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Correlation and regression studies and economics of cucumber under naturally ventilated polyhouse with different drip irrigation regimes and fertigation levels

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Abstract
A field experiment was conducted on cucumber under naturally ventilated polyhouse with various drip irrigation and NK fertigation regimes at Rajendranagar, Hyderabad, Telangana during *rabi* 2020-2021. The experiment was laid out in split plot design comprising of 12 treatments with three replications. The treatments consist of three irrigation regimes *viz*., 0.8 Epan (I_1), 1.0 Epan (I_2) and 1.2 Epan (I_3) as main plots and four N and K fertigation levels *viz*., F_1-75% RDNK (112.5:100:75 kg N P_2O_5 K_2O ha^{-1}), F_2-100% RDNK (150:100:100 kg N P_2O_5 K_2O ha^{-1}), F_3-125% RDNK (187.5:100:125 kg N P_2O_5 K_2O ha^{-1}) and F_4-150% RDNK (225:100:150 kg N P_2O_5 K_2O ha^{-1}) as sub plots. The independent variables significantly explained the variation in fruit yield in all components like dry matter production, yield attributes and NPK uptake as evident from the high coefficient of determination (R2) values which varied from 0.72 to 0.92. Dry matter production, yield attributes and NPK uptake had positive regression coefficients and statistically significant at P=0.01. Drip irrigation scheduled at 1.2 Epan recorded significantly higher net returns and B:C ratio (Rs 10,03,218 ha-1 and 3.0) than 1.0 Epan and 0.8 Epan. Drip fertigation of 150% recommended dose of NK got significantly higher net returns and B:C ratio (₹ 8,73,314 ha-1 and 2.7) than 125%, 100% and 75% recommended dose of NK.

Keywords: Cucumber, drip irrigation, fertigation, correlation, regression, economics

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.

A native to India, cucumber (*Cucumis sativus* L.) is commonly grown in all parts of the country, mainly for its immature fruits. It is cultivated in tropical and sub-tropical regions. It is a warm season crop and susceptible to frost, thermophilic and grows best under condition of high light, humidity, moisture, fertilizer and temperature (above 20 °C). Hence, growing cucumber during autumn-winter and spring-summer season can give off season supply to the nearby market in plains. Parthenocarpic fruits are common cucumber hybrids that can be grown in off season under protected conditions due to their ability to set fruit without pollination or fertilization even at low temperatures (Monisha *et al.* 2014) [6] making efficient utilization of the land, water, nutrient and other resources.

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 of pests and diseases and the photosynthetic activity is increased and transpiration losses reduced by which high water and nutrient efficiency is achieved. Poly house is a controlled environment where control of air, temperature, humidity, light, carbon dioxide and plant nutrition occurs throughout the crop cultivation period. But care should be taken regarding selection of varieties, suitable technologies like spacing, time of planting, water and nutrient management and plant protection methods. Under open field conditions there is more chance for pests and diseases.

The crop duration is three months and income is very high because of the demand due to its nutritious values (95% is water and 100 g consists of 16 calories and vitamins A, B, C & D, specially K-vitamin and several minerals are present). It has large nutritional values consists of energy, fat, protein, carbohydrate, dietary fibre, calcium, magnesium and potassium (Hashem *et al*. 2011) [4]. It also reduces the risk of cancer, eliminates uric acid and its fiber-rich skin and high levels of potassium and magnesium helps to regulate blood pressure and promote nutrient functions.

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) [11]. 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) [5]. 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) [3].

The location specific research data is not available on drip irrigation regimes and fertigation levels in cucumber cultivation under naturally ventilated poly house. Optimum drip irrigation scheduling and fertigation levels for cucumber grown under naturally ventilated poly house conditions need to be standardised for Telangana. Keeping this in view present study on “Drip irrigation regimes and NK fertigation levels for cucumber (*Cucumis sativus* L.) under naturally ventilated poly house” is proposed.

2. Materials and Methods

2.1 characterization of study area

The present experiment was conducted at Horticulture garden, 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. Cucumber was grown under naturally ventilated polyhouse with drip irrigation system. The experimental soil was sandy clay loam in texture having with 22.9 cm h^{-1} infiltration rate, slightly alkaline in reaction (pH 7.9) and non-saline (EC 1.07 dS m^{-1}). The soil fertility status of field was low in organic carbon (0.264%) and medium in available nitrogen (338.69 kg ha^{-1}) and available phosphorous (48.53 kg ha^{-1}) and high in available potassium (473.52 kg ha^{-1}).

2.2 Experiment details and cultivation management

A field experiment was conducted on cucumber under naturally ventilated polyhouse with various drip irrigation and NK fertigation regimes at Rajendranagar, Hyderabad, Telangana during *rabi* 2020-2021. The experiment was laid out in split plot design comprising of 12 treatments with three replications. The treatments consist of three irrigation regimes *viz*., 0.8 Epan (I_1), 1.0 Epan (I_2) and 1.2 Epan (I_3) as main plots and four N and K fertigation levels *viz*., F_1-75% RDNK (112.5:100:75 kg N P_2O_5 K_2O ha^{-1}), F_2-100% RDNK (150:100:100 kg N P_2O_5 K_2O ha^{-1}), F_3-125% RDNK (187.5:100:125 kg N P_2O_5 K_2O ha^{-1}) and F_4-150% RDNK (225:100:150 kg N P_2O_5 K_2O ha^{-1}) as sub plots. The source for N and K were urea and white MOP respectively and they were applied through fertigation as per the treatments. A common dose of P_2O_5 @ 100 kg ha^{-1} was applied through SSP to all treatments as a basal dose. The sowing of good quality seed of cucumber was done with a spacing 40 x 40 cm in paired row system on raised beds on 06-11-2020. The required seed rate was 0.85 kg ha^{-1} for sowing in poly house. Single seed per hill was sown at 5cm depth.

