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Influence of micro sprinkler fertigation on nutrient balance and yield of groundnut in Alfisols of eastern dry zone of Karnataka

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Abstract
A field experiment was conducted at Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bengaluru to study the influence of micro sprinkler fertigation on Groundnut yield and nutrient balance in Alfisols of Eastern Dry Zone of Karnataka. The study revealed that Micro sprinkler fertigation of WSF at 100 % RDF recorded significantly higher pod yield (2882 kg ha^{-1}) and haulm yield (3443 kg ha^{-1}) over all other treatments except Micro sprinkler fertigation of WSF at 75 % RDF (2632 kg ha^{-1} and 3237 kg ha^{-1} of pod yield and haulm yield, respectively). In all the micro sprinkler fertigation treatments, the net gain of fertilizers (N, P and K) was noticed. Higher net gain of soil N was recorded in micro sprinkler fertigation of WSF at 100 % RDF (39.3 kg ha^{-1}). Higher net gain of phosphorus was observed with micro sprinkler fertigation of WSF at 75 % RDF (17.2 kg ha^{-1}) and higher gain of potassium was noticed in micro sprinkler fertigation of 100 % RDF through NF (45.0 kg ha^{-1}). Micro sprinkler fertigation of WSF at 75 % RDF recorded significantly higher yields of groundnut along with 25 % saving in fertilizers there by causing less hazard to the environment.

Keywords: nutrient balance, micro sprinkler fertigation and alfisols

Introduction
Groundnut (*Arachis hypogaea* L.), king of oilseeds belongs to the family Leguminoceae and is commonly called as poor man’s almond. It is the world's fourth most important source of edible oil and third most important source of vegetable protein. Seed is valued both for its oil and protein content as it contains about 40-45 per cent oil, 25 per cent protein and 18 per cent carbohydrates in addition to minerals and vitamins (Desai *et al.*, 1999) [4].
Water and fertilizer are the two basic inputs in irrigated agriculture. In the recent year’s, the indiscriminate use of irrigation water and fertilizers have reduced the fertility of the soil to a considerable level, resulting in the poor yields of the crop. Thus, the judicious use of water and fertilizers is the present need of the hour. In this regard, the use of micro irrigation and fertigation techniques are only way to manage these resources efficiently.
Fertigation is the judicious application of fertilizers through irrigation water, to increase efficient use of water and fertilizers, to increase the yield, to protect environment and sustain irrigated agriculture (Singh *et al.*, 2005) [17]. Micro sprinkler and other micro-irrigation systems, which are highly efficient for water application, are ideally-suited for fertigation (Anon., 2006) [1]. Micro sprinkler irrigation is best suited for groundnut (Krishnamurthi *et. al.*, 2003) [8]. Reports of Vijayalaksmi *et al.*, 2011 [20] revealed that Micro sprinkler fertigation has increased yield attributes besides reducing the irrigation water requirement of groundnut. Keeping these points in view, the study was conducted to know the influence of Micro sprinkler fertigation on groundnut yield and nutrient balance in Alfisols of Eastern Dry Zone of Karnataka.

Materials and Methods
A field experiment was conducted during *kharif* 2014 at Zonal Agricultural Research Station, UAS, GKVK, Bengaluru, Karnataka to study the influence of Micro sprinkler fertigation on crop yield, soil properties and nutrient balance by Groundnut (*Arachis hypogaea* L.). The pH of soil was slightly acidic (6.10), medium EC (0.43 ds m^{-1}), medium nitrogen, phosphorous and potassium content (315.3, 32.3 and 219.0 kg ha^{-1}, respectively). ICGV-91114 variety was used along with spacing of 30 cm X 15 cm at recommended seed rate.

The experiment was laid out in a randomized complete block design with nine treatments replicated thrice. For soil application, 100 per cent N, P_2O_5 and K_2O *i.e.*, only normal fertilizer (NF) were applied in the form of urea, SSP and MOP, respectively at the time of planting as basal dose for the treatments under study. In Micro sprinkler fertigation methods, according to 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 recommended dose of fertilizers as per UAS, Bengaluru was 25:75:37.5 kg ha^{-1} N, P and K, respectively. 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.

