Research Article

Nitrogen, Phosphorus and Potassium Dynamics in Soil under Drip and Micro Sprinkler Fertigation and Its Effects on Turmeric Yield

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Abstract

A field experiment was conducted to study the nutrient dynamics under drip and micro sprinkler fertigation system in soil and its effects on turmeric yield during July-February of 2015-16 in Tamil Nadu Agricultural University. The treatments comprises of two micro irrigation systems (drip and micro sprinkler) with three irrigation levels *viz.*, 80, 100 and 120% of evaporation from a Class A Pan evaporimeter and two levels of fertigation with water soluble fertilizers (WSF) (urea, MAP and MOP) *viz.*, 75 and 100% RDF. Surface irrigation (5 cm depth) + soil application of fertilizers at 100% RDF was the control. The result indicated that the maximum amount of available nitrogen, phosphorus and potassium were found in fertigation with 100% RDF under both drip and micro sprinkler compared to 75% RDF and higher turmeric yield was also noticed under drip irrigation at 120% PE + fertigation with 100% RDF which is statistically on par with micro sprinkler irrigation at 120% PE + fertigation with 100% RDF. Micro sprinkler system is 25% cheaper than the drip irrigation system. This shows that, irrigation at 120% PE + fertigation with 100% RDF through micro sprinkler in turmeric is profitable.

Keywords: Nutrient, dynamics, evaporation, turmeric, yield

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Introduction

Turmeric is a nutrient loving plant and removes large amount of nutrients from soil, so sufficient quantities of nutrients have to be applied in order to meet its nutritional requirements and to obtain higher yields [1]. Micro irrigation system is a very efficient method of supplying water to plant [2]. Fertigation through micro irrigation facilitates precise application of fertilizers, as it delivers nutrients to the roots where it can be effectively utilized and results in greater uptake and nutrient use efficiency [3]. Plant nutrient availability in the soil is very important factor for obtaining higher yield. Therefore the mobility of the nutrients had been assessed from the soil sample taken at various distance from emitter both horizontal and vertical directions in drip and micro sprinkler fertigation system.

Materials and Methods

Field investigation was carried out to study the nutrient dynamics under drip and micro sprinkler fertigation system in soil and its effects on turmeric yield at Tamil Nadu Agricultural University. The experiment was conducted during July-February of 2015-16. The experiment was laid out in randomized block design with three replications. The treatments were T_1-Drip Irrigation (DI) at 120% PE + fertigation with WSF at 100% RDF, T_2-DI at 120% PE + fertigation with WSF at 75% RDF,T_3-DI at 100% PE + fertigation with WSF at 100% RDF, T_4-DI at 100% PE+ fertigation with WSF at 75% RDF, T_5-DI at 80% PE+ fertigation with WSF at 100% RDF, T_6- DI at 80% PE + fertigation with WSF at 75% RDF and T_7-Micro Sprinkler Irrigation (MSI) at 120% PE + fertigation with WSF at 100% RDF, T_8-MSI at 120% PE + fertigation with WSF at 75% RDF, T_9-MSI at 100% PE + fertigation with WSF at 100% RDF, T_{10}-MSI at 100% PE + fertigation with WSF at 75% RDF, T_{11}- MSI at 80% PE + fertigation with WSF at 100% RDF, T_{12}-MSI at 80% PE + fertigation with WSF at 75% RDF, T_{13}- Surface irrigation (5 cm depth) + soil application of fertilizers at 100% RDF. The recommended dose of fertilizer (RDF) is 150:60:108 kg N: P_2O_5: K_2O ha^{-1}. The turmeric variety BSR-2 was used for field experiment. Soil samples were taken at 3 points from emitters horizontally (0, 60 and 120 cm) as well as 4 points vertically (each at 15 and 30 cm) below the surface for obtaining the nutrient dynamics. Nutrient dynamics in soil profile is presented by contour maps using SURFER software.

