Influence of Drip Irrigation and Fertigation on fruit yield and water productivity of Cucumber under Naturally Ventilated Poly House

ABSTRACT

The experiment on cucumber was conducted in naturally ventilated polyhouse at Horticulture garden, College of Agriculture, Rajendranagar, Hyderabad, Telangana during *rabi* 2020-2021. The experiment was laid out in a split plot design with 12 treatments consist of three irrigation regimes *viz.*,drip irrigation scheduled at 0.8 Epan (I_1), 1.0 Epan (I_2) and 1.2 Epan (I_3) as main plots and four NK fertigation levels of 75% recommended dose of NK (F_1- $N_{112.5}$ K_{75}), 100% recommended dose of NK (F_2- N_{150} K_{100}), 125% recommended dose of NK (F_3- $N_{187.5}$ K_{125}) and 150% recommended dose of NK (F_4- N_{225} K_{150}) as sub plot and replicated thrice. yield attributes were significantly higher in irrigation scheduled at 1.2 Epan than 1.0 and 0.8 Epan. Fruit yield was significantly higher in drip irrigation scheduled at 1.2 Epan (83.90 t ha^{-1}) than 1.0 Epan (68.80 t ha^{-1}) and 0.8 Epan (59.50 t ha^{-1}). Yield attributes were significantly higher at 150% recommended dose of NK than 75% recommended dose of NK. Fruit yield was significantly higher at 150 % recommended dose of NK (76.70 t ha^{-1}) than 75% recommended dose of NK (60.30 t ha^{-1}) and onpar with both 125% and 100% recommended dose of NK. Water use efficiency was higher in drip irrigation scheduled at 0.8 Epan (28.6 kg m^{-3}) followed by 1.2 Epan (27.2 kg m^{-3}) and 1.0 Epan (26.6 kg m^{-3}). 150 % recommended dose of NK registered significantly higher water use efficiency (30.1 kg m^{-3}) than 75% recommended dose of NK (23.5 kg m^{-3}). It was recommended that application of 1.2 Epan irrigation and 150 kg N, 100 kg K_2O ha^{-1} by fertigation for maximization of yield.

Key words: cucumber; polyhouse; drip irrigation; fertigation; fruit yield; water productivity.

1. INTRODUCTION

Cucumber is grown both under open conditions and poly house. The crop duration is three months and income is very high due to its large nutritional values consists of energy, fat, protein, carbohydrate, dietary fibre, calcium, magnesium and potassium [1]. It also reduces the risk of cancer, eliminates uric acid and its fibre-rich skin and high levels of potassium and magnesium helps to regulate blood pressure and promote nutrient functions.

In India cucumber is grown in an area of 82,040 ha with a production of 12,60,000 MT [2]. Major cucumber producing states are Haryana, Madhya Pradesh, Karnataka, Punjab, Uttar Pradesh and Andhra Pradesh. In Telangana it is grown in an area of 3,070 ha with a production of 62,040 MT. Salad Cucumber is cultivated in 1150 acres in 917 farmer holdings under poly house [3]. Cucumber is 3rd most important crop after tomato and capsicum under poly house cultivation and is grown round the year and is also having export value.

The current problem with large scale cultivation of cucumber is that high fertilizer application and inefficient irrigation not only caused unnecessary waste of water and fertilizer

resources, but also led to shallow groundwater nitrate pollution and other environmental problems [4]. Sustainability of any system requires optimal utilization of resources such as water, fertilizer and soil. Maximization of crop yield, quality and minimization of leaching loss of nutrients below the rooting zone could be achieved by managing fertilizer concentrations in measured quantities of irrigation water using drip irrigation [5].

The package of practices for both irrigation and nutrient management were framed for cucumber varieties which are grown under open field conditions. Recently salad cucumber cultivation under poly houses is gaining popularity in Telangana, where farmers are relying on hybrids which require proper input management especially nutrient and irrigation management for achieving higher yields. The research data is not available on drip irrigation regimes and fertigation levels in cucumber cultivation under naturally ventilated poly house. Keeping in this view, the present study is proposed for quantification of water and yield under different irrigation regimes and fertigation levels.

