

## Horizontal and Vertical Distribution of Nutrients and Yield of Groundnut as Influenced by Micro Sprinkler Fertigation

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**Abstract** Micro sprinkler fertigation provides an efficient method of fertilizer delivery and minimizes the adverse environmental impact on crop production. The availability of nutrients at the root zone of the crops at regular intervals influences the uptake and yield of the crop. A field experiment was conducted to study the influence of micro sprinkler fertigation of N, P and K fertilizers (normal fertilizers and water soluble fertilizers) on yield and soil nutrient dynamics of groundnut (*Arachis hypogaea* L.) during *kharif*, 2014. The experiment was laid out with nine treatments which were replicated thrice in a randomized block design. The study revealed that mobility of nutrients was well pronounced under micro sprinkler fertigation system. In all the micro sprinkler fertigation treatments, the concentrations of nitrogen, phosphorus and potassium decreased horizontally from the base of micro sprinkler till the periphery of wetting zone. The available soil nitrogen found higher in subsoil (20 cm soil depth) as compared to surface soil (10 cm soil depth). The similar trend was noticed

in soil potassium dynamics. With respect to phosphorus, the soil P content was higher in the surface soil (10 cm soil depth) than in the subsoil (20 cm soil depth). Significantly higher yield was noticed in micro sprinkler fertigation of WSF at 100% RDF over all other treatments but it was found to be on par with micro sprinkler fertigation of WSF at 75% RDF.

**Keywords** Horizontal and Vertical distribution of nutrients, Micro sprinkler fertigation, Groundnut.

### Introduction

Groundnut is the major oil seed crop of India and the world. It is a matter of concern that in recent year's groundnut yields even in most of the potential areas of India are declining mainly due to poor availability of water and improper usage of chemical fertilizers. Fluctuating economy, declining resource base and inconsistent productivity alarms the efficient use of water and nutrients. At the other end, the fertilizers being used in India are in the form of granules, prills and amorphous form which are applied by various methods such as band application, broadcasting and drilling. Fertilizers are likely to be lost by higher rains, flood irrigation. Hence, in the present context adoption of micro irrigation systems viz. micro sprinkler irrigation in groundnut is the utmost need of the hour. Micro-sprinkler irrigation system operates under low pressure, typically 20 to 35 psi, with wetting patterns of 10 to 30 feet. It can also be used to apply the fertil-

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**Table 1.** Horizontal and vertical distribution of nitrogen ( $\text{kg ha}^{-1}$ ) as influenced by micro sprinkler fertigation. RDF-Recommended dose of fertilizers, WSF-Water soluble fertilizers, NF-Normal fertilizers, MS-Micro sprinkler. Treatments  $T_1$ ,  $T_2$  and  $T_9$  were not considered for the study.

Treatments	Horizontal distance from the base of MS					
	At 1 meter			At 2 meter		
	Vertical depth		Mean	Vertical depth		Mean
10 cm	20 cm	10 cm		20 cm		
$T_3$ : Micro sprinkler fertigation of NF at 100% RDF	280.1	294.5	287.3	270.3	279.9	275.1
$T_4$ : Micro sprinkler fertigation of NF at 75% RDF	273.4	285.0	279.2	263.1	272.1	267.6
$T_5$ : Micro sprinkler fertigation of NF at 50% RDF	265.2	276.2	270.7	256	263.4	259.7
$T_6$ : Micro sprinkler fertigation of WSF at 100% RDF	265.8	278.4	272.1	255.8	263.8	259.8
$T_7$ : Micro sprinkler fertigation of WSF at 75% RDF	258.0	270.0	264.0	248.9	256.7	252.8
$T_8$ : Micro sprinkler fertigation of WSF at 50% RDF	250.8	262.2	256.5	242.6	249.6	246.1
Mean	265.5	277.7	271.6	256.1	264.3	260.2

izers along with water in small rain like droplets over the crops in a circular manner [1]. But, the distribution efficiency of micro sprinkler irrigation is less, therefore, the moisture and fertilizer distribution in the soil is not uniform throughout the wetting area. Hence, the present investigation was carried out to know the influence of micro sprinkler fertigation on yield, horizontal and vertical distribution of nutrients i.e. soil nutrient dynamics of major nutrients N, P and K in groundnut.

### Materials and Methods

The experiment was laid out in randomized block design in red sandy loam soil with nine treatments which were replicated thrice. The crop was grown and well maintained by following all agronomic practices as per the package of practices given by UAS, Bengaluru. Micro sprinkler irrigation system consisted of pump (7.5 HP), filter units, sub main, laterals and micro sprinklers (metallic rod along with head). In each plot one micro sprinkler was installed except for the plot with surface irrigation as the treatment. The discharge capacity of the each micro sprinkler was 110 lph with wetting area of 3m radius. In micro sprinkler fertigation methods, according to the treatments, the required quantities of fertilizers (NF or WSF) were given in 4 equal splits at 20 days interval starting from 14 days after sowing to 74 days after sowing.