Results and Discussions

Nitrogen dynamics under drip and micro sprinkler fertigation

The distribution of available nitrogen throughout the profile varied both horizontally and vertically from the emitting point. The available nitrogen was distributed throughout the soil profile and the higher available nitrogen (271 kg ha^{-1}) was found to be in 15-30 cm depth at the emitter point under drip fertigation at 100% RDF (**Table 1** and **Figure 1**).

Table 1 Nutrient dynamics (available NPK kg ha^{-1}) under drip fertigation

Soil depth (cm)	Nitrogen at 100% RDF					Nitrogen at 75% RDF				
	60 cm	30 cm	Emitter	30 cm	60 cm	60 cm	30 cm	Emitter	30 cm	60 cm
0-15	249	257	268	255	248	240	247	258	245	236
15-30	247	253	271	251	244	237	243	260	241	234
	Phosphorus at 100% RDF					**Phosphorus at 75% RDF**				
0-15	32.3	34.1	36.5	34.3	32.5	22.2	25.7	26.1	23.9	22.4
15-30	31.1	31.9	34.8	32.1	31.4	20.9	21.6	25.2	21.8	21.1
	Potassium at 100% RDF					**Potassium at 75% RDF**				
0-15	597	629	649	621	593	586	619	638	611	581
15-30	568	610	635	610	571	559	598	627	599	561

