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Effect of fertigation on soil fertility, yield and nutrient uptake by Brinjal

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Abstract

A field experiment was conducted to study the effect of fertigation on yield, soil fertility status and nutrient uptake by brinjal during rabi season of 2017-18 at research farm of Department of Irrigation and Drainage Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment was laid out in randomized block design with five treatments replicated four times. The treatments consist of various levels of fertilizers through drip fertigation and a control treatment with traditional application of fertilizer. The results revealed that the yield increased with increasing level of fertigation. The maximum yield was recorded with drip fertigation at 150% RDF (557.10 q ha⁻¹) which was found to be at par with drip fertigation at 125% RDF (554.88 q ha⁻¹). Significantly lower yield obtained under control i.e. traditional fertilization at 100% RDF (428.56 q ha⁻¹). Similar trend was observed with highest available nitrogen, phosphorus, potassium and micronutrients in soil. Chemical properties of soil were also improved with fertigation as compared to traditional method of fertilizer application. Highest B:C ratio was obtained in treatment with drip fertigation at 125% RDF (3.22) followed by treatment with drip fertigation at 100% RDF (3.09).

Keywords: Lentil, Fusarium, fungicides, evaluation, neem

Introduction

Brinjal is a staple vegetable in our diet. It is preferred both by poor and rich people. It is quite high in nutritive value and can be compared with tomato. It contains 92.7% water, 1.4% protein, 4.0% carbohydrates, 0.3% fats, 0.3% minerals, 1.3% fibre (Aykroyd, 1963)^[1].

Drip irrigation system increases yield by 10-12%, reduces weed population by 50-60% and saves 40-50% water compared with surface irrigation system. In addition to this, it enhances fertilizer use efficiency, hastens crop maturity and improves the quality of the produce (Pawar *et al.* 2013)^[11]. Fertigation, a technology of applying water soluble fertilizer through drip irrigation is one of important functionality of drip system. Fertigation has number of advantages over traditional methods like high nutrient use efficiency, increased yield and quality, placement of fertilizer in the vicinity of root zone of the crop, saving of fertilizer and application of trace element along with major nutrients (Pawar *et al.* 2013)^[11].

Mulching is used to cover soil surface around the plants to create congenial condition for the plant growth. Inorganic mulch includes plastic mulch and accounts for the greatest volume of mulch use in commercial crop production. The plastic materials used as mulch are polyvinyl chloride or polyethylene films. Polythene mulches are widely used in the cultivation of vegetables.

Material and Methods

A field experiment was carried out during *Rabi* season of 2017-18 at research farm of Department of Irrigation and Drainage Engineering, Dr. P.D.K.V. Akola. The soil of the experimental site was low in available nitrogen (225.79 kg ha⁻¹), medium in available phosphorus (14.21 kg ha⁻¹) and high in available potassium (312.48 kg ha⁻¹). The experiment was laid out in randomized block design with five treatments (T₁ – 75% RDF, T₂ – 100% RDF, T₃ 125% RDF, T₄ – 150% RDF all through drip fertigation and T₅ – 100% RDF with traditional application of fertilizers) replicated four times. The recommended fertilizer dose of 150:75:75 N:P:K kg ha⁻¹ was used. The seedlings were transplanted at 90 cm X 75 cm. The yield of brinjal was recorded in 20 pickings. Plot wise soil samples were collected and analyzed for pH (1:2.5 Soil: Water suspension), EC by conductivity meter (Jackson, 1973)^[7], organic carbon by Walkley and Black method (Nelson & Sommers 1982)^[10], calcium

carbonate by rapid titration method (Piper, 1966)^[12], available N by alkaline permanganate method (Subbiah and Asija, 1956)^[16], available P by Olsen's method (Watnabe and Olsen, 1965)^[20], available K by ammonium acetate extraction method (Jackson, 1973)^[7], available sulphur by simple turbidimetric method (Chesnin and Yein, 1951)^[3] and available micronutrients (Fe, Mn, Zn, Cu) by extracting soil with 0.005 M DTPA (Lindsay and Norvell, 1978)^[8]. The plant samples were collected at harvest and analysed for total nitrogen by Kjeldahl method from acid digestion (Piper, 1966)^[12], total phosphorus by Vanado molybdate yellow colour method using diacid extract (Jackson, 1973)^[7], total potassium by Flame photometrically from diacid extract (Piper, 1966)^[12].

