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Effect of Drip Fertigation Levels on Nutrient Uptake of Green Pea (*Psium sativum* L.)

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Abstract A field experiment was conducted during rabi season for the year 2014 to study the effect of irrigation and fertigation levels on nutrient uptake of green pea under drip irrigation. The field experiment was laid out in a split plot design which comprised of four levels of irrigation (I_1 : 100% ETc, I_2 : 85% ETc, I_3 : 70% ETc, I_4 : 55% ETc) and four levels of fertigation (F_1 :125% of RD, F_2 : 100% of RD, F_3 : 75% of RD, F_4: 50% of RD) with three replications. Results showed that the total nitrogen, phosphorus and potassium uptake in case of different irrigation and fertigation levels for green pea in saline soil differed significantly. The maximum total uptake of nitrogen, phosphorus and potassium was observed as 41.22, 32.78 and 33.38 kg/ha respectively in irrigation level I_3 (70% ETc) and minimum total nitrogen, phosphorus and potassium uptake was observed as 28.17, 21.97 and 22.89 kg/ha respectively in irrigation level I_1 (100% ETc). Whereas, the maximum total uptake of nitrogen, phosphorus and potassium was observed as 39.80, 29.18 and 30.39 kg/ha respectively in fertigation level F_3 (75% RD), and minimum total uptake of nitrogen, phosphorus and potassium 30.96, 25.87 and 25.88 kg/ha respectively was observed in F_1 (125% RD). The interaction effect between irrigation and fertilizer levels in saline soil was found to be significant in respect of total nitrogen, phosphorus and potassium uptake. The maximum total uptake of nitrogen, phosphorus and potassium was observed 48.09, 34.51 and 34.51 kg/ha respectively in treatment combination I_3F_3 (70% ETc and 75% RD) and minimum total uptake of nitrogen, phosphorus and potassium was recorded 23.96, 20.32 and 19.99 kg/ha respectively in treatment combination I_1F_1 (100% ETc and 125% RD). The study reveals that the drip fertigation @ 70% of ETc with application of 75% RD of fertilizer in water soluble form results in better nutrient uptake under saline soil.

Keywords Irrigation, Fertigation, Nutrient uptake.

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Introduction

Drip fertigation is a highly efficient method for fertilizer application; minimize losses and adverse environment impact on crop production. Both water and nutrients applied through irrigation system will be used by the plants for photosynthesis finally enabling

plants to produce new tissues which have influence on growth and production of crops.

Pea is a cool-season vegetable crop of mild climate regions. Therefore, it gives higher yield in cold humid regions compared to warm-dry areas. Its minimum temperature range for germination is between 1-6^{0}C and it can survive in low temperature up to -5^{0}C. Pea is sensitive to salinity. Degree of salinity level affects rate of yield losses (Duke 1981, Maas 1986). Actual uptake and removal will vary with crop yield, crop variety, soil fertility and from year to year. Accurate removal values can only be determined by laboratory analysis. Crop uptake of nutrients is affected by soil and climatic conditions. Low soil moisture, poor aeration due to compaction or excessive moisture, low soil temperatures, high lime in the root zone, nutrient imbalances, and other factors may restrict uptake of plant nutrients. Crop fertility requirements will differ from these nutrient removal values. Crops are not able to extract all available plant nutrients from the soil, and fertilizers are not 100% efficient. For any given yield, the total nutrient supply in the soil (soil plus added fertilizer) will be somewhat greater than the amount removed by the crop. The best way to determine fertilizer requirements is regular soil analysis. Lower level irrigation can also improve water productivity and the saved water can be used to irrigate other areas or crops. Hence, the objective of this study was to determine effect nutrient uptake on saline soil. The ranges in nutrient uptake and removal values are different with various irrigation and fertigation levels which are based on typical nutrient concentrations and yields for good growing conditions in Ahmednagar district of Maharashtra state, India. Hence the study was planned to study effect of different irrigation and fertigation level on nutrient uptake for green pea in saline soil (Shejul 2014).

Materials and Methods

An experiment was carried out at the Instructional Farm of the Department of Irrigation and Drainage Engineering, Dr Annasaheb Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi* season November 2013– February 2014. The farm lies at 74^{0}38'00''E longitude and 19^{0}15'00''N latitude at 557 m above the mean sea level.The field experiment was laid out in a split plot design which comprised of four levels of irrigation (I_1 : 100% ETc, I_2 : 85% ETc, I_3 : 70% ETc, I_4 : 55% ETc) and four levels of fertigation (F_1 : 125% of RD, F_2 : 100% of RD, F_3: 75% of RD, F_4 : 50% of RD) with three replications. Irrigation was scheduled at an alternate day on the basis of reference evapotranspiration calculated by Penman-Monteith's equation and values of crop coefficient (Allen et al. 1998). Drip irrigation method was adopted for application of the water applied as per different treatments previously decided.