2. MATERIALS AND METHODS

The present study was conducted in naturally ventilated polyhouse at Horticulture garden, College of Agriculture, Rajendranagar, Hyderabad, Telangana during *rabi* 2020-2021. The experiment was laid out in a split plot design with 12 treatments consist of three irrigation regimes *viz.*,drip irrigation scheduled at 0.8 Epan (I_1), 1.0 Epan (I_2) and 1.2 Epan (I_3) as main plots and four NK fertigation levels of 75% recommended dose of NK (F_1- $N_{112.5}$ K_{75}), 100% recommended dose of NK (F_2- N_{150} K_{100}), 125% recommended dose of NK (F_3- $N_{187.5}$ K_{125}) and 150% recommended dose of NK (F_4- N_{225} K_{150}) as sub plot and replicated thrice. The experimental soil was sandy clay loam with p^H of 7.9 and EC of 1.07dSm^{-1}. The soil fertility status was low in organic carbon (0.26%) and medium in available nitrogen (338.69 kg ha^{-1}) and available phosphorous (48.53 kg ha^{-1}) and high in available potassium (573.52 kg ha^{-1}). The cucumber seed was sown with a spacing 40 X 40 cm in paired row system on raised beds.

Irrigation water was applied as per drip irrigation regimes at every alternate day based on daily pan evaporation data from USWB class 'A' pan evaporimeter recorded from agrometeorological station, ARI, Rajendranagar, Hyderabad. The cumulative daily evaporation during crop growth period was 251.7mm. The total water used by the crop was 208, 258.3 and 308.6 mm in 0.8, 1.0 and 1.2 Epan treatments. Recommended dose of fertilizers 150:100:100 N, P_2O_5 and K_2O kg ha^{-1} was used. NPK fertilizers were applied in the form of urea, single super phosphate and white MOP. A common dose of P_2O_5 @ 100 kg

ha^{-1} was applied commonly to all the treatments as basal. Nitrogen and potassium were applied through drip fertigation in 19 times once in four days interval starting from 15 DAS to 90 DAS. Weed, pest and disease management was done as per the recommendations of the university.

In the present study, data was recorded on yield attributes viz., fruit diameter (cm), fruit length (cm), fruit weight (g $plant^{-1}$), number of fruits $vine^{-1}$, fruit yield (t ha^{-1}), irrigation water applied and water productivity. The collected data was statistically analyzed by analysis of variance (ANOVA) for split plot design [6]. Op stat software used for analysis.

3. RESULTS AND DISCUSSION

3.1 Fruit length (cm)

Fruit length was significantly influenced by both irrigation regimes and fertigation levels. Interaction was found non significant (Table-1). Drip irrigation scheduled at 1.2 Epan recorded significantly higher fruit length (17.46 cm) than 1.0 Epan (15.21 cm) and 0.8 Epan (14.25 cm). Fruit length was comparable between 0.8 Epan and 1.0 Epan. This was due to the optimum moisture in the surroundings of root zone all over the crop growth period enhances the vegetative growth of the crop thereby increase the photosynthesis and efficient translocation of photosynthates towards the reproductive organ development. Such an effect was responsible for significant improvement in fruit length. These results were in conformity with the observations of Donavon et al., [7] and Om Prakash et al., [8].

Among the fertigation levels, fruit length was significantly higher at 150% recommended dose of NK (16.61 cm) than 75% (14.45 cm) and on par with 100% (15.67 cm) and 125% recommended dose of NK (15.82 cm). Increase in fruit length at higher doses may be due to complete solubility, mobilization and availability of nutrients at regular short interval in required quantity due to drip fertigation resulted into higher nutrient uptake by fruit may lead to higher fruit length. These results were similar with the observations of Sanjeev kumar et al., [9].

3.2 Fruit diameter (cm)

Fruit diameter was significantly influenced by both drip irrigation regimes and fertigation levels. Interaction was found non significant (Table-1).Drip irrigation scheduled at 1.2 Epan recorded significantly higher fruit diameter (4.02 cm) than 0.8 Epan (3.74 cm). Fruit

length at 1.0 Epan (3.88 cm) was comparable with both 1.2 Epan and 0.8 Epan. Higher fruit length at higher drip irrigation levels was due to the optimum moisture in the surroundings of root zone all over the crop growth period enhances the vegetative growth of the crop thereby increase the photosynthesis and efficient translocation of photosynthates towards the reproductive organ development. Such an effect was responsible for significant improvement in fruit diameter. These results were in conformity with the observations of Om Prakash et al., [8].