2.3 Data collection on growth and yield parameters, NPK analysis and economics

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 using Kelplus Supra LX-analyzer. The 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-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.

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

2.4 Statistical analysis

The data on various parameters collected from the experiment were statistically analyzed by analysis of variance (ANOVA) for split plot design. Critical difference was worked out at five per cent probability level when the treatment differences were found significant and the values were furnished. The treatment differences that were not significant were denoted by non-significant (NS).

The expenditure incurred on seed, fertilizer, pesticides, irrigation, labour and machinery was worked out from field preparation to harvest of cucumber and expressed as ₹ ha^{-1}. Gross monetary returns were worked out as per the treatment by multiplying the fruit yield with the prevailing market price of cucumber (₹ 18 kg^{-1}). The treatment wise net monetary returns were calculated by subtracting the cost of cultivation from the gross monetary returns. Benefit: Cost ratio was calculated by dividing gross returns with cost of cultivation for each treatment. The formula is given below.

$$\text{Benefit: Cost ratio} = \frac{\text{Gross returns (₹ /ha)}}{\text{Cost of cultivation (₹ /ha)}}$$

The correlation coefficient denoted by r, ranges between-1 to +1 and quantifies the direction and strength of the linear association between the two variables. The correlation between two variables can be positive indicates positive association and negative indicates negative association among two variables. Higher the r2 value, stronger is the strength of association between the measured variables. Correlation between fruit yield (kg ha^{-1}) with dry matter, yield attributes, and NPK uptakes was established by adopting least square technique.

Relationship of fruit yield with dry matter production, yield attributes and NPK uptake was established by using regression analysis. While doing so, the parameters for which significantly high correlation was noticed were selected for regression studies. Cucumber fruit yield (dependable variable) was assumed as a function of various growth parameters, yield attributes and uptake of NPK (independent variable) and the following straight-line model and quadratic model was established by least square technique (Gomez and Gomez, 1984) as follows:

$$Y = a + b\,(x)$$

Where,
Y = Fresh fruit yield (kg ha-1)
a = Y-axis intercept.
b= Regression coefficient.
x= Independent variable.

3. Results and Discussion

3.1. Growth Parameters

Drip irrigation regimes and fertigation levels significantly influenced the dry matter production at all stages except at 10 DAS. Interaction was found to be non-significant at all the growth stages.

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.

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.

The regression of fruit yield on dry matter production at different stages are presented in Table 1 and illustrated in Figure 1. Correlation between fruit yield and dry matter production at different stages was highly significant as it evident from the high coefficient of determination (R^2) values which varied from 0.72 to 0.92 at P=0.01.

3.2 Yield attributes and yield

Yield attributes and yield of cucumber were significantly influenced by both drip irrigation regimes and fertigation.

Drip irrigation scheduled at 1.2 Epan recorded significantly higher 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) than 1.0 Epan and 0.8 Epan.

Among the fertigation levels, significantly higher 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) was significantly higher at 150% recommended dose of NK than 75% and on par with 100% and 125% recommended dose of NK.

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) [2], Ningaraju and Joseph (2014) [8], Alomran *et al*. (2013) [1] and Sahin *et al*. (2015) [10].

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) [8], Naik *et al*. (2019) [7] and Nisha and Sreelathakumary (2020) [9].

3.3 NPK Uptake

NPK uptakes were significantly higher in irrigation scheduled at 1.2 Epan than 1.0 and 0.8 Epan during all stages. Drip NK fertigation levels significantly increased the NPK uptake with each increment in NK fertigation level from NK to 150% recommended dose of NK at all stages.

The regression of fruit yield on dry matter production at different stages are presented in Table 1 and illustrated in Figure 3, 4, 5 correlation between fruit yield and NPK uptake at different stages was highly significant as it evident from the high coefficient of determination (R^2) values which varied from 0.67 to 0.92 at P=0.01.

