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Effect of Irrigation Levels and Plant Growth Regulators on Cucumber (*Cucumis sativus* L.) under Poly House

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Authors' contributions

This work was carried out in collaboration among all authors. Author A designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RKN and SRB managed the analyses of the study. Author PKY managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during the winter season of 2017-18 at College of agriculture, Bikaner to study the effect of irrigation levels and plant growth regulators on Cucumber under naturally ventilated Poly house condition. The experiment was laid out in split plot design with three replications. The treatments comprised of four drip irrigation levels (0.4, 0.6, 0.8 and 1.0 ETc or crop evapotranspiration) assigned to main plots and three plant growth regulators *viz*; water spray, NAA or Naphthalene Acetic acid (100 ppm) and GA_3 (50 ppm) assigned to sub plots. The objectives of this study were to find out the effects of irrigation levels as well as plant growth regulators on yield attributes of cucumber and their interactions. Results indicated that earliness *i.e.* days to first flowering (35.40) and first harvest (52.00) were recorded maximum with 1.0 ETc as compared to other irrigation levels. The same treatment (1.0 ETc) significantly gave maximum fruit length (21.07 cm), number of fruits per vine (12.02), fruit weight (103.29 g), fruit yield (728.76 q ha^{-1}) and net returns (765035.9 ₹ha^{-1}) with B:C ratio (2.46). However, water use efficiency (3.61 q ha^{-1} cm^{-1}) was found maximum with 0.4 ETc. Among various plant growth regulators GA_3 (50 ppm)

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recorded significantly higher yield attributes namely fruit length (21.63 cm), number of fruits per vine (12.34), fruit weight (99.48 g) and fruit yield (729.23 q ha^{-1}). Water use efficiency, net returns and B:C ratio also exhibited higher values (2.57 q ha^{-1} cm^{-1}, 765307.7 ₹ ha^{-1} and 2.46, respectively) with same treatment. Similarly, earliness i.e. days to first flowering (34.19) and days to first harvest (50.70) were recorded with GA_3. The treatment combination 0.8 ETc + GA_3 (50 ppm) gave maximum value for fruit yield (793.93 q ha^{-1}) per hectare.

Keywords: Cucumber; irrigation levels; growth regulator; yield; water use efficiency.

1. INTRODUCTION

Cucumber *(Cucumis sativus* L.) is one the most important vegetable crops belonging to the family *Cucurbitaceae* having chromosome number 2n=14. It is a warm season vegetable crop grown throughout the world under tropical and sub-tropical conditions. The fruit of cucumber is said to have cooling effect, prevent constipation, checks jaundice and indigestion. Besides, raw fruits are also being used in cosmetic preparation. The estimated area under this crop is around 107 thousand hectares with total production of about 1658 thousand metric tons in India [1]. Efficient use of available irrigation water is essential for increasing agricultural production for ever increasing population in the country. Water availability for irrigation is going to be a major constraint for agriculture in the near future [2]. Hence, judicious use of the available water resources through more efficient methods of water application like drip irrigation under conditions of protected cultivation becomes necessary to enhance the yield and water use efficiency [3]. Drip irrigation system improves the WUE because of improving the yield and quality of produce [4]. The use of plant growth regulators mainly in cucumber crop is more beneficial under poly house condition. Plant growth regulators are also used to control the vegetative growth of cucumber plants, thereby increasing the plant population per unit area with regard to yield [5]. Therefore, this study was carried out to determine the effects of different irrigation levels and pant growth regulators on Cucumber under Poly house condition.