At harvest of groundnut crop, the soil samples collected from different treatments were processed and analysed for available nitrogen (Subbaiah and Asija, 1956) [8], available phosphorus (Jackson, 1973) [7] and available potassium (Page, 1982) [10]. At harvest, observations on yield parameters were recorded and yield parameters were expressed in quintal per hectare.

Balance sheet of nitrogen, phosphorus and potassium were worked out by considering the status of available N, P_2O_5 and K_2O in the initial soil sample, amount of N, P_2O_5 and K_2O added through fertilizer and uptake of N, P_2O_5 and K_2O. Expected balance of N, P_2O_5 and K_2O were calculated by subtracting N, P_2O_5 and K_2O taken up by the crop from total N, P_2O_5 and K_2O. Net gain or loss of nutrient was worked out by subtracting actual balance from the expected balance of the nutrients.

All these data's *viz*., pod yield, haulm yield, kernel yield, nutrient uptake, nutrient balance sheet and soil data were statistically analysed by adopting standard procedure outlined by Gomez and Gomez (1984) [5].

Results and Discussion

Effect of Micro sprinkler fertigation on nutrient balance in soil

The data pertaining to nutrient balance in soil is mentioned in Table 1. The initial nitrogen status of the experimental plot was 315.3 kg ha^{-1}. For the treatments with soil application of normal fertilizers, the addition of nitrogen was common (25 kg ha^{-1}) and over different fertigation treatments, addition of nitrogen was 12.5, 18.75 and 25 kg at 50, 75 and 100 % RDF of nitrogen either through normal fertilizers or water soluble fertilizers. Micro sprinkler fertigation of NF at 100 % RDF has recorded higher available nitrogen (281.2 kg ha^{-1}). The lower available nitrogen in the soil was observed in absolute control (238.3 kg ha^{-1}). The maximum loss (6.7 kg ha^{-1}) was obtained at soil application of normal fertilizers with surface irrigation and in absolute control (23.8 kg ha^{-1}). In all micro sprinkler fertigation treatments the gain of fertilizers was observed. However, more gain of soil N was recorded in micro sprinkler fertigation of WSF at 100 % RDF (39.3 kg ha^{-1}). Among the fertigation treatments less gain of nitrogen was noticed in 50 % fertilizer levels with NF and WSF (8.8 and 9.7 kg ha^{-1}, respectively). The loss of nitrogen might be due to leaching, volatilization and denitrification. These results are in line with findings of Rekha (2014) [14], Bharath Raj (2013) [3] and Hebbar (2004) [6].

Table 1: Balance for N, P_2O_5 and K_2O (kg ha^{-1}) in soil as by influenced by micro sprinkler fertigation in groundnut

Treatments	Initial available N, P_2O_5 and K_2O	Addition through fertilizer	Total	Removal by crops	Expected balance	Actual balance	Net loss (-) or gain (+)
*(1)	*(2)	*(3)	*(4=2+3)	*(5)	*(6=4-5)	*(7)	*(8=7-6)
Nitrogen							
T_1	315.3	25	340.3	62.2	278.1	271.4	-6.7
T_2	315.3	25	340.3	73.4	266.9	276.2	9.3
T_3	315.3	25	340.3	97.1	243.2	281.2	38.0
T_4	315.3	18.75	334.05	82.73	251.3	273.4	22.1
T_5	315.3	12.5	327.8	71.4	256.4	265.2	8.8
T_6	315.3	25	340.3	113.4	226.9	266.2	39.3
T_7	315.3	18.75	334.05	105.2	228.85	258.4	29.6
T_8	315.3	12.5	327.8	86.16	241.6	251.3	9.7
T_9	315.3	0	315.3	53.2	262.1	238.3	-23.8
Phosphorus							
T_1	32.3	75	107.3	39.4	67.9	45.8	-22.1
T_2	32.3	75	107.3	48.1	59.2	48.3	-10.9
T_3	32.3	75	107.3	57.7	49.6	57.3	7.7
T_4	32.3	56.25	88.55	51.1	37.5	48.6	11.1
T_5	32.3	37.5	69.80	41.9	27.9	39.7	11.8
T_6	32.3	75	107.3	72.4	34.9	49.4	14.5
T_7	32.3	56.25	88.55	65.3	23.3	40.5	17.2
T_8	32.3	37.5	69.8	40.5	29.3	35.2	5.9
T_9	32.3	0	32.30	23.8	8.5	31.5	23.0
Potassium							
T_1	219	37.50	256.50	24.60	231.9	221.3	-10.6
T_2	219	37.50	256.50	35.60	220.9	233.4	12.5
T_3	219	37.50	256.50	47.00	209.5	254.5	45.0
T_4	219	28.12	247.12	39.40	207.8	245.6	37.8
T_5	219	18.75	237.75	26.30	211.5	240.5	29.0
T_6	219	37.50	256.50	55.70	200.8	242.7	41.9
T_7	219	28.12	247.12	50.60	196.5	235.5	39.0

