

NPK UPTAKE OF DRIP IRRIGATION REGIMES AND NK FERTIGATION LEVELS FOR CUCUMBER (*Cucumis sativus* L.) UNDER NATURALLY VENTILATED POLY HOUSE

Abstract

The present study was conducted in naturally ventilated poly house at Horticulture garden, College of Agriculture, Rajendranagar, Hyderabad, Telangana during *rabi* 2020- 2021 to standardize the optimum N and K fertigation levels and their effect on growth, yield and uptake of nutrients and to derive the nutrients uptake curves for cucumber under poly house during *rabi* (*yasangi*). 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 plots and replicated thrice. The experimental soil was sandy clay loam with p^H of 7.9 and EC of 1.07 dS m^{-1} . The soil fertility status was low in organic carbon (0.26%) and medium in available nitrogen ($338.69 \text{ kg ha}^{-1}$) and available phosphorous (48.53 kg ha^{-1}) and high in available potassium ($473.52 \text{ kg ha}^{-1}$). The cucumber seed, variety multi star F_1 hybrid (Poly house cucumber seeds from Rijkz waan) was sown with a spacing $40 \times 40 \text{ cm}$ in paired row system on raised beds. NPK uptake increased with each increment in drip fertigation level from 75% recommended dose of NK to 150% recommended dose of NK at all stages.

Key words: Fertigation; NPK uptake; Epan; Variety; Drip irrigation; Cucumber

1. Introduction

Vegetables cultivation has lot of scope for income improvement of small and marginal farmers in India. It has vast potential to earn foreign exchange by export. Farmers are seeking innovative methods for increasing yield and quality of the vegetables. Vegetable production under protected structures is the best way to obtain higher yield and quality produce, especially cucurbits. Salad cucumber is a commercial crop. In naturally ventilated poly houses, salad cucumber can be grown round the year. Higher yield potential is obtained in poly houses than open field conditions with best management.

It is grown both under open conditions and poly house. Cucumber can be grown throughout the year in poly house condition and quality of fruit is high because of less incidence

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of pests and diseases and the photosynthetic activity is increased and transpiration losses reduced by which high water and nutrient efficiency is achieved.

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The current problem with large scale cultivation of cucumber is that unreasonable water and fertilizer management system (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 (Zhang *et al.*, 2010). Sustainability of any system requires optimal utilization of resources such as water, fertilizer and soil. Fertilizer management is the most important agro-technique, which controls development, yield and quality of a crop. Every attempt is therefore necessary in achieving this objective of higher water and fertilizer use efficiency. Under these circumstances, drip fertigation, which is known to be hi-tech and efficient way of applying fertilizers through irrigation system as a carrier and distributor of crop nutrients, holds bright promise (Magen, 1995). 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 (Hagin and Lowengart, 1995).

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.

2. Materials and methods

The experiment entitled “Drip irrigation regimes and NK fertigation levels for cucumber (*Cucumis sativus* L.) under naturally ventilated poly house” was conducted at Horticulture garden, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad, Telangana during *rabi* 2020-2021. It is situated at 17°19' 12.93” N latitude, 78°24' 58.13” E longitude and at an altitude of 545 m above MSL in the Southern Telangana Agro-Climatic Zone in Telangana State. It is categorized under semi- arid tropics as per the ~~troll's~~ Troll's (1965) classification.

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The experiment was laid out in split plot design comprising of 12 treatments with three replications. The treatments consist of three irrigation regimes as main plots viz., Drip irrigation scheduled at 0.8 Epan , Drip irrigation scheduled at 1.0 Epan and Drip irrigation scheduled at 1.2 E Pan and four N and K fertigation levels as sub plots viz.,75% RDNK (112.5:100:75 kg N P2O5

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K₂O ha⁻¹), 100% RDNK (150:100:100 kg N P₂O₅ K₂O ha⁻¹), 125% RDNK (187.5:100:125 kg N P₂O₅ K₂O ha⁻¹) and 150% RDNK (225:100:150 kg N P₂O₅ K₂O ha⁻¹).

NPK fertilizers were applied in the form of urea, single super phosphate and white MOP. Recommended dose of fertilizers 150:100:100 N, P₂O₅ and K₂O kg ha⁻¹ was used. A common dose of P₂O₅ @ 100 kg ha⁻¹ was applied commonly to all the treatments as basal dose before sowing. Nitrogen and potassium were applied through drip fertigation with the help of ~~V~~Venturi system at different growth stages as per treatments (75% Recommended dose of NK (N112.5 K75), 100 % recommended dose of NK (N150 K100) and 125 % recommended dose of NK (N187.5 K125) and 150 % recommended dose of NK (N225 K150). The total 19 number of fertigations were given once in four days interval starting from 15 DAS to 90 DAS.

