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RESEARCH PAPER

Yield response of parthenocarpic cucumber to irrigation and fertigation, grown under polyhouse condition

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Abstract : Impact of the experimentation of irrigation and fertigation on yield of parthenocarpic cucumber under naturally ventilated polyhouse was carried out for two seasons during 2019-20 and 2020-21 at Hi-tech Horticulture unit, Agriculture Research Station, University of Agricultural Sciences, Dharwad. The experiment was conducted to study the effect of different irrigation regimes (I) at I1-(60 % ETc), I2-(80 % ETc), I3-(100 % ETc) and fertigation levels (F) - F1-(60 % RDF), F2-(80 % RDF), F3-(100 % RDF), F4-(120 % RDF) and their interaction on cucumber hybrid under naturally ventilated polyhouse. The studies indicated that there is a significant influence of irrigation and fertigation on growth and yield of parthenocarpic cucumber under polyhouse condition. Among the treatment combinations I_2F_4 (80 % ETc and 120 % RDF) has recorded highest plant height at 90 days after planting, least days taken for first harvest (35.53 days)with more number days for final harvest (111.65 days), highest fruit length (15.65 cm), higher average fruit weight (158.13 gm), higher number of fruits per vine (24.76), higher yield (18.40 kg m^{-2}) (92.01 q $500m^{-2}$) and (184.02 t ha^{-1}). The significant increase in yield was due to better utilization water at 80 per cent ETc and 120 per cent recommended dose of fertilizers by reducing the percolation losses of water and reduction in leaching of nutrients where as compared to other treatment combinations.

Key words: Fertigation, Leaching nutrients, Parthenocarpic, Polyhouse

Introduction

Cucumber (*cucumis sativus* L.) is most popular and important vegetable of the Cucurbitaceae family. It is having a chromosome number 2n=14. This can be grown throughout the tropical and subtropical regions of the world. It is an ideal vegetable crop for summer. It is a thermophilic and susceptible frost, which is cultivated during spring-summer period (Bacci *et al*., 2006) and in green houses throughout the year. Cucumber is the fourth important vegetable after tomato, cabbage and onion and second most widely cultivated cucurbit after watermelon in Asia (Tatlioglu 1993). The cucumber is cultivated in most countries of world with the global production of 91.13 million metric tonnes, where maximum share is 72.78 million metric tonnes (79.86 %) of total global production from China followed by Turkey 1.99 million metric tonnes (2.11 %) and Russia with 1.69 million metric tons (1.80 %) (tridge.com, 2020). Whereas India is producing total of 1.67 million tonnes with 1.05 lakh hector and major growing states are Haryana, MP and Karnataka (NHB, 2019-20).

To develop an effective irrigation strategy, it is needed to estimate the consumptive use of water by the crop based on evapotranspiration (ET). Idea of crop coefficient (Kc) is needed as the canopy development and management of greenhouse crops otherwise different than that of outdoor condition; differences in plant spacing, crop height (use of vertical supports) and aerodynamic properties may affect the Kc and in turn the water use (Fernandez *et al.,* 2005 and Orgaz *et al.,* 2005). Several researchers have concluded that the water requirement is lesser for the greenhouse crops than the outdoor conditions as the solar radiation is 18-20 per cent lesser than outside and restricted wind speed (Harmanto *et al.,* 2005) resulting in reduced crop evapotranspiration (Patel and Rajput, 2011) fertigation can potentially reduce the transport of nutrients away from the root zone. This helps in increasing the fertilizer and water use efficiency which decrease the input costs (Bar - Yosef, 1999 and Solaimalai *et al.,* 2005).

The problem of nutrient leaching is potentially high which transport the plant nutrients away from the active root zone of the crop leading to reduced uptake of applied nutrients. Hence, there is a need to increase the fertilizer use efficiency by split application of fertilizers through drip irrigation system.

Material and methods

The present investigation is to study the influence of different levels of irrigations and fertigation on the performance of parthenocarpic English cucumber under naturally ventilated polyhouse. The experiment was carried out at Hi-Tech Horticulture Unit, University of Agricultural Sciences, Dharwad during 2019-20 and 2020-21. It is situated in Northern Transitional Tract of Karnataka State at 15 ^{0}26' North latitude and 75 ^{0} 70' East longitude at an altitude of 678 m above mean sea level.