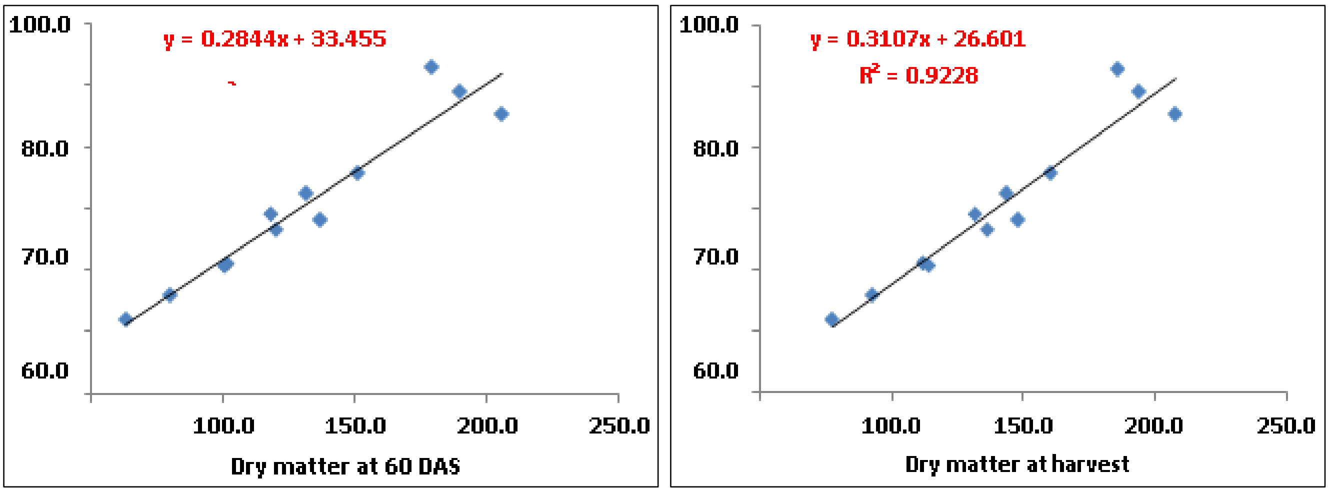
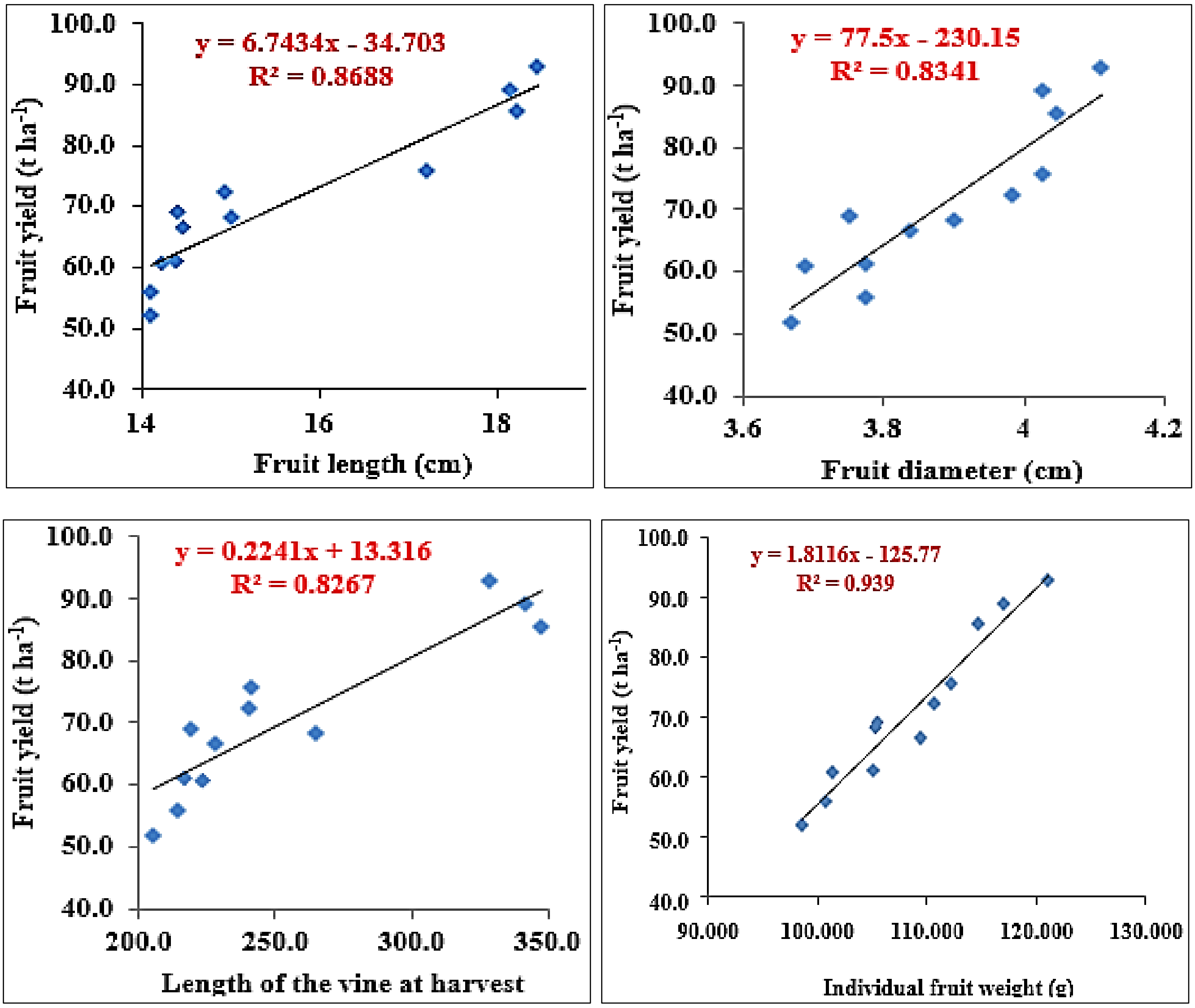


Fig 1: Regression of fruit yield (t ha^{-1}) on dry matter (g plant^{-1}) at 60 DAS and harvest