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The data was recorded on growth parameters like plant height, number of leaves plant⁻¹, dry matter production (g plant⁻¹), yield attributes viz., number of fruits vine⁻¹, fruit length (cm), diameter (cm), fruit weight (g), length of the vine at final harvest (cm), fruit yield per vine (kg). Pounded samples of leaf and fruit at harvest were used for nitrogen content (%) estimation by the micro Kjeldhal method or Kjeldahl digestion using ~~KELPLUS SUPRA~~ ~~Kelplus-Supra~~ LX - analyzer. The ~~Di~~Di-acid digested plant and fruit samples were analyzed for phosphorus content by Vanado-molybdo phosphoric acid. The intensity of yellow colour developed was measured by using UV-VIS spectrophotometer (Make - Systronics, Model -108) at 420 nm. Leaf and fruit potassium content in the ~~Di~~Di-acid was determined by using flame photometer (Make - Elico, Model - CL 361). The N, P and K uptake at harvest was calculated by using nutrient concentration and dry matter yield or fruit yield as follows.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%)} \times \text{Dry matter (kg ha}^{-1}\text{)}}{100}$$

The initial and final soil NPK status was analyzed by using standard procedures. Alkaline permanganate method using ~~KELPLUS SUPRA~~ LX – analyser was used for available nitrogen.

Available P status was ~~analysed~~analyzed by Olsen's method for extraction and Ascorbic acid method for estimation by using UV-VIS spectrophotometer (Make- systronics, Model-108) at 420 nm. Neutral normal ammonium acetate method using (Make-Elico, Model- CL361), Flame photometer was adopted for analysis of available potassium status.

The collected data was statistically analyzed by analysis of variance (ANOVA) for split plot design. ~~Op-stat~~OP SAT software used for analysis. Whenever the treatment differences were found significant, critical differences were worked out at five per cent probability level in LSD.

Treatment differences that were non significant were denoted by NS and the results were critically interpreted with proper justification with relevant literature.

3. Results and Discussion

3.1. Dry matter production (g plant⁻¹)

Dry matter production was significantly higher in drip irrigation scheduled at 1.2 Epan (10.6, 177.6 and 184.0 g plant⁻¹) than 1.0 Epan (7.2, 125.5 and 138.8 g plant⁻¹) and 0.8 Epan (5.1, 90.2 and 103.5 g plant⁻¹) at 30 DAS, 60 DAS and at harvest respectively.

Dry matter production increased significantly with increase in fertigation level from 75% recommended dose of NK to 150% recommended dose of NK. Significantly higher dry matter production was obtained at 150% recommended dose of NK (9.3, 158.1 and 166.8 g plant⁻¹) than 125% (8.2, 140.6 and 149.9 g plant⁻¹), 100% recommended dose of NK (7.3, 126.1 and 138.3 g plant⁻¹) and 75% recommended dose of NK (5.6, 99.7 and 113.3 g plant⁻¹). Dry matter production was comparable at 100% and 125% recommended dose of NK.

3.2 Fruit yield

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 Ashour *et al.* (2020), Ningaraju and Joseph (2014), Alomran *et al.* (2013) and Sahin *et al.* (2015).

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 (2014), Naik *et al.* (2019) and Nisha and Sreelathakumary (2020).

3. 3. NPK uptake (kg ha⁻¹)

3.3.1 Nitrogen uptake (kg ha⁻¹)

Nitrogen uptake was significantly influenced by both drip irrigation regimes and NK fertigation levels at all stages. Interaction was found non significant at all stages.

Among drip irrigation regimes significantly higher plant nitrogen uptake was recorded at drip irrigation scheduled at 1.2 Epan (1.9, 14.1, 32.6, 50.8, 13.8, 64.6, 86.3, 119.9, 106.4, 65.9 and 172.4 kg ha⁻¹) than 1.0 Epan (1.2, 7.9, 19.0, 29.8, 33.0, 61.1, 42.7, 46.6 and 89.3 kg ha⁻¹) and 0.8 Epan (1.0, 5.2, 11.6, 14.7, 20.7, 41.9, 25.4, 38.7 and 64.1 kg ha⁻¹) at 15, 30, 45, in plant at 60 DAS, 75 DAS and at harvest, in fruit 60 DAS and at harvest and total uptake at 60 DAS, 75 DAS and harvest respectively. Plant nitrogen uptake at 1.2 Epan was on par with 1.0 Epan during 60 DAS, while N uptake was comparable between 1.0 Epan and 0.8 Epan at 15 DAS, in plant and total uptake at 60 DAS, 75 DAS, and at harvest. Similar findings were reported by Srinivas *et al.* (1989).