The experiment was laid out in a factorial randomized block design with three replications. Planting was done with a spacing of 45x 45 cm with plot size of 8 x1 m. The first factor with three irrigation (I) regimes, I_1 (60 % ETc), I_2 (80 % ETc) and I_3 (100 % ETc) and second factor with four fertilizer (F) levels, F_1(60 % RDF), F_2 (80 % RDF), F_3 (100 % RDF) and F_4 (120 % RDF), where RDF is 150:75:75 NPK kg ha^{-1}. Observation recorded on five randomly selected plants in each replication for quantitative traits *viz.,* vine length (cm) , internodal length (cm) at 90 DAP, days taken for first blooming after planting, days taken for first harvest after planting, days taken for final harvest after planting, fruit length (cm), fruit girth (cm), average fruit weight (g), number of fruits per vine, fruit yield per vine (kg), fruit yield per square meter area (kg), fruit yield per 500 m^2 area (q), Fruit yield per hectare (t ha^{-1}). Greenhouse cucumber hybrids being indeterminate in nature, the vegetative and reproductive phases overlap and hence, plants need nutrients even after fruiting stage for better development of fruits. Considering the inadequacy of previous works, the present study was planned to understand the water and nutrient requirements of parthinocarpic cucumber grown in naturally ventilated polyhouse.

Results ans discussion

The data presented in the Table 1 revealed that the highest vine length at 90 DAP (224.86 cm) recorded at I_2 (80 % ETc), which was on par with I_3 (100 % ETc) (224.98 cm). Irrigation at I_1 (60 % ETc) which was recorded the lowest vine length (214.69 cm). Where F_4 (120 % RDF) recorded the highest vine length (242.38 cm), which was statistically superior over F_3 (100 % RDF) (230.16 cm). Fertigation at F_4 (120 % RDF) and F_3 (100 % RDF) realized significantly highest vine length. Interaction effect between irrigation regimes and fertigation levels have no significant effect on vine length.

The highest internodal length (6.36 cm) was recorded in I_3 (100 % ETc.), F_1 (60 % RDF) recorded the highest internodal length (6.45 cm) However, irrigation at F_4 (120 % RDF) recorded significantly lower internodal length (6.10 cm). The treatment combinations of I_3F_1 (6.64 cm) and I_3F_2 (6.59 cm) produced highest internodal length in both the seasons which were on par with each other and significantly superior over rest of the fertigation treatments except I_2F_1 in second season. This result is similar to the result reported by Pawar *et al.* (2018) for the cucumber crop. Similarly, Chand (2014) recorded a higher height of NPK's 100 per cent RDF through fertigation. Rahil and Qanadillo (2015) reported the highest plant height of the cucumbers at 75 per cent ETc.

Drip irrigation at I_1 (60 % ETc) recorded the least number of days taken for first blooming after planting (25.27 days). However, I_3 (100 % ETc) where as taken more number of days for first blooming (25.91 days) as compared to I_1 (60 % ETc) and I_2 (80 % ETc). Significantly lesser number of days taken for first blooming after planting (24.87 days) was recorded in F_4 (120 % RDF) fertigation level. However, significantly higher number of days taken for first blooming (25.99 days) was registered in F_1 (60 % RDF) followed by F_2 (80 % RDF) (25.81 days). Significantly least number of days taken for first emergence of flower was observed in I_2F_4 (24.00 days).

Drip irrigation at I_1 (60 % ETc) recorded least days taken for first harvest after planting (36.26 days). Significantly less number of days taken for first harvest after planting was observed in I_1F_4 (36.35) and I_2F_4 (36.26) in first season and I_2F_4 (34.80) and I_1F_4 (34.84) in second season and more days in I_3F_1

Table 1. Influence of irrigation regimes and fertigation levels on parthenocarpic cucumber under naturally ventilated polyhouse