Among the fertigation levels, fruit diameter was significantly higher at 150% recommended dose of NK (3.94 cm) than 75% (3.75 cm) and on par with 100% (3.91 cm) and 125% recommended dose of NK (3.93 cm). Higher dose of fertigation levels increases solubility, mobilization and availability of nutrients at regular short interval in required quantity due to drip fertigation resulted into higher nutrient uptake by fruit may lead to higher fruit diameter. These results were similar with the observations of Sanjeev kumar et al., [9].

3.3 Number of fruits per vine

Number of fruits per vine was significantly influenced by both drip irrigation regimes and fertigation levels. Interaction was found non significant (Table-1).Drip irrigation scheduled at 1.2 Epan recorded significantly higher number of fruits per vine (18.30) than 1.0 Epan (15.88 cm) and 0.8 Epan (14.47 cm) and number of fruits per vine were comparable between 0.8 Epan and 1.0 Epan. Higher number of fruits at increased drip irrigation levels is due to the optimum moisture in the surroundings of root zone all over the crop growth period enhances the vegetative growth of the crop thereby increase the photosynthesis and efficient translocation of photosynthates towards the reproductive organ development. Such an effect was responsible for significant improvement in number of fruits per vine. These results were in conformity with the observations of Ningaraju and Joseph [10].

Among the fertigation levels, number of fruits per vine was significantly higher at 150% recommended dose of NK (17.31) than 75% (14.80) and on par with 100% (16.13) and 125% recommended dose of NK (16.62). Higher dose of fertigation levels increases complete solubility, mobilization and availability of nutrients at regular short interval in required quantity due to drip fertigation resulted into higher nutrient uptake by fruits may lead to higher number of fruits per vine. These results were similar with the observations of kumar et al., [9].

3.4 Fruit weight (g)

Individual fruit weight did not influence significantly by both irrigation regimes and fertigation levels. Interaction was also found non significant. (Table -1).

3.5 Fruit yield (t ha^{-1})

Fruit yield was significantly influenced by both drip irrigation regimes and fertigation levels. Interaction was found non significant (Table-1). Fruit yield was significantly higher in drip irrigation scheduled at 1.2 Epan (83.90 t ha^{-1}) than 1.0 Epan (68.80 t ha^{-1}) and 0.8 Epan (59.50 t ha^{-1}). Fruit yield was comparable between 0.8 Epan and 1.0 Epan. Higher fruit yield at increased drip irrigation level might be due to that, the optimum moisture in the vicinity of root zone throughout the crop growth period enhanced the vegetative growth in the form of higher plant height, number of leaves $plant^{-1}$, leaf area, chlorophyll content and dry matter production of the crop thereby increase in the photosynthesis and efficient translocation of photosynthates towards the reproductive parts which increased the fruit length, diameter, weight and finally resulted into increased fruit yield of cucumber. Similar findings were reported by Abdelaziz Okasha et al., [11], Ningaraju and Joseph [10], Alomran et al., [12] and Sahin et al., [13].

Among the fertigation levels, fruit yield was significantly higher at 150 % recommended dose of NK (76.70 t ha^{-1}) than 75% recommended dose of NK (60.30 t ha^{-1}) and on par with 125% (74.20 t ha^{-1}) and 100% recommended dose of NK (71.80 t ha^{-1}). Fruit yield is a cumulative effect of yield attributes like fruit length, diameter, number of fruits and individual fruit weight. Fruit yield increased gradually with increase in 150 % recommended dose of the N and K fertigation level. This might be due to the continuous supply of nutrients in the root zone of the crop through drip fertigation, which created favourable conditions for growth and development by way of increasing metabolic activities in the plant system. These results are in harmony with the findings of Ningaraju and Joseph [10], Naik et al., [14] and Nisha and Sreelathakumary [15].