The treatment details were as follows:  $T_1$ : Surface irrigation with soil application of 100% RDF (NF),  $T_2$ : Micro sprinkler irrigation with soil application of 100% RDF (NF),  $T_3$ : Micro sprinkler fertigation of NF at 100% RDF,  $T_4$ : Micro sprinkler fertigation of NF at 75% RDF,  $T_5$ : Micro sprinkler fertigation of NF at 50% RDF,  $T_6$ : Micro sprinkler fertigation of WSF at 100% RDF,  $T_7$ : Micro sprinkler fertigation of WSF at 75% RDF,  $T_8$ : Micro sprinkler fertigation of WSF at 50% RDF,  $T_9$ : Absolute control. The treatments  $T_1$ ,  $T_2$  and  $T_9$  were not considered for the soil nutrient dynamics study. For the present study, the soil samples were collected from 10 cm and 20 cm vertical soil depth at one meter and two meter horizontal distance from the base of micro sprinkler.

### Results and Discussion

Soil nitrogen content found to be decreasing as the horizontal distance from the base of micro sprinkler increased. In general, at one meter horizontal distance from the base of micro sprinkler recorded higher nitrogen content ( $271.6 \text{ kg ha}^{-1}$ ) as compared to two meter horizontal distance from the base of micro sprinkler ( $260.2 \text{ kg ha}^{-1}$ ). Between two soil depths, i.e. at 10 cm and 20 cm, the higher nitrogen content was observed in 20 cm soil depth as compared to 10 cm soil depth. Further, between normal and water soluble fertilizers, fertigation with normal fertilizers recorded

**Table 2.** Horizontal and vertical distribution of phosphorus ( $\text{kg ha}^{-1}$ ) as influenced by micro sprinkler fertigation. RDF-Recommended dose of fertilizers, WSF-Water soluble fertilizers, NF-Normal fertilizers, MS-Micro sprinkler, Treatments  $T_1$ ,  $T_2$  and  $T_9$  were not considered for the study.

Treatments	Horizontal distance from the base of MS					
	At 1 meter			At 2 meter		
	Vertical depth		Mean	Vertical depth		Mean
10 cm	20 cm	10 cm		20 cm		
$T_3$ : Micro sprinkler fertigation of NF at 100% RDF	64.7	57.7	61.2	58.2	48.6	53.4
$T_4$ : Micro sprinkler fertigation of NF at 75% RDF	55.4	49.0	52.2	51.1	40.8	45.9
$T_5$ : Micro sprinkler fertigation of NF at 50% RDF	45.9	40.1	43.0	40.3	32.5	36.4
$T_6$ : Micro sprinkler fertigation of WSF at 100% RDF	57.2	49.6	53.4	49.8	41.0	45.4
$T_7$ : Micro sprinkler fertigation of WSF at 75% RDF	47.2	41.0	44.1	40.8	33.0	36.9
$T_8$ : Micro sprinkler fertigation of WSF at 50% RDF	41.1	35.5	38.3	35.6	28.6	32.1
Mean	51.92	45.48	48.7	45.97	37.42	41.69

higher available nitrogen in soil. At one meter horizontal distance from the base of micro sprinkler, at 10 cm vertical soil depth, the higher soil available nitrogen was noticed in micro sprinkler fertigation of NF at 100% RDF ( $280.1 \text{ kg ha}^{-1}$ ) followed by micro sprinkler fertigation of NF at 75% RDF ( $273.4 \text{ kg ha}^{-1}$ ). Lower values were observed in micro sprinkler fertigation of WSF at 50% RDF ( $250.8 \text{ kg ha}^{-1}$ ). At 20 cm soil depth, the higher soil available nitrogen was noticed in micro sprinkler fertigation of NF at 100% RDF ( $294.5 \text{ kg ha}^{-1}$ ) and lower nitrogen value was observed in micro sprinkler fertigation of WSF at 50% RDF ( $262.2 \text{ kg ha}^{-1}$ ). The similar trend was observed in different soil depths at two meter horizontal distance from the base of micro sprinkler (Table 1).