2. MATERIALS AND METHODS

The experiment was conducted to study the effect of irrigation levels and plant growth regulators on Cucumber cv. Aviva F_1 hybrid under naturally ventilated Poly house condition during the November, 2017- April, 2018 at Horticulture farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The mean maximum temperature during the crop growing period of cucumber ranged between 20.5 and 43.7°C. The total rainfall received during the crop growing period was 6.6 mm in 4 rainy days. The total evaporation of 123.1 mm was recorded during crop growing period. The experiment was laid out in split plot design with three replications. There were twelve treatment combination comprising of four level of irrigations *viz.,* 0.4 ETc (I_1), 0.6 ETc (I_2), 0.8 ETc (I_3), and 1.0 ETc (I_4), and three treatment of plant growth regulators *viz.,* water spray (P_0), NAA @ 100 ppm (P_1), and GA_3 @ 50 ppm (P_2). The field was divided into 36 plots (each plot is 8 m^2) in which plots were laid with drip irrigation.

The daily evapotranspiration of the cucumber crop (ETc) under naturally ventilated polyhouse at Bikaner conditions, was recorded by USWB class A Pan Evaporimeter to reference ET (ET_0) by multiplying with Pan co-efficient (Kp) (0.7). Then ET crop (ETc) was obtained by multiplying reference evapotranspiration (ET_0) for different growth stages throughout the growing season by a crop coefficient (Kc). Crop coefficients were: 0.45 for the initial stage, 0.70 for crop development, 0.90 for mid stage and 0.75 for final stage. The drip irrigation network consisted of lateral's GR of 16 mm in diameter, with emitters at 0.5m distance, with allocating two laterals for each row. The emitters had a discharge rate 4 l/h. irrigation frequency was every alternate day. All the parameters were determined using standard procedures. The water use efficiency was computed by dividing fruit yield (q ha^{-1}) with total water applied (cm) including effective rainfall. Five plants from each plot were selected randomly and tagged for recording yield and yield parameters. The fruit yield per hectare was worked out based on the plot yield. The analysis and interpretation of data were done using the Fisher's method of analysis of variance technique as described by Gomez and Gomez, [6].

3. RESULTS AND DISCUSSION

3.1 Flowering Attributes

Number of days to first flowering and harvest of fruit were significantly influenced by different levels of irrigation through drip. Significantly fewer days were taken to first flowering (35.40) and harvesting (52.00) at 1.0 ETc (Table 1). This might be due to the fact that drip irrigation level at 1.0 ETc resulted in optimum early vegetative growth and carbohydrate accumulation which induced early flowering and harvesting, assisted by more availability of water [7]. Another reason for this is that growth and development phases in cucumber synchronized under well-watered and nutritional conditions thus, photosynthate diverted towards vegetative growth rather than fruiting parts in moisture deficit conditions [7]. Sufficient water application is important for horticultural crops because water shortage in soil can cause delayed flowering and fruiting [7].

Minimum days were taken to first flowering (34.19) in treatment GA3 @ 50 ppm (Table 1) whereas, maximum number of days were taken to flowering in water spray treatment. The variation in the days taken to first flowering might be due to effect of plant growth regulators on initiation of flowering and fruiting. Early harvest is the desired character for early maturity and early marketing of a crop for higher return. These results are in close proximity with the results of, Dixit et al. [8] who observed early flowering in watermelon sprayed with GA3 (25 and 50 ppm). The significantly maximum days taken to first harvest was recorded in no plant growth regulator treatment, while, minimum (50.70) was noted in GA3 @ 50 ppm. The variations in 'days taken to first harvest' were due to effect of plant growth regulators on different treatments. These findings are in agreement with the results reported by Ullah et al. [9].

3.2 Yield and Yield Attributes

Irrigation level significantly influenced yield and yield attributes of cucumber. The highest fruit length (21.07 cm), number of fruits per vine (12.02), fruit weight (103.29 g) and fruit yield per hectare (728.76 q ha^{-1}) were recorded with drip irrigation level at 1.0 ETc which, remained at par with 0.8 ETc (Table 1). Similar findings were also reported by Ningaraju and Joseph [10] in pickling melon. It is well established fact that fruit yield and its components *viz.* number of fruits per vine, fruit weight, and fruit yield per hectare decreased with increasing water stress. From perspective of number of fruits per plant, the most negative effect was observed when the lowest irrigation level (0.4 ETc) was applied. Higher economic yield with higher levels of irrigation might be due to more availability of moisture in rhizosphere which in turn enhanced not only absorption of more water but also uptake of plant nutrients. Higher plant nutrients and more water thus boosted biochemical processes in plant which is ultimately reflected in higher economic yield. Similarly findings were also reported by Sahin et al. [11] recorded maximum fruit yield, fruit length, number of fruits per plant of cucumber was obtained at 1.0 ET_C irrigation level.