T_8	219	18.75	237.75	37.60	200.2	230.7	30.5
T_9	219	0.00	219	20.30	198.7	194.3	-4.4

Treatment details

T1: Surface irrigation with soil application of 100 % RDF (NF)
T2: Micro sprinkler irrigation with soil application of 100 % RDF (NF)
T3: Micro sprinkler fertigation of NF at 100 % RDF
T4: Micro sprinkler fertigation of NF at 75 % RDF
T5: Micro sprinkler fertigation of NF at 50 % RDF
T6: Micro sprinkler fertigation of WSF at 100 % RDF
T7: Micro sprinkler fertigation of WSF at 75 % RDF
T8: Micro sprinkler fertigation of WSF at 50 % RDF
T_9: Absolute control

The initial status of phosphorus of experimental site was 32.30 kg ha^{-1}. Phosphorus added through fertilizer was common for both methods of irrigation (75 kg ha^{-1}). Available phosphorus in the soil was more with micro sprinkler fertigation of NF at 100 % RDF (57.3 kg ha^{-1}). The lower available phosphorus was recorded in absolute control (31.5 kg ha^{-1}). Higher soil P loss was noticed in absolute control (23.0 kg ha^{-1}). Among the fertigation treatments, the addition of phosphorus through fertilizer was higher at 100 % RDF (75 kg ha^{-1}). Higher net gain of phosphorus was observed with micro sprinkler fertigation of WSF at 75 % RDF (17.2 kg ha^{-1}) followed by micro sprinkler fertigation of WSF at 100 % RDF (14.5 kg ha^{-1}). The loss of phosphorous may be due to fixation of phosphorous in the soil. These results are in conformity with Sanju (2013) [16] and Ashok Biradar (2012) [2].
Initial status of potassium of experimental site was 219 kg ha^{-1}. Between two irrigation methods, the addition of potassium through fertilizer was common (37.5 kg ha^{-1}). Among the fertigation treatments, addition of potassium was maximum at 100 % RDF (37.5 kg ha^{-1}). Available potassium in the soil was higher with micro sprinkler fertigation of NF at 100 % RDF (254.5 kg ha^{-1}) and it was followed by micro sprinkler fertigation of NF at 75 % RDF through (245.6 kg ha^{-1}). The net loss of potassium was observed with soil application of normal fertilizer through surface irrigation method (10.6 kg ha^{-1}) and in absolute control (4.4 kg ha^{-1}). Net gain of potassium was observed in all fertigation treatments. Higher gain of potassium was noticed in micro sprinkler fertigation of NF at 100 % RDF (45.0 kg ha^{-1}) followed by micro sprinkler fertigation of WSF at 100 % RDF (41.9 kg ha^{-1}). Maximum loss of potassium was noticed in surface irrigation with soil application of normal fertilizers at 100 % RDF (10.6 kg ha^{-1}). This might be due to the fact that crop could not completely utilise the available potassium. These results are in line with findings of Rekha (2014) [14] and Bharath Raj (2013) [3].
The nutrient retained in the soil after harvest of the crop mainly depends on both supply of nutrients through various sources and uptake by the crop. In general, higher the uptake of nutrients by the crop lower will be the residual available nutrients in the soil. Further, higher the nutrient supplied higher is the residual soil nutrients. However, several factors influence the uptake as well as available nutrients. These results are in conformity with Ashok Biradar (2012) [2].