Total cost (fixed cost plus operating cost) per ha was calculated for comparison on per hectare basis. Gross return is worked out by considering the yield of produce and its selling price. Net return is calculated by subtracting cost of production from gross return in each treatment. Net return is calculated by subtracting cost of production from gross return in each treatment. Benefit cost ratio was estimated by using following formula.

$$\text{Benefit cost ratio} = \frac{\text{Gross return per season}}{\text{Total cost per season}}$$

Results and Discussion

Yield

The data on yield of brinjal (Table 1) indicated that treatment T₄ i.e. Drip fertigation at 150% RDF recorded significantly highest yield (557.10 q ha⁻¹) and it was found at par with treatment T₃ i.e. Drip fertigation at 125% RDF (554.88 q ha⁻¹), followed by treatments of drip fertigation at 100% RDF and drip fertigation at 75% RDF. Lowest yield (428.56 q ha⁻¹) was observed in treatment T₅ (Traditional fertilization at 100% RDF). Yield obtained was higher in case of drip fertigation because of more availability of nutrients throughout growth period of crop, whereas, in traditional fertilization treatment, yield may be low due to application of whole dose of fertilizer during vegetative growth which may affected the availability of nutrients at flowering and fruiting stage of crop. The results are in conformity with the findings of Ughade and Mahadkar (2015)^[19] and Xiukang *et al.* (2016)^[21]. Ughade and Mahadkar (2015)^[19] conducted an experiment and found that between different levels of fertigation the higher fertigation level recorded significantly higher yield of brinjal. Xiukang *et al.* (2016)^[21] evaluated that tomato yield was significantly influenced by fertilizer rate which is higher for higher fertigation rate.

Chemical properties of soil

Data regarding chemical properties of soil is presented in Table 2. pH and calcium carbonate content of soil were not significantly influenced by various levels and methods of fertilizer application. The electrical conductivity of soil as influenced by different treatments was statistically significant. The highest value of EC (0.38 dS m⁻¹) was observed in control treatment T₅ (Traditional fertilization at 100% RDF). The lowest EC (0.30 dS m⁻¹) was recorded in the treatment T₄ (Drip fertigation at 150% RDF) and it was found to be at par with treatment T₃ (Drip fertigation at 125% RDF). The significantly highest (0.64%) organic carbon was recorded in the treatment T₄ (Drip fertigation at 150% RDF) and it was

found to be at par with treatment T₃ (Drip fertigation at 125% RDF). The lowest (0.49%) organic carbon was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). Organic carbon content in surface soil was increased significantly due to application of fertilizers as the application of increasing fertilizer rate helped in increasing the biomass production. Increased root biomass added to the organic carbon content of soil. Similar results were also reported by Tank and Patel (2013)^[17] and Singh *et al.* (2018)^[14]. Tank and Patel (2013)^[17] revealed that organic carbon content in surface soil was increased significantly due to application of fertilizers as the application of fertilizer helped in increasing the biomass production. Organic carbon was higher with higher fertigation rates i.e. 0.60% at 60% RDF and 0.66% at 100% RDF in papaya. Singh *et al.* (2018)^[14] found that increasing fertilizer doses tend to increase the organic carbon to the extent of 0.61, 0.63 and 0.64% under F₁, F₂ and F₃, respectively in banana.