Treatments	Average fruit weight (g)			Number of fruits per vine			Fruit yield per vine (kg)		
Irrigation	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
I_1	141.89	147.54	144.71	20.83	21.65	21.24	3.42	3.56	3.49
I_2	147.27	153.14	150.21	22.69	23.60	23.14	3.73	3.87	3.80
I_3	147.03	152.88	149.95	22.85	23.76	23.31	3.82	3.97	3.90
S.Em±	1.44	1.51	1.48	0.21	0.22	0.21	0.057	0.060	0.058
C.D. (P=0.05)	4.23	4.43	4.33	0.61	0.64	0.63	0.17	0.18	0.17
Fertigation									
F_1	139.37	144.88	142.12	20.30	21.10	20.70	3.23	3.36	3.29
F_2	141.67	147.28	144.47	21.75	22.61	22.18	3.58	3.72	3.65
F_3	147.19	153.06	150.12	22.99	23.91	23.45	3.82	3.98	3.90
F_4	153.37	159.52	156.45	23.46	24.39	23.92	3.99	4.15	4.07
S.Em±	1.66	1.75	1.70	0.21	0.25	0.25	0.07	0.07	0.07
C.D. (P=0.05)	4.88	5.12	5.00	0.61	0.74	0.72	0.19	0.20	0.20
Interactions									
I_1 X F_1	128.60	133.70	131.15	18.04	18.75	18.40	2.76	2.87	2.81
I_1 X F_2	141.73	147.33	144.53	19.69	20.46	20.08	3.25	3.38	3.31
I_1 X F_3	146.11	151.91	149.01	22.71	23.62	23.16	3.72	3.86	3.79
I_1 X F_4	151.13	157.19	154.16	22.87	23.78	23.32	3.95	4.11	4.03
I_2 X F_1	140.97	146.54	143.75	20.73	21.56	21.15	3.35	3.48	3.41
I_2 X F_2	145.25	151.02	148.14	22.28	23.16	22.72	3.73	3.88	3.80
I_2 X F_3	147.83	153.77	150.80	23.47	24.41	23.94	3.76	3.91	3.84
I_2 X F_4	155.05	161.22	158.13	24.27	25.24	24.76	4.06	4.22	4.14
I_3 X F_1	148.53	154.39	151.46	22.11	22.99	22.55	3.58	3.72	3.65
I_3 X F_2	138.03	143.48	140.75	23.28	24.20	23.74	3.76	3.91	3.84
I_3 X F_3	147.63	153.49	150.56	22.79	23.69	23.24	3.99	4.15	4.07
I_3 X F_4	153.95	160.14	157.04	23.23	24.15	23.69	3.96	4.12	4.04
S.Em±	2.88	3.02	2.95	0.42	0.44	0.43	0.11	0.12	0.12
C.D.(P=0.05)	8.45	8.86	8.66	1.22	1.29	1.25	0.34	0.35	0.34

(38.97, 37.71 and 38.34 days in first and second season followed pooled data). Significantly lowest number of days taken for final harvest 99.10 days) at F_1 fertigation level. However, significantly the maximum number of days taken for final harvest after planting (106.79 days) was registered at F_4(120 % RDF) where as compared to other fertigation levels. Significantly maximum number of days taken for final harvest (111.16 days) was recorded with I_2F_4. Significantly least number of days taken for final harvest (95.60 days) was recorded with I_1F_2. At higher fertilizer dosage, there was higher growth of plant, higher accumulation of carbohydrates and build up of new cells, which might have contributed for higher growth which taken more time. Hence, slow biochemical activities, require more days for flowering. Water shortage and soil water depletion in the root zone during the initial flowering stage decrease the number of flowers as well (Doorenbos and Kassam, 1979 and Jones *et al.,* 2000).

The I_3 (100 % ETc) recorded highest fruit length of 14.01 cm. The highest fruit length (15.19 cm) was recorded with fertigation at F_4 (120 % RDF). Treatment combinations of I_2F_4, I_3F_2 and I_3F_4 registered significantly higher fruit length over all other treatment. The significantly highest fruit girth (3.69 cm) was observed in I_3 (100 % ETc) followed by I_2 (80 % ETc) (3.56 cm). Fertigation at F_4 (120 % RDF) recorded significantly higher fruit girth (3.80 cm). The interaction effect between irrigation regimes and fertigation levels also did not differ significantly with respect to fruit girth. However, highest fruit girth (3.99 cm) was registered in the treatment combination of I_3F_4.

Among them, I_2 (80 % ETc) gave the highest average fruit weight of 150.21 g, which was on par with I_3 (100 % ETc) 149.95 g, respectively. However, both the treatments were superior over the I_1 (60 % ETc) 144.71 g.The highest average fruit weight 156.45 g was recorded with fertigation F_4 (120 % RDF) followed by F_3 (100 % RDF) 150.12 g. However, they are superior over F_1 (60 % RDF) 142.12 g and F_2 (80 % RDF) 144.47 g. Treatment combinations, I_2F_4(518.13 g.) I_3F_4 (157.04 g) and I_1F_4(154.16 g) registered significantly higher average fruit weight. The significantly highest number of fruits per vine 23.31 was recorded in I_3 (100 % ETc) followed by I_2 (80 % ETc) 23.14 Fertigation at F_4 (120 % RDF) recorded significantly higher number of fruits per vine 23.92. Significantly higher number of fruits per vine (24.76) was registered in the treatment combination of I_2F_4. I_3 (100 % ETc) gave the highest fruit yield per vine of 3.90 kg. The highest fruit yield per vine was 4.07 kg. The treatment combinations of I_2F_4 (4.14 kg) registered significantly higher fruit yield.