The chemical and physical analysis were conducted by standard methods. The soil was pre-dominantly clay with field capacity. Permanent wilting point and bulk density were observed as 37.50%, 19.50% and 1.27 g cc^{-1} respectively. Based on soil analysis the required fertilizers (N:P:K) were used as follows: 25:60: 60 kg´ ha^{-1}. Chemical analysis of irrigation water indicated that electrical conductivity was 2.31 dS/m and the pH value was 8.32. The class obtained for water was C_3S_1 (high salinity and excellent low hazard alkalization). The observed chemical properties such as EC and pH of soil were as 0.45 dS/m and 8.20 respectively, it indicates that soil is saline in nature and similar results have also been reported by Patil (2012).

Methodology for analysis for plant samples

To study the nutrients uptake viz., nitrogen, phosphorus and potassium, green pod with straw from each treatment were collected at harvest and dried in oven at 60^{0}C– 70^{0}C. These samples were grinded in willery mill. The grain and straw pod samples digested by adopting the standard procedure. The concentration of N, P and K were estimated by standards method. The uptake of N, P and K by grain and straw was calculated by multiplying percent values of nutrients with grain and straw yield of respective treatments.

Analysis of plant samples

For estimating nitrogen content, plant samples were

Table 1. Total nitrogen, phosphorus and potassium uptake as influenced by different treatments.

Treatment	Total nitrogen uptake (kg/ha)	Total phosphorus uptake (kg/ha)	Total potassium uptake (kg/ha)
A. Irrigation levels			
I_1	28.17	21.97	22.89
I_2	30.73	26.00	26.21
I_3	41.22	32.78	33.38
I_4	36.95	29.61	28.70
F test	Sign	Sign	Sign
SE ±	0.76	0.49	0.47
CD at 5%	2.62	1.71	1.64
B. Fertilizer levels			
F_1	30.96	25.87	25.88
F_2	31.05	26.71	26.54
F_3	39.80	29.18	30.39
F_4	35.09	28.60	28.35
F test	Sign	Sign	Sign
SE ±	0.74	0.34	0.42
CD at 5%	2.15	1.00	1.22
C. Interaction			
Between two sub plots means at same level of main plot mean (A × B)	Sign	Sign	Sign
Between two main plots means at same level of sub plot mean (A × B)	Sign	Sign	Sign
D. General mean	34.22	27.79	27.79

digested with concentrated sulfuric acid and H_2O_2 (30%) in 1:1 proportion digestion mixture. For the estimation of phosphorus and potassium, plant samples were digested with HNO_3 : $HCLO_4$ (9:4 ratio) mixture. The method followed for the estimation of nitrogen, phosphorus and potassium are as mentioned below.

Nitrogen analysis

The nitrogen in the digest was estimated by modified kjeldhal's method (Jackson 1973).

Phosphorus analysis

Phosphorus in diacid digested plant samples were estimated by vandomolybdate yellow color method in HNO_3 system as given by Jackson (1973) and color intensity was read on spectrophotometer at 427 nm.

Potassium analysis

Potassium content in diacid digested plant samples were estimated with the help of flame photometer (Chapaman and Pratt 1961).

Nutrient uptake (kg/ha)

The uptake of nitrogen, phosphorus and potassium were calculated using the equation.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Percent nutrient concentration} \times \text{biomass (kg ha}^{-1})}{100}$$

Results and Discussion

Total nitrogen uptake

The total nitrogen uptake in saline soil differed significantly due to different irrigation levels. It was found that the nitrogen uptake was highest i.e. 41.22 (kg/ha) in I_3 (70% ETc) as shown in Table 1 which was significantly superior to I_4 (55% ETc), I_1 (100% ETc), and I_2 (85% ETc). The minimum total nitrogen uptake (28.17) (kg/ha) was observed in irrigation level I_1 (100% ETc).

The total nitrogen uptake per hectare of green pea in saline soil differed significantly due to fertilizer levels. The highest total nitrogen uptake (39.80 kg/ha) was observed in F_3 (75% RD) and was significantly superior over other fertigation levels F_4 (50% RD), F_1 (125% RD) and F_2 (100 % RD). The lowest total nitrogen uptake (30.96 kg/ha) was observed in F_1.

The interaction effect between irrigation and fertigation in saline soil was found to be significant in respect of total nitrogen uptake. The highest nitrogen uptake 48.03 kg/ha was found in treatment combination of I_3F_3 (70% ETc and 75% RD) and lowest nitrogen uptake 23.96 kg/ha was found in treatment combinations of I_1F_1 i.e. (100% ETc and 125% RD)

Table 2. Effect of interaction between different irrigation and fertigation levels on nitrogen uptake for green pea.

Treat-ments	F_1	F_2	F_3	F_4	Mean
I_1	23.96	26.83	38.28	34.76	28.17
I_2	26.84	28.58	37.26	31.51	30.73
I_3	29.15	38.40	48.09	43.56	41.22
I_4	29.18	31.96	41.23	37.97	36.95
Mean	30.96	31.05	39.80	35.09	34.22
		Source		SE±	CD at 5%
Between two sub plots means at same level of main plot mean				1.47	4.30
Between two main plots means at same level of sub plot mean				1.48	3.21

as shown in Table 2 and graphically depicted in Fig 1.