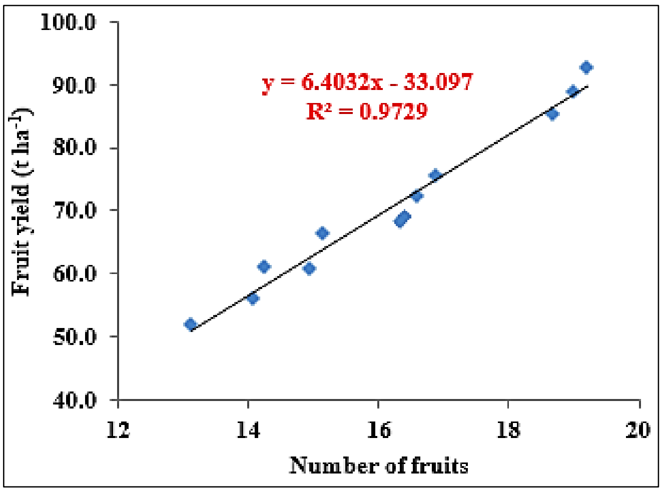
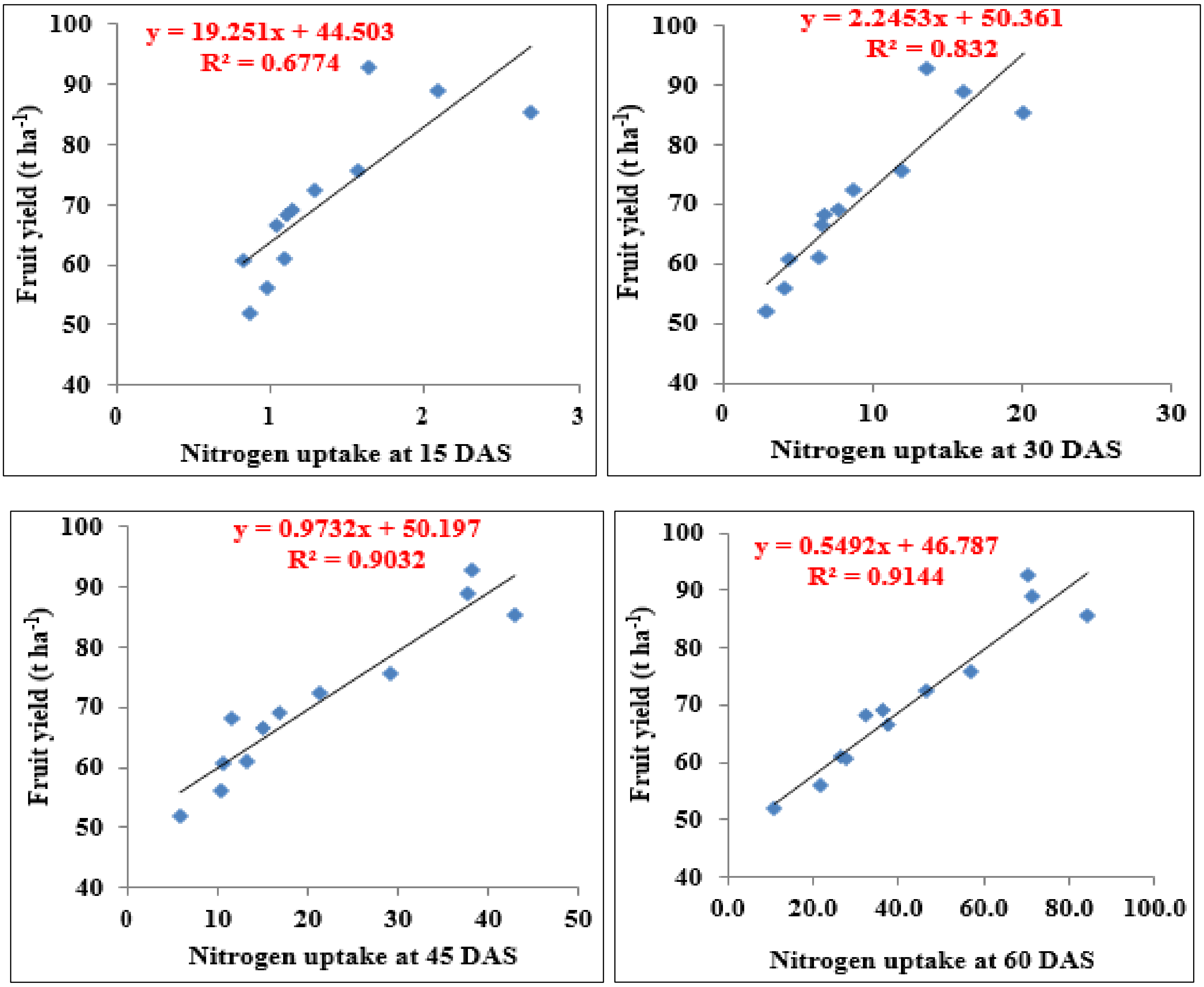


Fig 2: Regression of fruit yield (t ha^{-1}) on fruit length (cm), diameter (cm), length of the vine at harvest (cm), individual fruit weight (g fruit^{-1}) and number of fruits vine^{-1}