The data presented in the Table 2 revealed that the significantly highest yield per square meter (17.31 kg) was recorded in I_3 (100 % ETc). Fertigation at F_4 (120 % RDF) recorded significantly higher fruit yield per square meter (18.09 kg). Significantly highest yield per square meter (18.40 kg) The highest yield per 500 m^2 (86.56 q/ 500 m^2) was recorded with I_3 (100 % ETc). Application of F_4 (120 % RDF) recorded the highest yield (90.44 q/ 500 m^2). Treatment combinations of I_2F_4 registered the highest yield (92.01 q/ 500 m^2). The highest yield (173.12 t ha^{-1}) was recorded with I_3 (100 % ETc). F_4 (120 % RDF) recorded the

Table 2. Influence of irrigation regimes and fertigation levels on parthenocarpic cucumber under naturally ventilated polyhouse.

Treatments	Yield per M ^{2} area (kg)			Yield per 500 M ^{2} (q)			Fruit yield per ha. (t/ha)		
Irrigation	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
I_1	15.19	15.79	15.49	75.95	78.96	77.46	151.89	157.93	154.91
I_2	16.55	17.21	16.88	82.74	86.04	84.39	165.48	172.08	168.78
I_3	16.98	17.65	17.31	84.88	88.24	86.56	169.75	176.48	173.12
S.Em±	0.25	0.27	0.26	1.27	1.32	1.30	2.54	2.65	2.59
C.D.(P=0.05)	0.75	0.78	0.76	3.73	3.88	3.80	7.45	7.77	7.61
Fertigation									
F_1	14.33	14.91	14.62	71.67	74.53	73.10	143.35	149.05	146.20
F_2	15.90	16.53	16.22	79.52	82.66	81.09	159.05	165.32	162.19
F_3	16.98	17.65	17.32	84.88	88.27	86.58	169.76	176.55	173.15
F_4	17.74	18.44	18.09	88.68	92.20	90.44	177.35	184.39	180.87
S.Em±	0.29	0.31	0.30	1.47	1.53	1.50	2.93	3.06	2.99
C.D.(P=0.05)	0.86	0.90	0.88	4.30	4.48	4.39	8.60	8.97	8.78
Interactions									
I_1 X F_1	12.26	12.74	12.50	61.30	63.71	62.51	122.61	127.43	125.02
I_1 X F_2	14.44	15.01	14.72	72.20	75.03	73.62	144.39	150.07	147.23
I_1 X F_3	16.51	17.16	16.84	82.53	85.82	84.18	165.06	171.65	168.35
I_1 X F_4	17.55	18.26	17.90	87.76	91.29	89.52	175.52	182.57	179.04
I_2 X F_1	14.86	15.47	15.16	74.32	77.33	75.82	148.63	154.66	151.65
I_2 X F_2	16.57	17.23	16.90	82.84	86.13	84.49	165.67	172.27	168.97
I_2 X F_3	16.72	17.38	17.05	83.59	86.90	85.25	167.17	173.81	170.49
I_2 X F_4	18.05	18.76	18.40	90.23	93.79	92.01	180.46	187.58	184.02
I_3 X F_1	15.88	16.51	16.19	79.40	82.54	80.97	158.80	165.07	161.94
I_3 X F_2	16.71	17.36	17.04	83.54	86.82	85.18	167.08	173.63	170.35
I_3 X F_3	17.70	18.42	18.06	88.52	92.09	90.31	177.05	184.18	180.61
I_3 X F_4	17.61	18.30	17.96	88.04	91.51	89.78	176.09	183.03	179.56
S.Em±	0.51	0.53	0.52	2.54	2.65	2.60	5.08	5.30	5.19
C.D.(P=0.05)	1.49	1.55	1.52	7.45	7.77	7.60	14.89	15.53	15.21

highest yield (180.87 t ha^{-1}). Treatment combination of I_2F_4 registered the highest yield (184.02 t ha^{-1}) which was on par with I_1F_4, I_2F_3, I_3F_2, I_3F_3 and I_3F_4, but significantly superior over other fertigation treatments. However, the lowest yield (125.02 t ha^{-1}) was recorded with I_1F_1.

Conclusion

From this study, it is evident that adopting I_2F_4 (80 % ETc with120 % RDF) is the most profitable compared to other treatments and 20 per cent of irrigation and energy required to supply the irrigation can be saved which can reduce the cost of cultivation of cucumber. It was important to notice that by using considerably less amount of irrigation water (20 %), the higher productivity was achieved. This was a significant step towards good agricultural practices to get more production by using minimum possible resources in view of suitability which otherwise showed soil health problems like salinity reduced microbial activity, degradation of soil productivity due to addition of high inputs that had been a characteristic feature of greenhouse cultivation.

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