The significantly maximum fruit length, fruits per vine, fruit weight and fruits yield (21.63 cm, 12.34, 99.48 g and 729.23 q ha^{-1}, respectively) were recorded in treatment GA_3 (50ppm) followed by NAA application while, minimum was noted in no plant growth regulators (Table 1). It is concluded that the reason for variation on fruit yield was due to effect of plant growth regulators on treatment. Plant growth regulators might have modified plant bio-chemical processes in favour of higher yields. These findings are in agreement with the results reported by Merentoshi [12] who suggested that application of GA_3 (50 ppm) gave maximum fruits yield and yield attributes.

3.3 Economics of Treatments

Among the irrigation levels higher net returns (765035.9 ₹ ha^{-1}) and B:C ratio (2.46) were recorded with drip irrigation level at 1.0 ETc followed by 0.8 ETc (Table 2). Hakkim and Jishachand [2] also reported that irrigation level at 65 per cent ETc gave higher benefit cost (B:C) ratio of 3.41 in cucumber.

Higher monetary returns with low cost of cultivation are desirable for getting higher returns. It is revealed from the data that a significantly highest marketable fruit yield and net returns (765307.7 ₹ha^{-1}) along with benefit cost ratio (2.46) was obtained under cucumber treated with GA_3 @ 50ppm. While, the lowest marketable fruit yield and net return along with benefit cost ratio was recorded in no plant growth regulators. The finding corroborates with results obtained by Hassanpour et al. [13].

3.4 Water Use Efficiency

Maximum water use efficiency (3.61 q ha^{-1} cm^{-1}) was recorded with drip irrigation level at 0.4ETc

(Table 2). Lower irrigation level might have utilized more efficiently by plant in producing photosynthate and diverting that from source to sink. Kirnak and Demirtas [14] and Hashem et al. [15] also reported maximum WUE at lower irrigation level in cucumber. Similar results were also found by Panigrahi et al. [16] in tomato.

Table 1. Effect of irrigation levels and plant growth regulators on yield attributes of cucumber

Treatments	Days to first flowering	Days to first harvest	Fruit length (cm)	Number of fruits per vine	Fruit weight (g)	Fruit yield (q ha^{-1})
Irrigation levels						
0.4 ETc	37.50	54.64	17.65	8.32	72.27	534.41
0.6 ETc	36.48	53.31	19.31	10.49	91.27	679.53
0.8 ETc	35.42	52.00	20.29	11.56	101.38	722.40
1.0 ETc	35.40	52.00	21.07	12.02	103.29	728.76
S.Em±	0.26	0.37	0.46	0.19	1.64	11.96
CD at 5%	0.91	1.28	1.59	0.65	5.66	41.37
Plant growth regulators						
Water spray	37.86	54.85	17.31	8.13	84.32	625.00
NAA (100 ppm)	36.56	53.40	19.80	11.31	92.37	644.59
GA_3 (50 ppm)	34.19	50.70	21.63	12.34	99.48	729.23
S. Em±	0.15	0.25	0.30	0.17	1.94	7.13
CD at 5%	0.46	0.75	0.90	0.50	5.81	21.36

Replication-3, S. Em± -Standard error mean, CD at 5%- Critical Difference at 5% level of significance