Total phosphorus uptake

The total phosphorus uptake per hectare for green pea in saline soil differed significantly due to different irrigation levels. The highest phosphorus uptake (32.78 kg/ha) was found in I_3 (70% ETc) and which was significantly superior to other irrigation levels. Whereas, the lowest total phosphorus uptake 21.97 (kg/ha) was observed in irrigation level I_1 (100% ETc).

The total phosphorus uptake of green pea in saline soil differed significantly due to fertilizer levels. The highest total phosphorus uptake (25.87 kg/ha) was observed in F_3 (75% RD) and was significantly superior over other fertilizer levels. Treatment E_4 was superior over treatment F_2, the lowest total phosphorus uptake (25.87 kg/ha) was observed in F_1 (125% RD) in saline soil and presented in Table 1.

The interaction effect between irrigation and fertigation levels in saline soil was found to be significant in respect of total phosphorus uptake. The highest phosphorus uptake (34.51 kg/ha) was found in treatment combination of I_3F_3 (70% ETc and 75% RD) and lowest phosphorus uptake (20.32 kg/ha) was found in treatment combinations of I_1F_1 i.e. (100% ETc and 125% RD) as presented in the Table 3 and graphically depicted in Fig. 1.

Total potassium uptake

Total potassium uptake per hectare for green pea in saline soil differed significantly due different irrigation levels. It was found that the higher potassium uptake 33.38 (kg/ha) was found in I_3 (70% ETc) as shown in Table 1 and which was significantly superior to other irrigation levels. Whereas, the lowest potassium uptake (22.89 kg/ha) was observed in irrigation level I_1 (100% ETc).

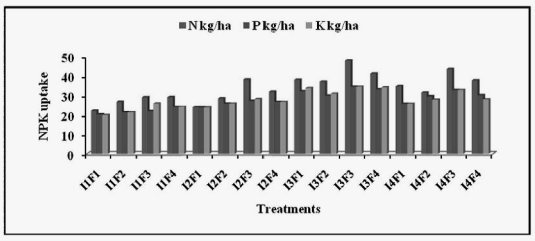

Fig. 1. Effect of interaction on nutrient uptake of different treatments.

The total potassium uptake per hectare of green pea in saline soil differed significantly due to fertilizer levels. The maximum potassium uptake (30.39 kg/ha) was observed in F_3 (75% RD) and was significantly superior over other fertigation levels. The minimum potassium uptake (25.88 kg/ha) was observed in F_1 (125% RD) as shown in Table 1.

The interaction effect between irrigation and fertilizer levels in saline soil was found to be significant in respect of total potassium uptake. The highest potassium uptake (34.51 kg/ha) was found in treatment combination of I_3F_3 (70% ETc and 75% RD),

Table 3. Effect of interaction between different irrigation and fertigation levels on phosphorus uptake for green pea.

Treat-ments	F_1	F_2	F_3	F_4	Mean
I_1	20.32	23.84	33.45	25.85	21.97
I_2	21.38	25.93	29.93	29.60	26.00
I_3	21.96	27.40	34.51	32.85	32.78
I_4	24.23	26.81	33.22	30.15	29.61
Mean	25.87	26.71	29.18	28.60	27.59
		Source		SE ±	CD at 5%
Between two sub plots means at same level of main plot mean				0.68	1.99
Between two main plots means at same level of sub plot mean				0.77	1.71

Table 4. Effect of interaction between different irrigation and fertigation levels on potassium uptake for green pea.

Treat-ments	F_1	F_2	F_3	F_4	Mean
I_1	19.99	23.84	33.84	25.85	22.89
I_2	21.38	25.93	30.93	27.93	26.21
I_3	25.96	28.25	34.51	32.85	33.38
I_4	24.23	26.81	34.22	28.15	28.70
Mean	25.88	26.54	30.39	28.35	27.79
Source				SE ±	CD at 5%
Between two sub plots means at same level of main plot mean				0.68	1.99
Between two main plots means at same level of sub plot mean				0.77	1.71

whereas, the lowest mean potassium uptake (19.99 kg/ha) was found in treatment combinations of I_1F_1 i.e. (100% ETc and 125% RD) as shown in Table 4 and graphically depicted in Fig. 1.

Conclusion

The maximum total uptake of nitrogen, phosphorus and potassium was observed as 41.22, 32.78 and 33.38 kg/ha respectively in irrigation level I_3 (70% ETc). Whereas the maximum total uptake of nitrogen, phosphorus and potassium was observed as 39.80, 29.18 and 30.39 kg/ha respectively in fertigation level F_3 (75% RD). Among different treatment combinations, the NPK uptake for green pea in saline soil was found maximum 48.09 kg/ha, 34.51 kg/ha and 34.51 kg/ha respectively in treatment combination of I_3F_3 (70% ETc and F_3 75% of RD). Hence drip fertigation @ 70% of ETc with application of 75% RD of fertilizer in water soluble form is recommended for better nutrient uptake under saline soil.

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