Soil fertility status

Major nutrients

Table 3 shows the data regarding soil fertility status at harvest. The significantly highest available N (266.56 kg ha⁻¹) in soil was recorded in the treatment T₄ (Drip fertigation at 150% RDF) and it was found to be at par with treatment T₃ (Drip fertigation at 125% RDF). The lowest available N (228.93 kg ha⁻¹) was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). Similar trend was observed in case of available potassium. Significantly highest available P (18.98 kg ha⁻¹) was recorded in the treatment T₄ (Drip fertigation at 150% RDF) and it was found to be at par with treatment T₃ (Drip fertigation at 125% RDF) and T₂ (Drip fertigation at 100% RDF). The lowest available P (14.57 kg ha⁻¹) was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). The split application of fertilizers through drip fertigation increased the availability of nitrogen, phosphorus and potassium in soil. The increased available N, P and K with higher level of fertilizer application might be due to direct contribution towards the available N, P and K pool in soil. Similar results were observed by Shedeed *et al.* (2009)^[13], Tank and Patel (2013)^[17] and Brewer *et al.* (2018)^[2]. Shedeed *et al.* (2009)^[13] conducted a field experiment and found that in drip fertigated tomato fertigation maintained higher concentration of NO₃⁻ - N, P and K in soil being higher with increasing rate of fertigation. Tank and Patel (2013)^[17] also revealed that the plots treated with higher level of fertilizers recorded higher available N in soil which was 252 kg ha⁻¹ at 60% RDF and 286 kg ha⁻¹ at 100% RDF in papaya. Brewer *et al.* (2018)^[2] found that soil NH₄⁺ and NO₃⁻ concentration increased with fertilizer N rate which is significantly greater with greater fertilizer N rate in drip irrigated tomato. Available sulphur was non significantly influenced by various levels and methods of fertilizer application.

Micronutrients

The data regarding micronutrients availability in soil at harvest of brinjal is presented in Table 4. The highest iron and zinc content in soil was observed in the treatment T₄ (Drip fertigation at 150% RDF) and it was found to be at par with treatment T₃ (Drip fertigation at 125% RDF). The lowest available iron and zinc was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). The significantly highest available copper was observed with the treatment T₄

(Drip fertigation at 150% RDF), while, the lowest available copper was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). The results are in conformity with the findings of Glonek and Komosa (2013) [6] and Elhindi *et al.* (2016) [5]. Glonek and Komosa (2013) [6] revealed that in highbush blueberry fertigation of nutrient solutions in relation to drip irrigation, resulted in the increasing contents of micronutrients in soil. The effect of fertigation and traditional application of fertilizer on available manganese was found to be non-significant.

Total nutrient uptake

The data presented in Table 5 revealed that the total uptake of nitrogen by brinjal plant at harvest was significantly influenced due to different fertigation levels and traditional method of fertilizer application. Significantly higher nitrogen uptake (130.68 kg ha⁻¹) was observed in treatment T₄ (Drip fertigation at 150% RDF) and it was found to be at par with treatment T₃ i.e. Drip fertigation at 125% RDF (120.68 kg ha⁻¹).

While the lowest nitrogen uptake (70.37 kg ha⁻¹) was recorded in the treatment T₅ (Traditional fertilization at 100% RDF). Similar trend was observed with total P and K uptake by brinjal. Increased nutrient uptake by plant was due to the higher availability of nutrient in the root zone. Similar findings were reported by Christou *et al.* (1999) [4], Mohammad *et al.* (2004) [9], Ugade *et al.* (2014) [18] and

Sollapur and Hiremath (2017) [15]. Ugade *et al.* (2014) [18] conducted a field experiment and found that the uptake of nitrogen was increased with increasing fertigation levels of N, P and K in brinjal. Sollapur and Hiremath (2017) [15] revealed that application of higher fertilizer levels increases nutrient uptake in hybrid brinjal.

Cost economics of the study

Cost economics of the study shows that the highest net monetary returns was obtained in treatment T₃ i.e. fertigation with 125% RDF (267653 Rs ha⁻¹) followed by treatment T₄ i.e. fertigation with 150% RDF (261580 Rs ha⁻¹). Highest B:C ratio was obtained in treatment T₃ i.e. fertigation with 125% RDF (3.22) followed by treatments T₂ i.e. fertigation with 100% RDF (3.09) as depicted in Table 6.

Table 1: Yield of brinjal as influenced by different levels and methods of fertilizer application

Treatments	Yield (q ha ⁻¹)
T ₁ (Drip fertigation at 75% RDF)	443.94
T ₂ (Drip fertigation at 100% RDF)	499.67
T ₃ (Drip fertigation at 125% RDF)	554.88
T ₄ (Drip fertigation at 150% RDF)	557.10
T ₅ (Traditional fertilization at 100% RDF)	428.56
SE (m) ±	17.78
CD at 5%	54.78
CV%	7.16

Table 2: Soil properties as influenced by different levels and methods of fertilizer application