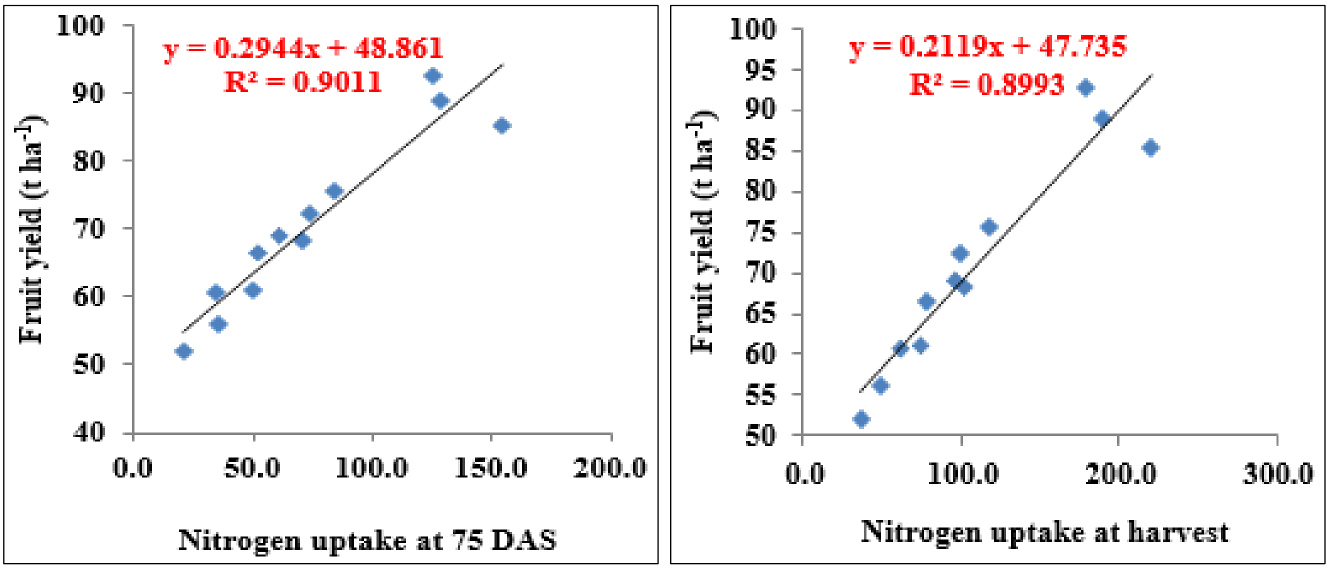
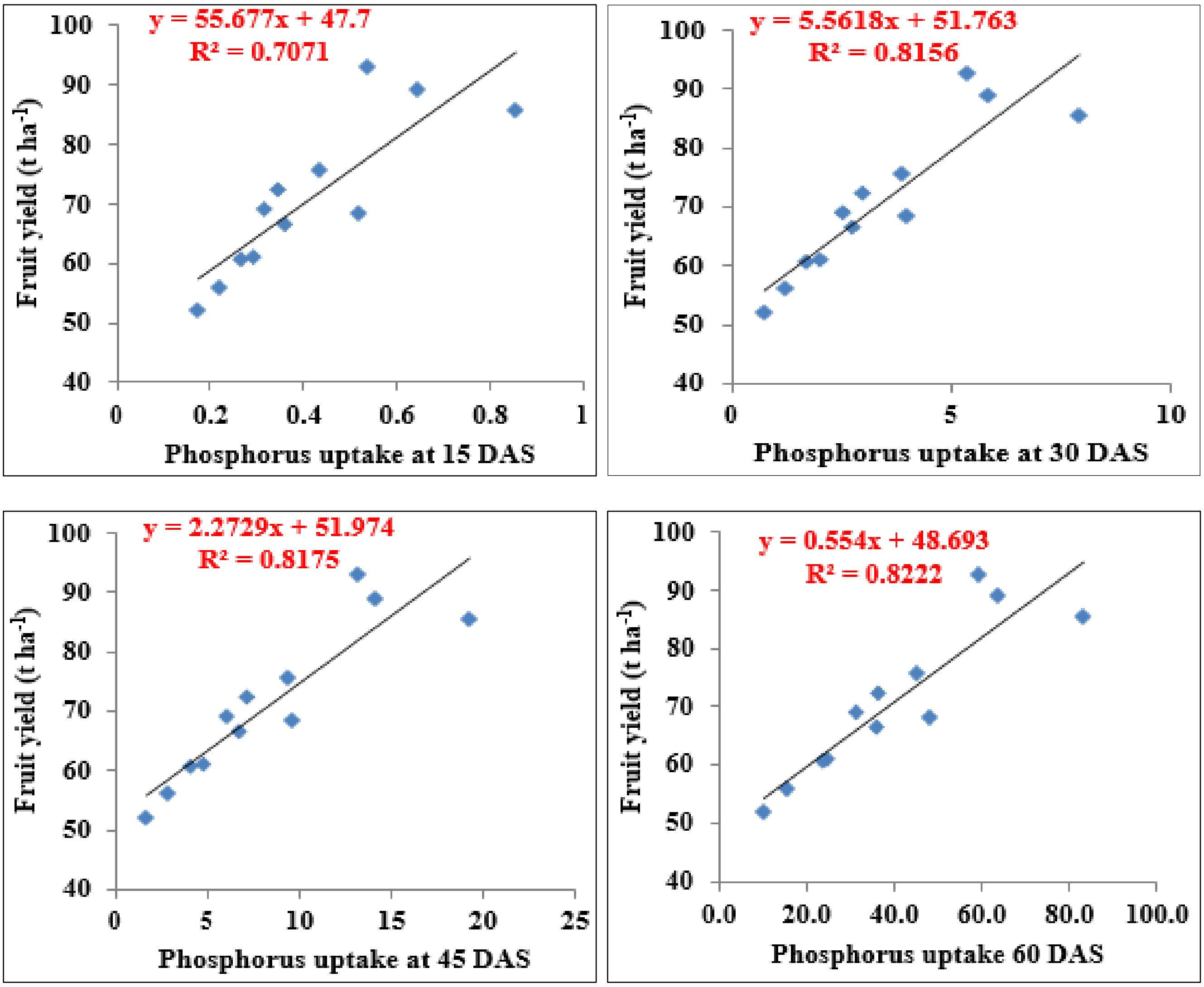


Fig 3: Regression of fruit yield (t ha^{-1}) on nitrogen uptake (kg ha^{-1}) at 15, 30, 45, 60, 75 DAS and harvest