3.6 Water use

Irrigation water was applied separately for each treatment based on Epan indicated that the quantity of water increased as Epan ratio increased from 0.8 to 1.2 Epan. The quantity of water applied including special operations at different drip irrigation levels of 0.8, 1.0 and 1.2 Epan was 208.0, 258.3 and 308.6 mm respectively (Table 2.). Drip irrigation

regimes did not significantly influence water use efficiency while drip fertigation levels significantly influenced the water use efficiency. Interaction was found to be non significant (Table 2). Water use efficiency was significantly higher at 150 % recommended dose of NK (25.9 kg m^{-3}) than 75% recommended dose of NK (20.3 kg m^{-3}) and on par with 125% (24.8 kg m^{-3}) and 100% recommended dose of NK (23.8 kg m^{-3}).

4. CONCLUSIONS

cucumber crop grown under naturally ventilated poly house during rabi season under drip irrigation in sandy clay loam soils of Southern Telangana Zone, application of 1.2 Epan irrigation and 150 kg N, 100 kg K_2O ha^{-1} by fertigation is recommended for maximization of yield and water productivity.

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Table 1: Yield parameters of cucumber influenced by varied drip irrigation regimes and fertigation levels under naturally ventilated poly house.

Treatments	Fruit length (cm)	Fruit diameter (cm)	Number of fruits per vine	Fruit weight (g)	Fruit yield (t ha^{-1})
Main plots - Irrigation levels					
I_1: Drip irrigation at 0.8 Epan	14.25	3.74	14.47	153.70	59.50
I_2: Drip irrigation at 1.0 Epan	15.21	3.88	15.88	162.70	68.80
I_3: Drip irrigation at 1.2 Epan	17.46	4.02	18.30	171.80	83.90
SEm ±	0.52	0.05	0.55	0.004	3.00
C.D (P=0.05)	2.04	0.18	2.18	NS	11.80
Sub plots - Fertigation levels					
F_1: 75% Recommended dose ($N_{112.5}$ K_{75})	14.45	3.75	14.80	152.60	60.30
F_2:100% Recommended dose (N_{150} K_{100})	15.67	3.91	16.13	165.60	71.80
F_3:125% Recommended dose ($N_{187.5}$ K_{125})	15.82	3.93	16.62	166.50	74.20
F_4:150% Recommended dose (N_{225} K_{150})	16.61	3.94	17.31	166.20	76.70
SEm ±	0.43	0.05	0.55	0.01	3.10
C.D (P=0.05)	1.27	0.14	1.63	NS	9.20
Fertigation at same level of irrigation					
SEm ±	0.74	0.08	0.95	0.01	5.40
C.D (P=0.05)	NS	NS	NS	NS	NS
Irrigation at same or different fertigation levels					
SEm ±	0.83	0.09	0.99	0.01	5.60
C.D (P=0.05)	NS	NS	NS	NS	NS

Table 2 Irrigation water applied (mm), total water consumed (mm) and water use efficiency (kg m^{-3}) of cucumber at different days after sowing as - influenced by varied drip irrigation and fertigation levels under naturally ventilated poly house.

Treatments	Irrigation water applied (mm)	Irrigation water applied for special operations (mm)	Total water consumption (mm)	Total water consumption (m^3)	Water Use Efficiency (kg m^{-3})
Main plots - Irrigation levels					
I_1: Drip irrigation at 0.8 Epan	201.4	6.6	208.0	2080	28.6
I_2: Drip irrigation at 1.0 Epan	251.7	6.6	258.3	2583	26.6
I_3: Drip irrigation at 1.2 Epan	302.0	6.6	308.6	3086	27.2
SEm ±	-	-	-	-	1.1
C.D (P=0.05)	-	-	-	-	NS
Sub plots - Fertigation levels					
F_1: 75% Recommended dose ($N_{112.5}$ K_{75})	251.7	6.6	258.3	2583	23.5
F_2:100% Recommended dose (N_{150} K_{100})	251.7	6.6	258.3	2583	27.6
F_3:125% Recommended dose ($N_{187.5}$ K_{125})	251.7	6.6	258.3	2583	28.7
F_4:150% Recommended dose (N_{225} K_{150})	251.7	6.6	258.3	2583	30.1
SEm ±	-	-	-	-	1.4
C.D (P=0.05)	-	-	-	-	4.1
Fertigation at same level of irrigation					
SEm ±	-	-	-	-	2.4
C.D (P=0.05)	-	-	-	-	NS
Irrigation at same or different fertigation levels					
SEm ±	-	-	-	-	2.3
C.D (P=0.05)	-	-	-	-	NS