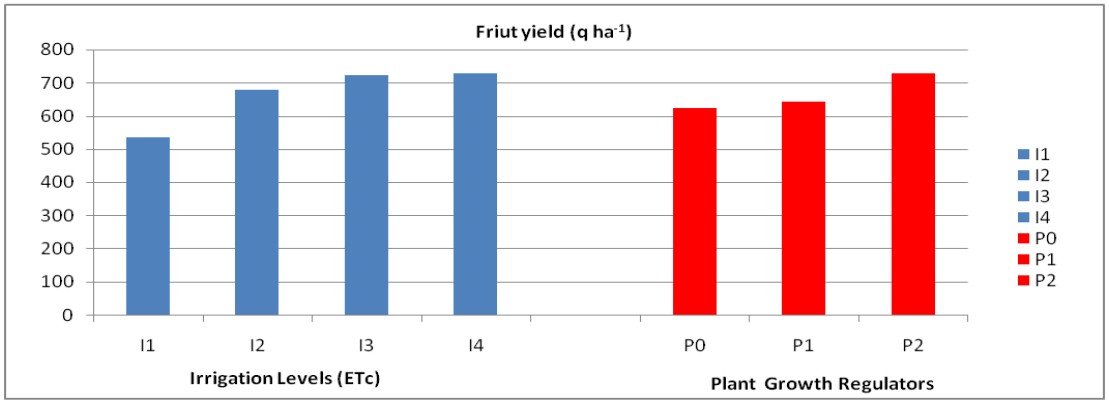

Fig. 1. Effect of irrigation levels and plant growth regulators on yield of cucumber

Table 2. Effect of irrigation levels and plant growth regulators on net returns, B:C ratio, net returns and water use efficiency of cucumber

Treatments	Net returns	B:C ratio	WUE (q $ha^{-1}cm^{-1}$)
Irrigation levels			
0.4 ETc	376328.8	1.21	3.61
0.6 ETc	666559.1	2.15	3.06
0.8 ETc	752300.3	2.42	2.44
1.0 ETc	765035.9	2.46	1.97
S.Em±	23912.5	0.08	-
CD at 5%	82748.2	0.27	-
Plant growth regulators			
Water spray	558091.0	1.80	2.20
NAA (100 ppm)	596769.3	1.92	2.27
GA_3 (50 ppm)	765307.7	2.46	2.57
S.Em±	14250.9	0.05	-
CD at 5%	42724.2	0.14	-

Table 3. Interaction effect of irrigation levels and plant growth regulators on fruit yield (q ha^{-1}) of cucumber

Plant growth regulators	Irrigation levels			
	0.4 ETc	0.6 ETc	0.8 ETc	1.0 ETc
Water spray	483.33	638.33	677.67	700.67
NAA (100 ppm)	513.23	672.91	695.59	696.63
GA_3 (50 ppm)	606.67	727.33	793.93	789.00
	S.Em±	14.25		
	CD at 5%	42.72		

3.5 Interaction Effect of Irrigation Levels and Plant Growth Regulators on Fruit Yield of Cucumber

A perusal of data (Table 3) showed that drip irrigation and plant growth regulators had significant effect on yield of cucumber. Irrigation level of 0.8 ETc + GA_3 application gave maximum yield (793.93 q ha^{-1}) as compared to all other combinations, however it was at par with 1.0 ETc + GA_3 application. Minimum yield of cucumber fruit (483.33 q ha^{-1}) was recorded with 0.4 ETc + water spray treatment.

4. CONCLUSION

On the basis of the results obtained during the present study, it may be concluded that out of four irrigation levels under drip, 1.0 ETc found to be the best treatment in enhancing the yield attributes, yield and B: C ratio. However, all parameters remained statistically at par with 0.8 ETc. Further highest water use efficiency was recorded with 0.4 ETc. Among the different plant growth regulators the GA_3 at 50 ppm found to be superior in respect of yield attributes, yield, B:C ratio and water use efficiency. The treatment combination of drip irrigation at 0.8 ETc and GA_3 recorded the higher of fruit yield that all other treatment combination.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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