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Nitrogen uptake and yield of groundnut as influenced by secondary and micronutrients

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Abstract
A field experiment was carried out at on sandy loam soils of Agricultural College farm, Mahanandi during *rabi* season of 2015-2016 to study the response of groundnut to secondary and micronutrients. The experiment was laid out in a randomized block design with ten treatments and replicated thrice. The treatments consisted of T_1: Control, T_2: RDF: 20-40-50 kg N-P_2O_5-K_2O ha^{-1}, T_3: RDF + foliar application of 1% $CaNO_3$,T_4: RDF + foliar application of 1% $MgNO_3$, T_5: RDF + foliar application of 1% Sulphur, T_6: RDF + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur, T_7: RDF + foliar application of $ZnSO_4$ @ 0.2%, T_8: RDF + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur + $ZnSO_4$ @ 0.2%, T_9: RDF +foliar application of micronutrient mixture @ 0.2%, T_{10}: RDF + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur + micronutrient mixture @ 0.2%. Data collected on yield and nitrogen uptake of groundnut were subjected to statistical analysis and results indicated that all the characters studied were significantly higher with application of RDF + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur + micronutrient mixture @ 0.2% (T_{10}).

Keywords: groundnut, yield, nutrient uptake, micronutrients and foliar application

Introduction
Groundnut (*Arachis hypogaea* L.) also known as peanut is a crop of global importance. It is classified as both a grain legume and an oilseed crop, because of its high oil content. The productivity of Andhra Pradesh (890 kg ha^{-1}) is much lower compared to national average (1750 kg ha^{-1}) (INDIASTAT, 2015). There are several production constraints which could be attributed to lower productivity. Mainly the crop is grown on low fertility marginal lands with low input supply and rainfed conditions. The productivity enhancement target is still elusive. With limited scope of bringing additional area under oilseeds, bulk of the future increase in production has to come through crop nutrition. Therefore, it is most essential to pay a great attention to the nutrition of the groundnut to enhance its productivity. Among the crops, groundnut responds well to secondary and micronutrient fertilization.
The supplementation of these essential nutrients through soil application is a common practice. Since the secondary and micronutrients applied to soil may undergo different physico-chemical transformations, so the response to secondary and micronutrients is studied with foliar sprayings.

Material and Methods
A field experiment was conducted with groundnut variety K6, under irrigated conditions during *rabi*, 2015-16 on sandy loam soils of Agricultural College Farm, Mahanandi, Andhra Pradesh. The soil of the experimental field was neutral in pH (7.38), medium in organic carbon (0.59%), N (319 kg ha^{-1}), P_2O_5 (40 kg ha^{-1}) and high in K_2O (369 kg ha^{-1}). Exchangeable calcium, magnesium (2.85 and 1.12 C mol. (P^+) kg^{-1}), available sulphur (30 kg ha^{-1}) and micronutrients were sufficient in availability. Weather during the crop period was normal without any marked deviation from mean of the experimental site. The experiment was laid out in a randomized block design having ten treatments and replicated thrice. The treatments consisting of T_1 : Control, T_2 : RDF: 20-40-50 kg N-P_2O_5-K_2O ha^{-1}, T_3 : RDF + foliar application of one per cent $CaNO_3$, T_4 : RDF+ foliar application of one per cent $MgNO_3$, T_5 : RDF + foliar application of one per cent sulphur, T_6 : RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur, T_7 : RDF + foliar application of $ZnSO_4$ @ 0.2 per cent, T_8: RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + foliar application of $ZnSO_4$ @ 0.2 per cent, T_9 : RDF + foliar application of micronutrient mixture @

0.2 per cent and T_{10}: RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent. Ssecondary nutrients and zinc was supplied through $CaNO_3$, $MgNO_3$, wet table sulphur and $ZnSO_4$ respectively. Micronutrient mixture consists of Boron (B) 1.5%, Copper (Cu) 0.5%, Iron (Fe) 3.4%, Manganese (Mn) 3.2%, Molybdenum (Mo) 0.05% and Zinc (Zn) 4.2%. Foliar spray of secondary and micronutrients was done at 22 DAS. The seeds were sown @100 kg ha^{-1} with a spacing of 22.5 cm X 10 cm. Seed treatment was done with *Trichoderma viride* @ 10 grams per kilo gram seed as prophylactic measure against seed born diseases. The data on pod yield, haulm yield and nutrient uptake analysed adopting standard procedures. The uptake of nitrogen at 30, 60, 90 DAS by whole plant and at harvest by pod and haulm sample was calculated as follows.

$$\text{Uptake of nutrient} = \frac{\text{Nutrient content (\%)}}{\text{(kg ha}^{-1}\text{) 100}} \text{X Dry matter yield (kg ha}^{-1}\text{)}$$

Results and Discussion

Different combinations of secondary and micronutrients had significant effect on yield (Table 1) and nutrient uptake (Table 2) of groundnut.