Treatments	pH (1:2.5)	EC (dS m ⁻¹)	OC (%)	CaCO ₃ (%)
T ₁ (Drip fertigation at 75% RDF)	7.56	0.37	0.51	7.10
T ₂ (Drip fertigation at 100% RDF)	7.52	0.35	0.54	7.07
T ₃ (Drip fertigation at 125% RDF)	7.50	0.32	0.57	7.01
T ₄ (Drip fertigation at 150% RDF)	7.48	0.30	0.64	6.94
T ₅ (Traditional fertilization at 100% RDF)	7.57	0.38	0.49	7.19
SE (m) ±	0.02	0.01	0.03	0.06
CD at 5%	NS	0.04	0.09	NS
Initial status	7.61	0.39	0.48	7.22

Table 3: Available nutrient status in soil as influenced by different levels and methods of fertilizer application

Treatment	Available nutrients			
	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	S (mg kg ⁻¹)
T ₁ Drip fertigation at 75% RDF	232.06	15.46	324.80	7.32
T ₂ Drip fertigation at 100% RDF	235.20	16.30	333.20	8.01
T ₃ Drip fertigation at 125% RDF	254.01	18.06	355.60	8.58
T ₄ Drip fertigation at 150% RDF	266.56	18.98	369.60	8.80
T ₅ Traditional fertilization at 100% RDF	228.93	14.57	319.20	7.21
SE (m) ±	8.8	0.98	9.82	0.45
CD at 5%	27.1	3.03	30.26	NS
Initial status	225.79	14.21	312.48	7.15

Table 4: Available micronutrients in soil as influenced by different levels and methods of fertilizer application

Treatment	Available micronutrients (mg kg ⁻¹)			
	Fe	Mn	Cu	Zn
T ₁ Drip fertigation at 75% RDF	5.38	11.20	3.36	0.59
T ₂ Drip fertigation at 100% RDF	5.45	11.25	3.56	0.62
T ₃ Drip fertigation at 125% RDF	6.06	11.32	3.64	0.65
T ₄ Drip fertigation at 150% RDF	6.43	11.42	3.98	0.68
T ₅ Traditional fertilization at 100% RDF	5.33	11.09	3.23	0.57
SE (m) ±	0.186	3.56	0.106	0.019
CD at 5%	0.572	NS	0.326	0.059
Initial status	5.24	11.03	3.16	0.55

Table 5: Total nutrient uptake by brinjal as influenced by different levels and methods of fertilizer application

Treatment	Nutrient Uptake (Kg ha ⁻¹)			
	N Uptake	P Uptake	K Uptake	
T ₁	Drip fertigation at 75% RDF	78.16	20.17	85.32
T ₂	Drip fertigation at 100% RDF	93.83	26.91	105.93
T ₃	Drip fertigation at 125% RDF	120.68	36.72	134.53
T ₄	Drip fertigation at 150% RDF	130.68	40.86	144.38
T ₅	Traditional fertilization at 100% RDF	70.37	17.58	73.72
	SE (m) ±	5.86	1.49	4.99
	CD at 5%	18.06	4.59	15.38
	CV%	11.87	10.47	9.18

Table 6: Cost economics of the study

Treatment	Yield of brinjal (q ha ⁻¹)	Gross return (Rs ha ⁻¹)	Total cost (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	B:C ratio
T ₁ (Drip fertigation at 75% RDF)	443.94	310758	105502	205256	2.95
T ₂ (Drip fertigation at 100% RDF)	499.67	349771	113131	236640	3.09
T ₃ (Drip fertigation at 125% RDF)	554.88	388414	120761	267653	3.22
T ₄ (Drip fertigation at 150% RDF)	557.10	389971	128391	261580	3.04
T ₅ (Traditional fertilization at 100% RDF)	428.56	299991	98733	201258	3.04

Conclusion

The initial soil analysis indicated that soil was low in available nitrogen and medium in available phosphorus so increased level of drip fertigation give quick response. Higher yield of brinjal with improvement in nutrient uptake and chemical properties of soil was obtained in treatment T₄ (drip fertigation at 150% RDF) and was found at par with T₃ (drip fertigation at 125% RDF). Also B:C (Benefit: Cost) ratio was higher in treatment T₃ (drip fertigation at 125% RDF). On the basis of benefit cost ratio and net monetary returns, it is economically viable for the farmers to adopt drip fertigation at 125% RDF Hence, drip fertigation at 125% RDF (T₃) along with silver polyethylene mulch was found superior to obtain higher yield of brinjal and highest benefit cost ratio.

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