Effect of Micro sprinkler fertigation on pod yield, haulm yield and kernel yield

The data on pod yield, haulm yield and kernel yield of groundnut as influenced by micro sprinkler fertigation are presented in Table 2**.** Significant differences were noticed in yield parameters of groundnut due to micro sprinkler fertigation treatments. Among the different treatments, Micro sprinkler fertigation of WSF at 100 % RDF recorded significantly higher pod yield (2882 kg ha^{-1}), haulm yield (3343 kg ha^{-1}) and kernel yield (2263 kg ha^{-1}) over all other treatments. However, it was on par with micro sprinkler fertigation of WSF 75 % RDF (2632, 3237 and 2013 kg ha^{-1} of pod yield, haulm yield and kernel yield, respectively).
The increased yield in Micro sprinkler fertigation of WSF at 100 % RDF and Micro sprinkler fertigation of WSF at 75 % RDF is mainly attributed to enhanced availability and even distribution of nutrients in the root zone 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 Vijayalakshmi (2011) [20], Sanju (2013) [16] and Mathukia *et al*. (2014) [9] in groundnut, Rathore *et al*. (2014) [13] in mustard, Prabhakar *et al*. (2011) [11] in onion.
Significantly lower pod yield (1377 kg ha^{-1}), haulm yield (2077 kg ha^{-1}) and kernel yield (956 kg ha^{-1}) were noticed in absolute control followed by surface irrigation with soil application of normal fertilizers at100 % RDF (1779, 2409 and 1275 kg ha^{-1} of pod yield, haulm yield and kernel yield, respectively).
Micro sprinkler fertigation treatments recorded significantly higher pod yield, haulm yield and kernel yield on comparison with surface method of irrigation. This may be due to the beneficial effect of fertigation on physiology of plants through its stimulating effect on initiating more pegs and their subsequent development leading to relatively higher number of pods plant^{-1} which in turn reflected in increased pod yield plant^{-1}. These results are in conformity with the findings of Vijayalakshmi *et al*. (2011) [20] and Sanju (2013) [16] and Sabina (1995) [15].
Even with same level and method of application of fertilizers (NF), micro sprinkler irrigation method produced 17.2 per cent higher pod yield (2151 kg ha^{-1}) over surface irrigation (1779 kg ha^{-1}). Micro sprinkler irrigation maintained good soil moisture condition at all the crop growth stages, while, the surface method of irrigation had high fluctuation of moisture, which might have resulted in lower pod yield under surface irrigation. Similar results were reported by reported by Sukeshni Wane *et al*. (2009) [19], Sanju, (2013) [16] and Rank, H.D. (2007) [12] in groundnut.

Table 2: Pod yield, haulm yield, and kernel yield as influenced by micro sprinkler fertigation in groundnut

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Kernel yield (kg ha^{-1})
T_1: Surface irrigation with soil application of 100 % RDF (NF)	1779	2409	1275
T_2: Micro sprinkler irrigation with soil application of 100 % RDF (NF)	2151	2806	1563
T_3: Micro sprinkler fertigation of NF at 100 % RDF	2517	3137	1910
T_4: Micro sprinkler fertigation of NF at 75 % RDF	2277	2887	1702
T_5: Micro sprinkler fertigation of NF at 50 % RDF	1933	2562	1408
T_6: Micro sprinkler fertigation of WSF at 100 % RDF	2882	3443	2263
T_7: Micro sprinkler fertigation of WSF at 75 % RDF	2632	3237	2013
T_8: Micro sprinkler fertigation of WSF at 50 % RDF	2159	2837	1605
T_9: Absolute control	1377	2077	956
S.Em ±	118.08	105.17	87.64
C.D at 5 %	354.01	315.31	262.75

Treatment details

T1: Surface irrigation with soil application of 100 % RDF (NF)
T2: Micro sprinkler irrigation with soil application of 100 % RDF (NF)
T3: Micro sprinkler fertigation of NF at 100 % RDF
T4: Micro sprinkler fertigation of NF at 75 % RDF
T5: Micro sprinkler fertigation of NF at 50 % RDF
T6: Micro sprinkler fertigation of WSF at 100 % RDF
T7: Micro sprinkler fertigation of WSF at 75 % RDF
T8: Micro sprinkler fertigation of WSF at 50 % RDF
T_9: Absolute control

Conclusion

In all the micro sprinkler fertigation treatments, the net gain of N, P and K was noticed. However, it varied with source of fertilizers and level of fertilizers applied. Micro sprinkler fertigation of WSF at 75 % RDF recorded significantly higher yields of groundnut along with 25 % saving in fertilizers there by causing less hazard to the environment.

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