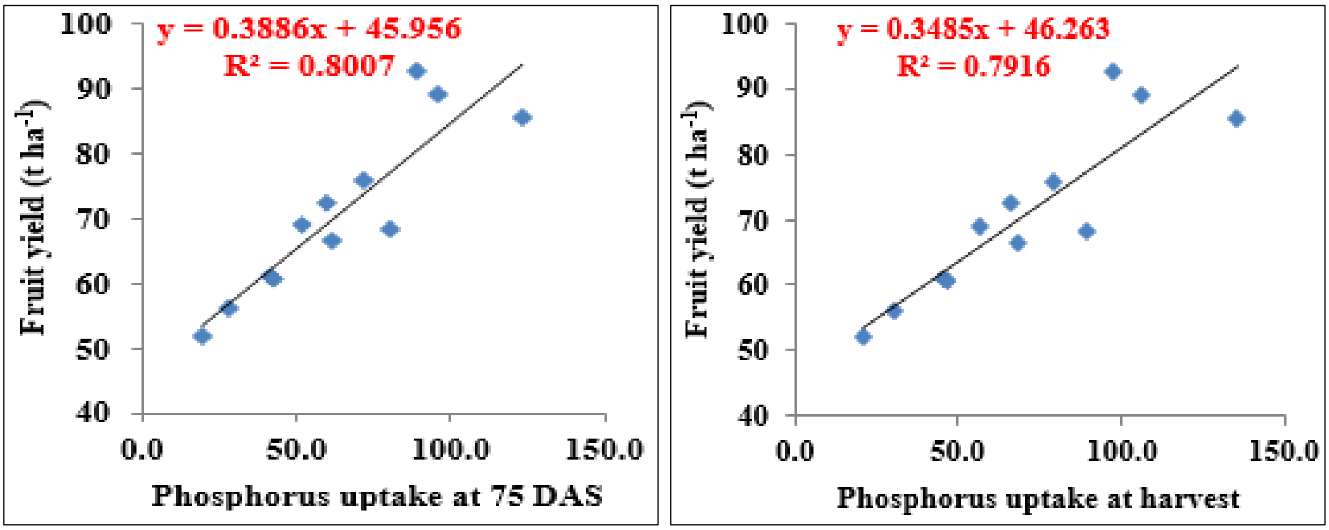
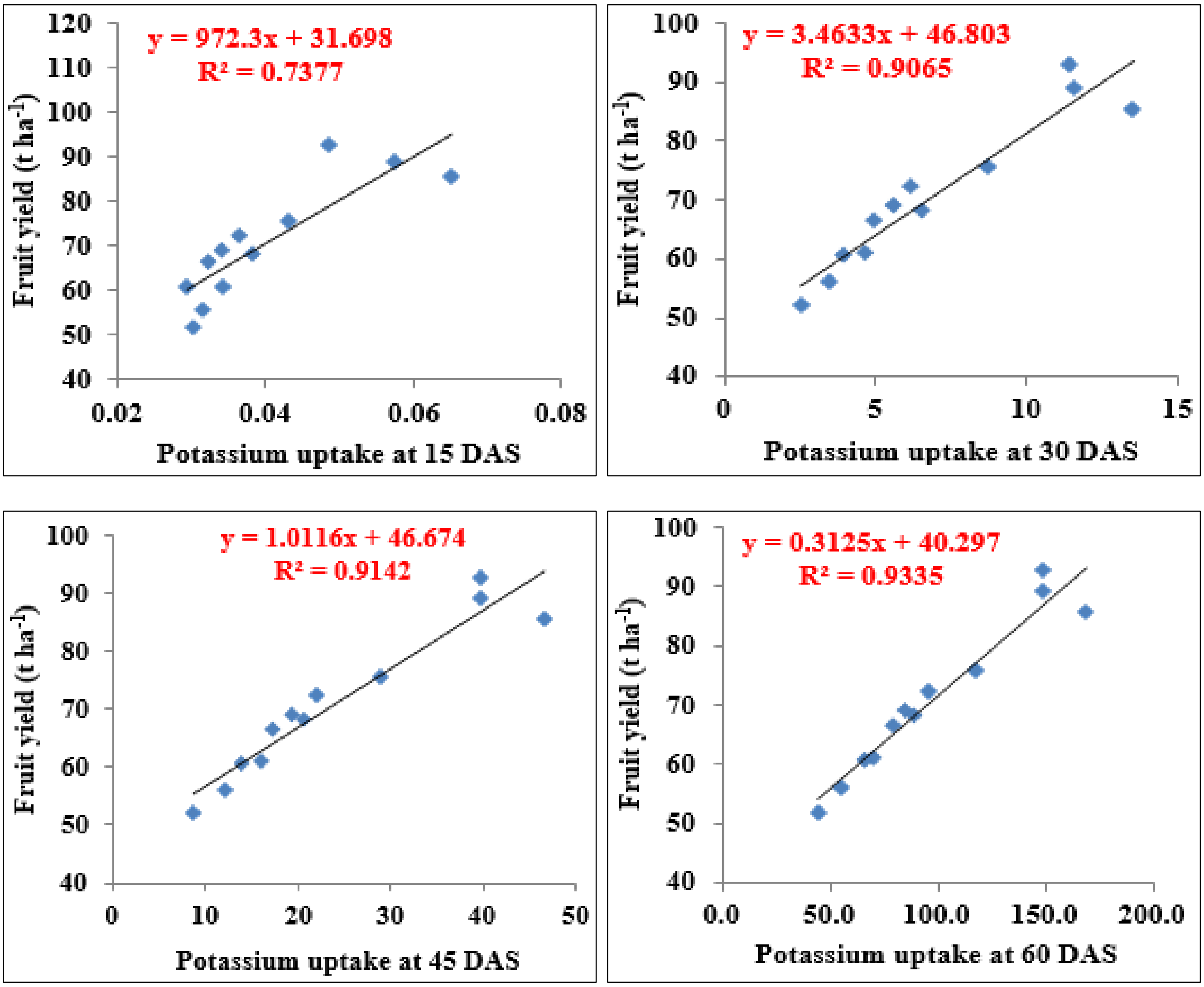


Fig 4: Regression of fruit yield (t ha^{-1}) on Phosphorus uptake (kg ha^{-1}) at 15, 30, 45, 60, 75 DAS and harvest