Among fertigation levels nitrogen uptake increased significantly with an each increment in drip NK fertigation level from 75% to 150% recommended dose of NK fertigation at all stages. Nitrogen uptake was significantly higher at 150% recommended dose of NK (1.8, 13.2, 29.6, 44.0, 15.3, 59.3, 63.0, 36.9, 80.3, 64.3 and 144.6 kg ha⁻¹) than 125% recommended dose of NK (1.5, 10.4, 24.2, 35.2, 13.1, 48.2, 52.8, 31.4, 84.2, 67.3, 54.0 and 121.3 kg ha⁻¹), 100% (1.2, 8.1, 21.3, 31.3, 12.0, 43.3, 46.2, 25.0, 71.2, 55.1, 46.8 and 101.8 kg ha⁻¹) and 75% recommended dose of NK (0.9, 4.6, 9.4, 16.7, 7.0, 23.7, 24.8, 17.3, 42.1, 30.0, 36.7 and 66.7 kg ha⁻¹) during all stages except at 45 DAS, in plant samples and total uptake at 60 DAS and 75 DAS and in plant samples at harvest where it was on par between 100% and 125% recommended dose of NK while N uptake was comparable between 150% and 125% recommended dose of NK in fruit at 60 DAS, in plant at 75 DAS and at final harvest. Similar findings were reported by Abdrabbo *et al.* (2005) and Maragal *et al.* (2018).

3.3.2 Phosphorus uptake (kg ha⁻¹)

Both drip irrigation regimes and fertigation levels significantly influenced the phosphorus uptake at all stages. Interaction was found non significant at all stages.

Among drip irrigation levels, phosphorous uptake was significantly higher in drip irrigation scheduled at 1.2 Epan (0.6, 5.8, 14.1, 50.3, 13.2, 63.6, 57.0, 40.0, 97.1, 60.3, 46.8 and 107.1 kg ha⁻¹) than 1.0 Epan (0.4, 2.8, 6.8, 25.1, 10.3, 35.3, 27.5, 31.5, 59.0, 28.8, 36.3 and 65.1 kg ha⁻¹) and 0.8 Epan (0.3, 1.6, 3.9, 14.4, 6.1, 20.5, 15.9, 19.4, 35.3, 16.6, 21.9 and 38.5 kg ha⁻¹) at 15, 30, 45, in plant, fruit and total uptake at 60 DAS, 75 DAS and at harvest respectively. Similar findings were reported by Srinivas *et al.* (1989).

Among fertigation levels, phosphorous uptake was significantly higher at 150 % recommended dose of NK (0.5, 4.8, 11.6, 41.7, 11.6, 53.3, 47.0, 35.3, 30.3, 65.8, 49.7, 41.0 and 90.7 kg ha⁻¹) than 125 % (0.4, 3.6, 8.7, 31.7, 9.8, 41.5, 35.5, 30.3, 65.8, 37.4, 35.0 and 72.5 kg ha⁻¹) and 100 % (0.4, 3.1, 7.6, 27.6, 9.5, 37.0, 30.5, 29.1, 59.6, 31.8, 33.6 and 65.4 kg ha⁻¹) and 75 % recommended dose of NK (0.3, 2.1, 5.1, 18.8, 8.6, 27.3, 20.9, 26.5, 47.4, 22.1, 30.4 and 52.4 kg ha⁻¹) at 15, 30, 45, in plant, fruit and total uptake at 60, 75 DAS and at harvest respectively except fruit uptake 75 DAS at 150 % recommended dose of NK was on par with 125 % recommended dose of NK at. Phosphorous uptake was comparable between 125% and 100% recommended dose of NK during all stages. Similar findings were reported by Abdrabbo *et al.* (2005) and Maragal *et al.* (2018).

3.3.3 Potassium uptake (kg ha⁻¹)

Both drip irrigation regimes and NK fertigation levels significantly influenced the potassium uptake at all stages. Interaction was found to be non significant at all stages.

Among drip irrigation regimes, potassium uptake was significantly higher in drip irrigation scheduled at 1.2 Epan (0.053, 10.8, 36.8, 104.6, 34.3, 138.9, 167.0, 106.5, 273.4, 189.6, 125.5 and 315.0 kg ha⁻¹) than 1.0 Epan (0.035, 5.9, 20.5, 59.1, 30.5, 89.6, 91.4, 94.6, 186.0, 103.4, 111.5 and 214.9 kg ha⁻¹) and 0.8 Epan (0.033, 4.1, 14.1, 40.2, 23.4, 63.7, 63.4, 72.6, 136.0, 71.8, 85.6 and 157.4 kg ha⁻¹) at all the growth stages respectively. Potassium uptake was comparable in plant between 1.0 Epan and 0.8 Epan at 15 DAS, in plant at 75 DAS and final harvest. Similar findings were reported by Srinivas *et al.* (1989).