Soil phosphorus dynamics varied significantly due to micro sprinkler fertigation. The higher available soil phosphorus was recorded at one meter horizontal distance from the base of micro sprinkler as compared to two meter horizontal distance from the base of micro sprinkler (Table 2). Between two soil depths i.e. at 10 cm and 20 cm, the higher available soil phosphorus content was recorded in 10 cm depth as compared to 20 cm soil depth. At one meter horizontal distance from the base of micro sprinkler at 10 cm vertical depth, the higher soil available P was recorded in micro sprinkler fertigation of NF at 100% RDF ( $64.7 \text{ kg ha}^{-1}$ ) followed by micro sprinkler

fertigation of WSF at 100% RDF ( $57.2 \text{ kg ha}^{-1}$ ). Similar trend was noticed in 20 cm soil depth. At two meter horizontal distance from the base of micro sprinkler, at 10 cm vertical depth, micro sprinkler fertigation of NF at 100% RDF recorded higher nutrient content ( $58.2 \text{ kg ha}^{-1}$ ) followed by micro sprinkler fertigation of NF at 75% RDF ( $51.1 \text{ kg ha}^{-1}$ ). Lower soil available P was recorded in micro sprinkler fertigation of WSF at 50% RDF ( $35.6 \text{ kg ha}^{-1}$ ) at two meter horizontal distance from the base of micro sprinkler at 10 cm soil depth. Similar results were obtained in 20 cm soil depth.

The available soil potassium content showed the varying nutrient dynamics under micro sprinkler fertigation. Between two soil depths i.e. at 10 cm and 20 cm, higher potassium content was observed in 20 cm depth as compared to 10 cm soil depth. Further, between normal and water soluble fertilizers, fertigation with normal fertilizers recorded higher available potassium in soil. Numerically higher soil available potassium was recorded in micro sprinkler fertigation of NF at 100% RDF ( $252.9 \text{ kg ha}^{-1}$ ), followed by micro sprinkler fertigation of NF at 75% RDF ( $244.9 \text{ kg ha}^{-1}$ ) at 10 cm soil depth at one meter horizontal distance from the base of micro sprinkler. At 20 cm soil depth, higher soil available potassium was noticed in micro sprinkler fertigation of NF at 100% RDF ( $267.5 \text{ kg ha}^{-1}$ ) and lower potassium val-

**Table 3.** Horizontal and vertical distribution of potassium ( $\text{kg ha}^{-1}$ ) as influenced by micro sprinkler fertigation. RDF-Recommended dose of fertilizers, WSF-Water soluble fertilizers, NF-Normal fertilizers, MS-Micro sprinkler, Treatments  $T_1$ ,  $T_2$  and  $T_9$  were not considered for the study.

Potassium dynamics	Horizontal distance from the base of MS					
	At 1 meter			At 2 meter		
	Vertical depth		Mean	Vertical depth		Mean
10 cm	20 cm	10 cm		20 cm		
$T_3$ : Micro sprinkler fertigation of NF at 100% RDF	252.9	267.5	260.2	261.3	245.3	253.3
$T_4$ : Micro sprinkler fertigation of NF at 75% RDF	244.9	257.7	251.3	252.4	238.3	245.3
$T_5$ : Micro sprinkler fertigation of NF at 50% RDF	239.4	251.2	245.3	244.9	232.9	238.9
$T_6$ : Micro sprinkler fertigation of WSF at 100% RDF	240.4	257.0	248.7	251.7	235.7	243.7
$T_7$ : Micro sprinkler fertigation of WSF at 75% RDF	233.8	248.2	241.0	243.8	229.2	236.6
$T_8$ : Micro sprinkler fertigation of WSF at 50% RDF	228.9	241.9	235.4	237.4	225.4	231.4
Mean	240.5	253.9	247.0	246.2	235.9	241.6

ues were recorded in micro sprinkler fertigation of WSF at 50% RDF ( $241.9 \text{ kg ha}^{-1}$ ). The similar trend was observed in different soil depths at two meter horizontal distance from the base of micro sprinkler (Table 3).

In all the micro sprinkler fertigation treatments, the nutrient concentrations (N, P and K) decreased horizontally from the base of micro sprinkler till the periphery of wetting zone. This may be attributed to lesser distribution efficiency of water through micro sprinkler, wherein more water has been applied at one meter horizontal distance from the base of micro sprinkler than at the periphery i.e. at two meter horizontal distance from the base of micro sprinkler. The results are in line with the findings of Anitha and Muthukrishnan [2].

At two different soil depths, the higher soil nitrogen and potassium were recorded in 20 cm soil depth at both the horizontal distances but the reverse was noticed in case of phosphorus. The higher phosphorus content was observed in upper soil layer i.e. at 10 cm soil depth at both horizontal distances. The higher soil nitrogen status in the sub soil (20 cm) may be attributed to higher mobility of nitrogen in the soil and it is not strongly adsorbed by soil colloids which tends to be more evenly distributed in soil profile. The results are in line with the findings of Anitha and

Muthukrishnan [2] and Krishnamurthi and Rajmani [3]. Accumulation of the higher amount of P in the upper soil layer (10 cm depth) may be attributed to the restricted mobility of phosphorus which might be due to the strong retention of soil P by the soil colloids and clay minerals. The results are in conformity with the findings of Zang et al. [4]. Accumulation of higher potassium in the deeper layer may be attributed to higher mobility of K in the soil. These results are in conformity with the findings of Zang et al. [4] ; Krishnamurthi and Rajmani [3] and Sivasakti et al. [5].