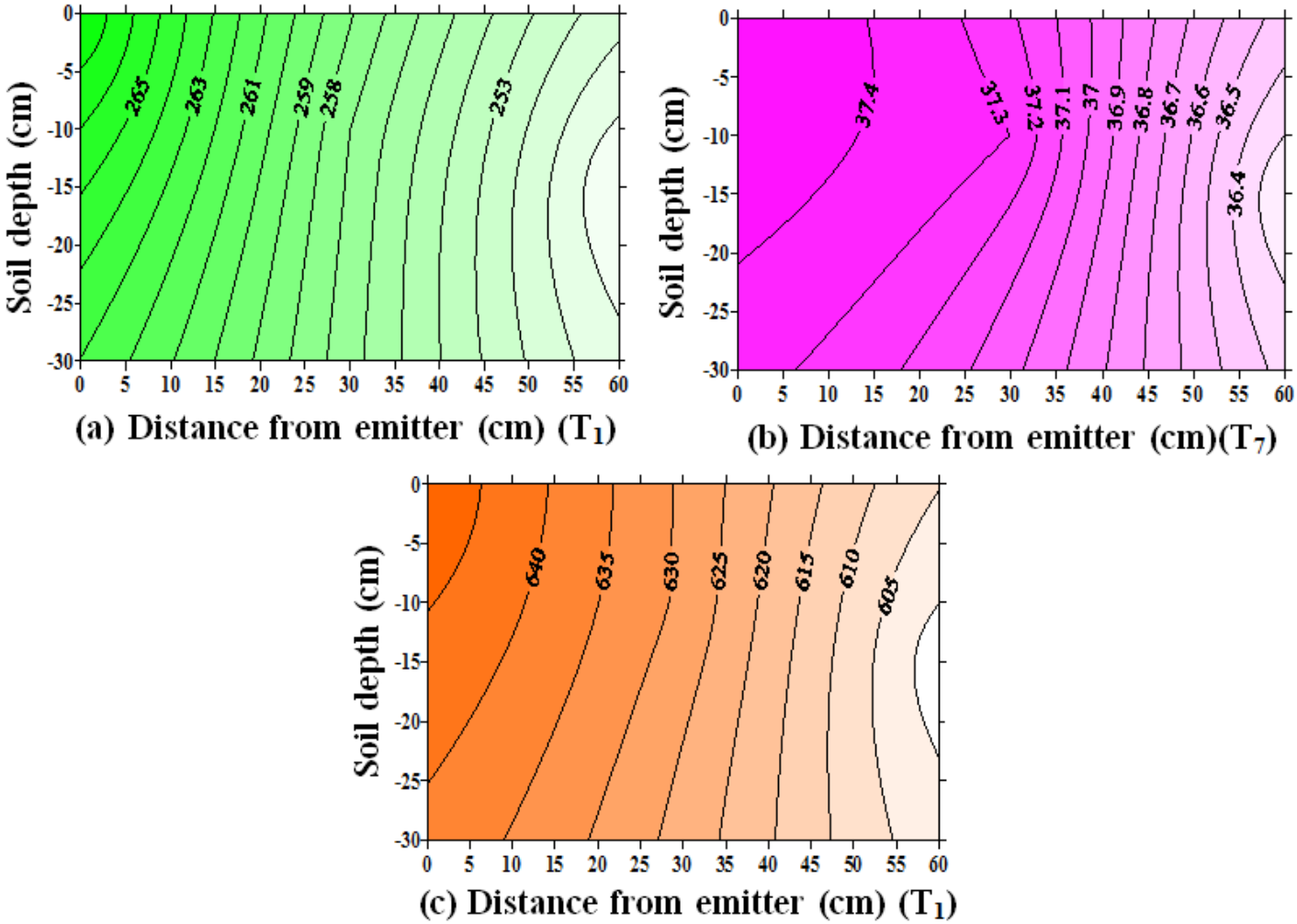

Figure 1 Available nitrogen (a), phosphorus (b) and potassium(c) dynamics in soil

The nitrogen concentration in upper soil (0-15 cm) was lower than 15-30 cm soil layer. In micro sprinkler fertigation maximum amount of available nitrogen was found to be in 0-15 cm depth at 100% RDF (**Table 2**). The nitrogen concentration in upper soil (0-15 cm) was higher than 15-30 cm soil layer. The nitrogen mobility in the soil was due to the concentration gradient created on account of mass flow which has rendered nutrients to move from

higher concentration to lower one. It could be that inferred there was a direct association between nitrogen availability and presence of soil moisture *in situ* [4]. The nitrate ion being mobile has a tendency to move away from the emitter to the periphery of the waterfront [5]. In general, comparatively available nitrogen was more in WSF than conventional fertilizer in the present study. The dismissal performance of WSF was attributed to the higher solubility of nutrients compared to conventional fertilizer [6].

Table 2 Nutrient dynamics (available NPK kg ha^{-1}) under micro sprinkler fertigation

Soil	Nitrogen at 100% RDF					Nitrogen at 75% RDF				
depth (cm)	60 cm	30 cm	Emitter	30 cm	60 cm	60 cm	30 cm	Emitter	30 cm	60 cm
0-15	258	262	263	260	260	258	256	252	252	258
15-30	243	251	253	247	244	232	230	231	231	243
	Phosphorus at 100% RDF					**Phosphorus at 75% RDF**				
0-15	36.2	37.3	37.5	37.1	37.5	27.1	27.5	27.8	27.9	27.1
15-30	30.8	31.4	30.8	30.4	30.2	22.1	22.2	23.2	22.1	21.1
	Potassium at 100% RDF					**Potassium at 75% RDF**				
0-15	637	639	642	636	632	631	635	636	636	634
15-30	621	626	629	628	621	600	604	608	606	606

Phosphorus dynamics under drip and micro sprinkler fertigation

The maximum available phosphorus in soil was confined to 0-15 cm of soil layer in both drip and microsprinkler fertigation treatments. Higher phosphorous availability was recorded under fertigation at 100% RDF with WSF with micro sprinkler fertigation (T_7) (37.5 kg ha^{-1}) in 0-15 cm soil depth at all the horizontal distance. Continuous phosphorus applications in drip irrigation systems will further increase phosphorus availability compared with other application methods [7].Phosphorus availability was more at near to the emitter in both 100 and 75% RDF. But the available phosphorous decreased with increase in distance and soil depth under drip fertigation. It is because phosphorus is less mobile in the soil and tends to accumulate near the point of application *i.e.*, under the dripper, with little being leached downward or moved laterally [8].