Potassium uptake was significantly higher at 150 % recommended dose of NK (0.048, 9.3, 31.6, 90.5, 33.4, 123.9, 143.2, 103.4, 246.6, 162.7, 121.8 and 284.5 kg ha⁻¹) followed by 125 % recommended dose of NK (0.043, 7.5, 26.0, 74.5, 30.4, 104.9, 117.4, 94.4, 211.8, 133.5, 111.3 and 244.7 kg ha⁻¹), 100 % (0.038, 6.6, 23.1, 65.7, 28.7, 94.4, 103.3, 89.1, 192.4, 116.3, 105.0 and 221.4 kg ha⁻¹) and 75 % recommended dose of NK (0.033, 4.3, 14.4,

41.3, 25.2, 66.5, 65.2, 78.1, 143.2, 73.9, 91.9 and 165.9 kg ha⁻¹) at all the growth stages respectively. Potassium uptake in plant was on par between 150% and 125% recommended dose of NK and also between 125% and 100% RDNK at all stages. Similar findings were reported by Abdrabbo *et al.* (2005) and Maragal *et al.* (2018).

4. CONCLUSION

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 K₂O ha⁻¹ by fertigation in 19 number of split doses at four days interval is recommended for maximization of yield and nutrient uptake.

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Table 1. Dry matter production (g plant⁻¹) of cucumber at different days after sowing as influenced by varied drip irrigation and fertigation levels under naturally ventilated poly house.

Treatments	10 DAS	30 DAS	60 DAS	Harvest
Main plots - Irrigation levels				
I ₁ : Drip irrigation at 0.8 Epan	1.0	5.1	90.2	103.5
I ₂ : Drip irrigation at 1.0 Epan	1.1	7.2	125.5	138.8
I ₃ : Drip irrigation at 1.2 Epan	1.3	10.6	177.6	184.0
SEm ±	0.07	0.2	3.7	4.0
C.D (P=0.05)	NS	0.8	14.6	15.8
Sub plots - Fertigation levels				
F ₁ : 75% Recommended dose (N _{112.5} K ₇₅)	1.1	5.6	99.7	113.3
F ₂ :100% Recommended dose (N ₁₅₀ K ₁₀₀)	1.1	7.3	126.1	138.3
F ₃ :125% Recommended dose (N _{187.5} K ₁₂₅)	1.2	8.2	140.6	149.9
F ₄ :150% Recommended dose (N ₂₂₅ K ₁₅₀)	1.2	9.3	158.1	166.8
SEm ±	0.08	0.3	4.6	3.9
C.D (P=0.05)	NS	0.9	13.5	11.5
Fertigation at same level of irrigation				
SEm ±	0.14	0.5	8.0	6.7
C.D (P=0.05)	NS	NS	NS	NS
Irrigation at same or different fertigation levels				
SEm ±	0.15	0.5	7.9	7.1
C.D (P=0.05)	NS	NS	NS	NS

Table 8. Post - harvest soil nutrient status of cucumber as influenced by varied drip irrigation and fertigation levels under naturally ventilated poly house.

Treatments	Soil status after harvest (kg ha ⁻¹)		
	N	P ₂ O ₅	K ₂ O
Main plots - Irrigation levels			
I ₁ : Drip irrigation at 0.8 Epan	332.4	54.4	496.6
I ₂ : Drip irrigation at 1.0 Epan	307.3	54.4	475.1
I ₃ : Drip irrigation at 1.2 Epan	264.5	49.8	457.1
SEm ±	10.8	1.6	2.5
C.D (P=0.05)	42.5	NS	9.9
Sub plots - Fertigation levels			
F ₁ : 75% Recommended dose (N _{112.5} K ₇₅)	274.6	48.2	455.5
F ₂ :100% Recommended dose (N ₁₅₀ K ₁₀₀)	288.5	49.0	453.0
F ₃ :125% Recommended dose (N _{187.5} K ₁₂₅)	306.6	53.8	493.4
F ₄ :150% Recommended dose (N ₂₂₅ K ₁₅₀)	335.9	60.3	503.1
SEm ±	9.7	4.2	11.6
C.D (P=0.05)	28.9	NS	34.6
Fertigation at same level of irrigation			
SEm ±	16.9	7.3	20.2
C.D (P=0.05)	NS	NS	NS
Irrigation at same or different fertigation levels			
SEm ±	18.2	6.6	17.6
C.D (P=0.05)	NS	NS	NS
Initial soil nutrient status (kg ha⁻¹)	N	P₂O₅	K₂O
	338.7	48.5	473.5