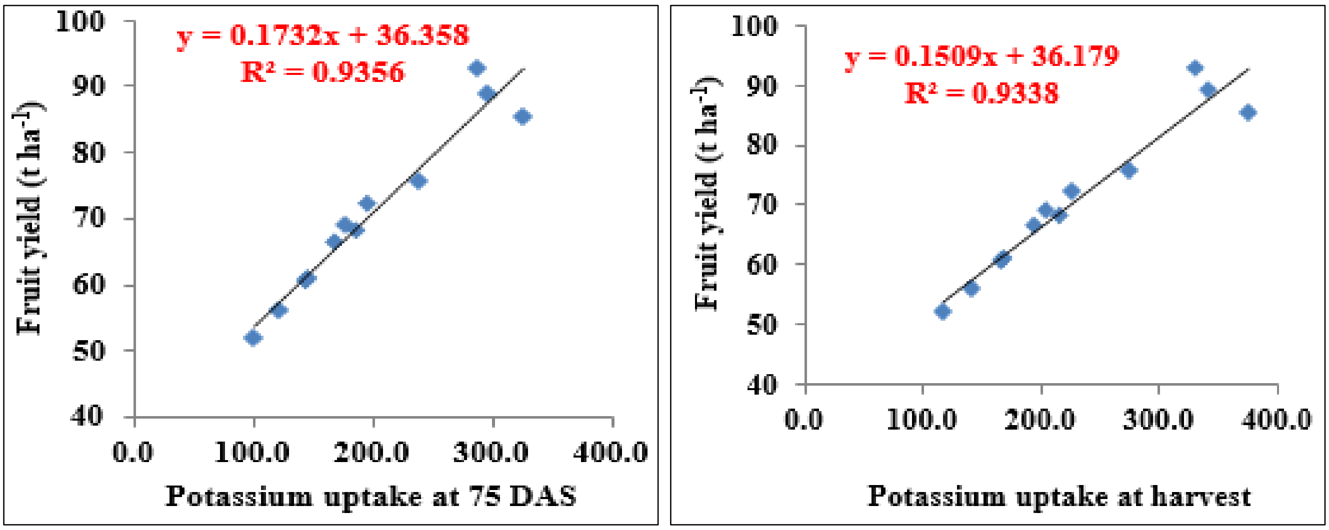


Fig 5: Regression of fruit yield (t ha^{-1}) on Potassium uptake (kg ha^{-1}) at 15, 30, 45, 60, 75 DAS and harvest

Table 1: Correlation and regression studies between cucumber fruit yield vs growth, yield attributes, growth analysis and nutrient uptake of cucumber at different days after sowing as-influenced by varied drip irrigation and fertigation levels under naturally ventilated poly house

S. No.	Parameter	Stage of the crop (DAS)	r2 value	Regression equation	S. No.	Parameter	Stage of the crop (DAS)	r^2 value	Regression equation
1.	Plant height (cm)	10	0.96**	y = 13.518x - 54.748					
		30	0.98**	y = 5.9919x - 102.76					
		60	0.93**	y = 0.7667x - 61.907	11.	Nitrogen uptake (kg ha^{-1})	15	0.82**	y = 19.251x + 44.503
		Harvest	0.91**	y = 0.2241x + 13.316			30	0.91**	y = 2.2453x + 50.361
2.	Number of leaves	10	0.87**	y = 82.269x - 52.662			45	0.95**	y = 0.9732x + 50.197
		30	0.95**	y = 18.271x - 67.812			60 (vine + fruit)	0.96**	y = 0.5492x + 46.787
		60	0.95**	y = 3.9142x - 57.644			75 (vine + fruit)	0.95**	y = 0.2944x + 48.861
		Harvest	0.86**	y = 2.4805x - 31.181			Harvest (vine + fruit)	0.95**	y = 0.2119x + 47.735
3.	Leaf Area Index (LAI)	10	0.91**	y = 10647x + 47.01	12.	Phosphorus uptake (kg ha^{-1})	15	0.84**	y = 55.677x + 47.7
		30	0.91**	y = 27.905x + 46.625			30	0.90**	y = 5.5618x + 51.763
		60	0.96**	y = 3.8262x + 42.68			45	0.90**	y = 2.2729x + 51.974
		Harvest	0.97**	y = 2.6005x + 41.985			60 (vine + fruit)	0.91**	y = 0.554x + 48.693
4.	Dry matter (g plant^{-1})	10	0.85**	y = 73.604x - 13.147			75 (vine + fruit)	0.89**	y = 0.3886x + 45.956
		30	0.96**	y = 4.4854x + 36.524			Harvest (vine + fruit)	0.89**	y = 0.3485x + 46.263
		60	0.96**	y = 0.2844x + 33.455	13.	Potassium uptake (kg ha^{-1})	15	0.86**	y = 972.3x + 31.698
		Harvest	0.96**	y = 0.3107x + 26.601			30	0.95**	y = 3.4633x + 46.803
5.	Leaf chlorophyll content (SPAD)	10	0.87**	y = 3.6578x - 37.509			45	0.96**	y = 1.0116x + 46.674
		30	0.87**	y = 2.9262x - 37.509			60 (vine + fruit)	0.97**	y = 0.3125x + 40.297
		60	0.88**	y = 2.6778x - 37.597			75 (vine + fruit)	0.97**	y = 0.1732x + 36.358
		Harvest	0.88**	y = 2.8837x - 37.296			Harvest (vine + fruit)	0.97**	y = 0.1509x + 36.179
6.	Fruit length (cm)	Harvest	0.93**	y = 6.7434x - 34.703	Note: (*)-Significant at 95% and (**)-Significant at 99% of confidence. (n-2) = 12-2=10. At n=10, r^2: Equal or above of 0. 58 at 95% and 0.71 at 99% level of significance.				
7.	Fruit diameter (cm)	Harvest	0.91**	y = 77.5x - 230.15					
8.	Individual fruit weight (g)	Harvest	0.97**	y = 1.8116x - 125.77					
9.	Number of fruits vine^{-1}	Harvest	0.99**	Y= 6.4032 - 33.097					
10.	Length of the vine (cm)	Harvest	0.91**	Y = 0.2241 + 13.316					