Significant differences were noticed in pod yield, haulm yield and kernel yield of groundnut due to micro sprinkler fertigation treatments (Table 4). Among different treatments, micro sprinkler fertigation of WSF at 100% RDF recorded significantly higher pod yield, haulm yield and kernel yield ( $2,882 \text{ kg ha}^{-1}$ ,  $3,443 \text{ kg ha}^{-1}$  and  $2,263 \text{ kg ha}^{-1}$ , respectively) over all other treatments, but it was on par with micro sprinkler fertigation of WSF 75% RDF ( $2,632 \text{ kg ha}^{-1}$ ,  $3,237 \text{ kg ha}^{-1}$  and  $2,013 \text{ kg ha}^{-1}$ , respectively). With respect to pod yield, micro sprinkler fertigation of NF at 100% RDF ( $2,517 \text{ kg ha}^{-1}$ ) and micro sprinkler fertigation of NF at 75% RDF ( $2,277 \text{ kg ha}^{-1}$ ) were on par with each other, but were significantly superior over micro sprinkler fertigation of NF at 50% RDF ( $1,933 \text{ kg ha}^{-1}$ ). Significantly lower pod yield was noticed in absolute

**Table 4.** Pod yield, haulm yield and kernel yield as influenced by micro sprinkler fertigation in groundnut. RDF- Recommended dose of fertilizers, WSF-Water soluble fertilizers, NF-Normal fertilizers.

Treatments	Pod yield (kg ha <sup>-1</sup> )	Haulm yield (kg ha <sup>-1</sup> )	Kernel yield (kg ha <sup>-1</sup> )
T <sub>1</sub> : Surface irrigation with soil application of 100% RDF (NF)	1779	2409	1275
T <sub>2</sub> : Micro sprinkler irrigation with soil application of 100% RDF (NF)	2151	2806	1563
T <sub>3</sub> : Micro sprinkler fertigation of NF at 100% RDF	2517	3137	1910
T <sub>4</sub> : Micro sprinkler fertigation of NF at 75% RDF	2277	2887	1702
T <sub>5</sub> : Micro sprinkler fertigation of NF at 50% RDF	1933	2562	1408
T <sub>6</sub> : Micro sprinkler fertigation of WSF at 100% RDF	2882	3443	2263
T <sub>7</sub> : Micro sprinkler fertigation of WSF at 75% RDF	2632	3237	2013
T <sub>8</sub> : Micro sprinkler fertigation of WSF at 50 % RDF	2159	2837	1605
T <sub>9</sub> : Absolute control	1377	2077	956
SEm ±	118.08	105.17	87.64
CD at 5%	354.01	315.31	262.75

control (1,377 kg ha<sup>-1</sup>) followed by surface irrigation with soil application of 100% RDF through normal fertilizers (1,779 kg ha<sup>-1</sup>). The increased yield in micro sprinkler fertigation of WSF at 100% RDF is mainly attributed to enhanced availability of nutrients through micro sprinkler fertigation at regular intervals and higher solubility percentage of water soluble fertilizers has led to increased nutrient uptake which ultimately reflected in the yield. These results are in conformity with the findings of Vijayalakshmi [6], Sanju [7] and Sukeshni Wane et al. [8] in groundnut and Rathore et al. [9] in mustard.

Proportionately higher pod yield was recorded with the use of water soluble fertilizers as compared to normal fertilizers this is mainly attributed to the higher solubility percentage and mobility of nutrients resulted in the higher nutrient uptake. Under normal fertilizer application, non-uniformity of nutrients coupled with improper solubility resulted in various losses which in turn reflected in significantly lower pod yield of groundnut. These results are in concordance with the findings of Sanju [7], Mathukia et al. [10] and Jain et al. [11].

The present investigation revealed that mobility of nutrients was well pronounced under micro sprinkler fertigation system. In all the micro sprinkler fertigation treatments, the concentrations of nitrogen, phosphorus and potassium decreased horizontally

from the base of micro sprinkler till the periphery of wetting zone. The available soil nitrogen and potassium found higher in subsoil (20 cm soil depth) than in the surface soil (10 cm soil depth). The reverse results were noticed in phosphorus. The yields of Micro sprinkler fertigation of WSF at 100% RDF and Micro sprinkler fertigation of WSF at 75% RDF were on par with each other. Therefore, Micro sprinkler fertigation of WSF at 75% RDF can be recommended which saves 25% of fertilizers without much reduction in the yield.

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