September 10, to February 28, under protected cultivation in both the years. Under ambient condition fruits were harvested 5 times at 15 days interval during September 10, to February 28, also in both the years. All the cultural operations were carried out as per recommendations.

Results and Discussions

Irrigation levels

Increasing irrigation levels from 40% to 80% ETc under drip increased plant height, fruit/ plant and fruit yield (Table 2). Increased plant height and yield attributes with increasing irrigation levels through drip irrigation thus, enhanced fruit yield of cucumber and highest fruit yield of 625 q /ha was recorded at 80% ETc against 614, 502 and 176 q /ha with irrigation at 60%, 40% ETc through drip and surface irrigation, respectively. However fruit yield obtained with 60% ETc was at par with 80% ETc. It was further revealed that all drip irrigation levels under protected cultivation gave significantly higher fruit yield of cucumber than surface irrigation at open field condition (176 q/ha). This is in confirmation with Nagalakshami *et al*, 2001, who reported that capsicum grown in naturally ventilated poly house gave four times more yield and yield componenst compared to those grown in the field.

Cucumber being a long duration crop and very sensitive to environmental condition, under protected cultivation used more water than the crop grown in open field condition. Highest amount of water use of 679.42 mm was recorded with 80% ETc followed by 509.59, 339.71 and 441.23 mm with 60% and 40% ETc under protected cultivation and surface irrigation under open field condition, respectively. Increased water use in protected cultivation decreased water use efficiency. Thus, crop grown with 40% ETc gave the highest water

Table 1. Monthwise irrigation events and irrigation water applied (means of two years)

Month	Irrigation events	Drip irrigation (mm)		
		40% ETc	60% ETc	80% ETc
July (15-30)	8	20.19	30.29	40.39
August	15	58.23	87.35	116.46
September	16	56.42	84.63	112.83
October	15	66.83	100.24	133.65
November	15	51.92	77.88	103.84
December	16	36.57	54.86	73.15
January	15	36.63	54.96	73.26
February	14	12.92	19.38	25.84
Total	114	339.71	509.59	679.42

Table 2. Effect of drip irrigation and fertigation levels on height, yield, yield attributes, water use and water use efficiency of cucumber (pooled of two years)

Treatment	Plant height at harvest (m)	Fruit/ plant	Fruit yield (q/ha)	Water use (mm)	WUE (kg/ha-mm)
Irrigation level					
40% ETc	3.75	9.1	502	339.71	147.77
60% ETc	4.15	12.3	614	509.59	120.48
80% ETc	4.20	13.8	625	679.42	91.99
Control (Surface irrigation)	2.95	4.2	176	441.23	39.88
SE+	0.2	0.7	6		
CD at 5%	0.6	2.1	19		
Fertigation					
75% RD	3.68	10.5	510	509.57	100.08
100% RD	4.15	11.8	590	509.57	115.78
125% RD	4.27	12.9	641	509.57	125.79
SE+	0.2	0.7	6	-	-
CD at 5%	0.6	2.1	19	-	-

use efficiency (147.77 kg/ ha-mm) against 120.48 and 91.99 kg/ ha-mm with 60 and 80% ETc, respectively under protected cultivation. Lowest water use efficiency of 39.88 kg/ha-mm was recorded with surface irrigation under open field condition. Lower water use efficiency in surface irrigation (absolute control) may be due to loss of irrigation water from sandy loam soil through deep percolation, which resulted in higher water use but lowered fruit yield.

Increase in irrigation level increased N, P and K uptake and highest N, P and K uptake of 112.5, 34.3 and 140.0 kg/ha, respectively was recorded at 80% ETc (Table 3). However, 80% ETc gave lower nutrient use efficiency. All the drip irrigation levels gave higher nutrient uptake than control, i.e., with surface irrigation.

Fertigation

The study of three fertigation levels indicated that plant height, fruit per plant, fruit yield and water use efficiency increased with increasing the fertigation level from 75% to 125% recommended dose of fertilizer. However fruit per plant was not influenced by higher dose of fertilizers and it was at par between 100% and 125% recommended dose of fertilizer. The highest fruit yield 641 q/ha was recorded at 125% recommended dose against 590 and 510 q/ha at 100% and 75% recommended dose, respectively (Table 2). The water use in 75% to 125% recommended dose of fertilizers was same but the water use efficiency increased with increasing the fertigation level from 75% to 125% of recommended dose of fertilizer. The highest water use efficiency of 125.79 kg/ha-mm was recorded at 125% recommended dose against 115.78 and 100.08 kg/ha-mm at 100% and 75% recommended dose, respectively.

Highest N, P and K uptake of 116.8, 35.8 and 148.6 kg/ha, respectively was recorded with 125% of recommended dose (RD) of fertilizer (Table 3).

Table 3. Effect of drip irrigation and fertigation levels on N, P and K uptake and nutrient use efficiency of cucumber (pooled of two years)

Treatment	Nutrient up take (Kg/ha)			Nutrient use efficiency (q/ kg nutrient)		
	N	P	K	N	P	K
Irrigation level						
40% ETc	85.3	25.4	110.4	5.9	19.8	4.5
60% ETc	107.5	33.0	135.1	5.7	18.6	4.4
80% ETc	112.5	34.3	140.0	5.6	18.2	4.2
Control (Surface irrigation)	30.8	9.5	38.7	5.9	18.6	4.2
SE+	1.1	0.3	1.4	-	-	-
CD at 5%	3.3	1.0	4.6	-	-	-
Fertigation						
75% RD	82.3	25.2	107.1	6.2	20.2	4.8
100% RD	106.2	31.7	129.8	5.6	18.6	4.5
125% RD	116.8	35.8	148.6	5.5	17.9	4.3
SE+	1.1	0.3	1.4	-	-	-
CD at 5%	3.3	1.0	4.6	-	-	-

However, higher nutrient use efficiency was recorded with 75% RD.

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