Potassium dynamics under drip and micro sprinkler fertigation

Potassium availability was higher in the top layers in both drip and micro sprinkler fertigation. Potassium availability was more under drip fertigation with 100% RDF (T_1) (649 kg ha^{-1}) at 0-15 cm depth of soil layer in the emitter point. Drip fertigation of 100% RDF with WSF recorded higher values of soil available nutrients than 75% RDF [9]. Potassium availability was decreased with increasing depth from the emitter at all the distances this might be due to majority of applied potassium was held in the surface soil and the downward movement was slow. Slow downward movement of applied potassium may be partially attributed to net upward flux of soil water in the soil profile as a result of high evapotranspiration [10].

Yield

Higher turmeric yield was noticed under DI at 120% PE + fertigation with WSF at 100% RDF (28.56 t/ha) which is comparable with MSI at 120% PE + fertigation with WSF at 100% RDF (28.14 t/ha). The lower yield was noticed under surface irrigation (5 cm depth) + soil application of fertilizers at 100% RDF (20.87 t/ha). This might be due to the maximum available nutrient present in drip and micro sprinkler fertigation with 100% RDF compared to surface irrigation. The applied nutrients at any stage of the crop should properly reflect in terms of available nutrient in the soil, so that crop could absorb these nutrients without hindrance (**Figure 2**).

The uptake of nitrogen, phosphorus and potassium was significantly increased with higher rate of application. Higher uptake of nutrients was attributed to better availability of nutrients which was reflected in better growth and rhizome yield [11]. Response of turmeric to increased levels of fertilizers has been significant [12]. Unlike surface irrigation and conventional fertilizer application, fertigation results in uniform distribution of nutrient solution in the root zone, thereby increasing the fertilizer use efficiency, since the uptake of nutrients by the plant roots depends on their availability in the root system [13]. It also enhanced the overall root activity, improved the mobility of nutritive elements their uptake and increased the yield of turmeric.

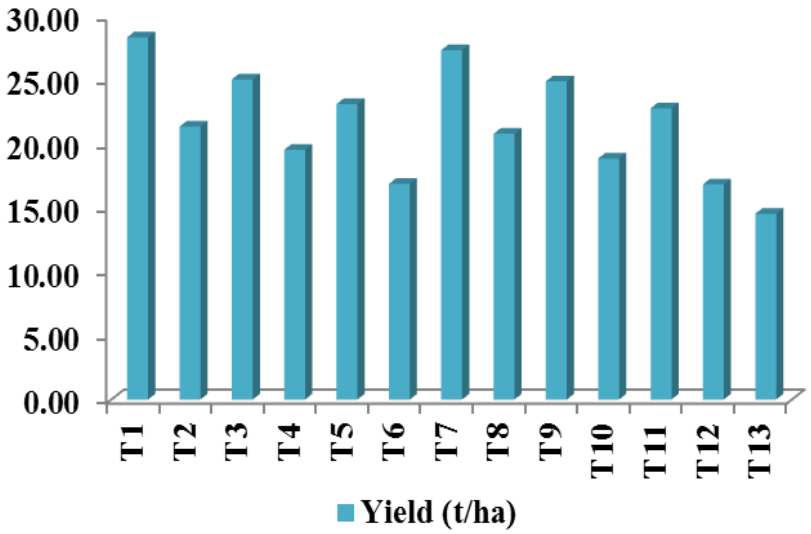

Figure 2 Effect of drip and micro sprinkler fertigation on turmeric yield

Conclusion

Maximum amount of available nitrogen, phosphorus and potassium were found in fertigation with 100% RDF under both drip and micro sprinkler compared to 75% RDF. Due to this higher yield was noticed under drip irrigation at 120% PE + fertigation with 100% RDF which is on par with micro sprinkler irrigation at 120% PE + fertigation with 100% RDF. Considering the low cost of micro sprinkler system, irrigation at 120% PE and fertigation with 100% RDF could be recommended as an alternative option to realize a equivalent yield in turmeric.

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