Table 2: Gross returns, cost of cultivation, net return and B: C ratio of cucumber as influenced by varied drip irrigation and fertigation levels under naturally ventilated poly house

Treatments	Gross returns (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C Ratio
Main plots-Irrigation levels				
I_1: Drip irrigation at 0.8 Epan	1071402.3	505776.5	565625.8	2.1
I_2: Drip irrigation at 1.0 Epan	1238896.4	506206.5	732689.9	2.4
I_3: Drip irrigation at 1.2 Epan	1509765.1	506546.5	1003218.6	3.0
S.Em ±	54129.8	-	54129.8	0.1
C.D (P=0.05)	212539.8	-	212539.8	0.4
Sub plots-Fertigation levels				
F_1: 75% Recommended dose ($N_{112.5}$ K_{75})	1085416.3	504332.0	581084.3	2.2
F_2: 100% Recommended dose (N_{150} K_{100})	1291908.3	505567.0	786341.3	2.6
F_3: 125% Recommended dose ($N_{187.5}$ K_{125})	1334761.7	506789.0	827972.7	2.6
F_4: 150% Recommended dose (N_{225} K_{150})	1381332.2	508018.0	873314.2	2.7

S.Em ±	56006.6	-	56006.6	0.1
C.D (P=0.05)	166404.1	-	166404.1	0.3
Fertigation at same level of irrigation				
S.Em ±	97006.2	-	97006.2	0.2
C.D (P=0.05)	NS	-	NS	NS
Irrigation at same or different fertigation levels				
S.Em ±	99938.4	-	99938.4	0.2
C.D (P=0.05)	NS	-	NS	NS
Market price: ₹ 18 kg^{-1} of cucumber				

Table 3: Yield parameters of cucumber as influenced by varied drip irrigation regimes and fertigation levels under naturally ventilated poly house

Treatments	Number of fruits per vine	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Length of the vine at final harvest (cm)	Fruit yield per vine (kg)	*Total fruit yield (t ha^{-1})	Biological yield (t ha^{-1})
Main plots-Irrigation levels								
I_1: Drip irrigation at 0.8 Epan	14.47	14.25	3.74	102.46	214.2	1.49	59.50	4.14
I_2: Drip irrigation at 1.0 Epan	15.88	15.21	3.88	108.46	233.7	1.72	68.80	5.55
I_3: Drip irrigation at 1.2 Epan	18.30	17.46	4.02	114.51	320.9	2.10	83.90	7.36
S.Em ±	0.55	0.52	0.05	2.376	8.6	0.08	3.00	1.16
C.D (P=0.05)	2.18	2.04	0.18	NS	33.6	0.30	11.80	0.06
Sub plots-Fertigation levels								
F_1: 75% Recommended dose ($N_{112.5}$ K_{75})	14.80	14.45	3.75	101.74	231.5	1.51	60.30	4.53
F_2: 100% Recommended dose (N_{150} K_{100})	16.13	15.67	3.91	110.41	257.4	1.79	71.80	5.53
F_3: 125% Recommended dose ($N_{187.5}$ K_{125})	16.62	15.82	3.93	110.97	266.6	1.85	74.20	6.00
F_4: 150% Recommended dose (N_{225} K_{150})	17.31	16.61	3.94	110.79	269.6	1.92	76.70	6.67
S.Em ±	0.55	0.43	0.05	4.47	6.5	0.08	3.10	1.16
C.D (P=0.05)	1.63	1.27	0.14	NS	19.3	0.23	9.20	0.46
Fertigation at same level of irrigation								
S.Em ±	0.95	0.74	0.08	7.74	11.3	0.14	5.40	0.27
C.D (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Irrigation at same or different fertigation levels								
S.Em ±	0.99	0.83	0.09	7.11	13.0	0.14	5.60	0.28
C.D (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

3.4 Economics
Gross and net returns and B:C ratio were influenced significantly by both drip irrigation levels and drip NK fertigation levels. But interaction was found to be non-significant.

Drip irrigation scheduled at 1.2 Epan significantly increased both gross and net returns and B:C ratio (₹ 15,09,765 ha-1, ₹ 10,03,218 ha-1 and 3.0) respectively than 1.0 Epan (₹ 12,38,896 ha-1, ₹ 7,32,689 ha-1 and 2.4 respectively) and 0.8 Epan (₹ 10,71,402 ha-1, ₹ 5,65,625 and 2.1 respectively).

Drip NK fertigation levels significantly increased the gross and net returns and B:C ratio at each increment level of drip NK fertigation from 75 to 150% recommended dose of NK. Gross and net returns and B:C ratio were significantly higher at 150% recommended dose of NK (₹13,81,332 ha-1, ₹ 8,73,314 ha-1 and 2.7) than 125% recommended dose of NK (₹13,34,761 ha-1, ₹ 8,27,972 ha-1 and 2.6) and 100% recommended dose of NK (₹ 12,91,908 ha-1, ₹- 7,86,341 and 2.6). Lowest was recorded with 75% recommended dose of NK (₹ 10, 85,416 ha-1, ₹ 5, 81,084 and 2.2).

4. Conclusion
Application of 1.2 Epan irrigation and 150% recommended dose of NK (N_{225} K_{150}) by fertigation in 19 number of split doses once in four days interval is recommended for maximization of yield and nutrient uptake in cucumber cultivated in *rabi* season.

5. Competing Interests
Authors have declared that no competing interests exist.

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