Pod Yield

Pod yield (kg ha^{-1}) of groundnut with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent (T_{10}) (2654 kg ha^{-1}) increased significantly to the tune of 76.93 per cent over RDF treatment (T_2) (1154 kg ha^{-1}). The highest pod yield might be due to better lateral root growth favoring nodulation and also involvement of secondary and micronutrients in catalyzing the metabolism of carbohydrates and increase in enzyme activity and other biological oxidation reactions (Nayak *et al*., 2009).Among the secondary nutrients sources along with RDF treatments RDF + foliar application of one per cent sulphur (T_5) recorded higher pod yield.This might be due to multiple role of sulphur in metabolism and efficient partitioning and translocation of metabolites. RDF + foliar application of micronutrient mixture @ 0.2 per cent (T_9) and RDF + foliar application of $ZnSO_4$ @ 0.2 per cent (T_7) were on par with each other. This clearly shows the micronutrients especially zinc involvement in plant metabolism and nutrient assimilation which resulted in increased stature of all the yield attributes led to higher pod yield (Fakeerappa Arabhanvi *et al*., 2015).

Haulm Yield

Haulm yield (kg ha^{-1}) of groundnut increased significantly with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent (T_{10}) (3603 kg ha^{-1}) which was at par with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + $ZnSO_4$ @ 0.2 per cent (T_8) (3484 kg ha^{-1}). The easy transfer of nutrients through foliar spray and auxins assimilation could have created the stimuli in the plant system which in turn increased the production of growth regulators in cell system leading to better haulm yield Naiknaware *et al.* (2015). RDF + foliar application of one per cent $CaNO_3$ (T_3) recorded superior haulm yield which on par with RDF + foliar application of one per cent sulphur (T_5). The highest haulm yield due to calcium foliar spray might be due to effective participation of calcium in structural and developmental processes of plant growth (Kamara *et al*., 2011). RDF + foliar application of micronutrient mixture @ 0.2 per cent (T_9) and RDF + foliar application of $ZnSO_4$ @ 0.2 per cent (T_7) were at par with each other. This was due to the involvement of micronutrients mainly zinc in regulatory functions, auxin production which ultimately improves the vegetative growth of the plant (Mahakulkar *et al*.,1994).

Harvest Index

Maximum harvest index was recorded with the treatment RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent (T_{10}) (42.41%) which was at par with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + $ZnSO_4$ @ 0.2 per cent (T_8) and RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur (T_6). Optimum utilization of solar radiation, higher assimilates production and its conversion to starch results in higher biomass, pod yield leading to higher harvest index (Heba Mohamed Noman *et al.*, 2015).

Table 1: Yield and harvest index of groundnut as influenced by secondary and micronutrients

Treatments	Yield (kg ha^{-1})		Harvest index (%)
	Pod	Haulm	
T_1: Control	1118	2070	35.07
T_2: 20-40-50 kg N-P_2O_5-K_2O ha^{-1}	1500	2641	36.22
T_3: T_2 + foliar application of 1% $CaNO_3$	1790	3095	36.64
T_4: T_2 + foliar application of 1% $MgNO_3$	1811	2713	40.03
T_5: T_2 + foliar application of 1% Sulphur	1932	3020	39.01
T_6: T_2 + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur	2383	3307	41.88
T_7: T_2 +foliar application of $ZnSO_4$ @ 0.2%	1951	3039	39.10
T_8: T_6 +foliar application of $ZnSO_4$ @ 0.2%	2538	3484	42.15
T_9: T_2 + foliar application of micronutrient mixture @ 0.2%	1976	3101	38.92
T_{10}: T_6 + foliar application of micronutrient mixture @ 0.2%	2654	3603	42.42
SEm±	37	58	0.71
CD (P=0.05)	110	175	2.12

Nitrogen Uptake

Among all the treatments, RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent (T_{10}) recorded the highest nitrogen uptake (27.24 kg ha^{-1} at 30 DAS, 64.72 kg ha^{-1} at 60 DAS, 80.77 kg ha^{-1} at 90 DAS, 40.76 and 63.77 kg ha^{-1} in haulm and pod at harvest stage respectively) at all the stages of crop growth, but it was at par with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + $ZnSO_4$ @ 0.2 per cent (T_8) at 30 DAS and haulm uptake of nitrogen at harvest. At harvest pod uptake of nitrogen was more which might be due to translocation of nitrogen from leaves to pod

or dilution effect of nutrient in the plant. The maximum uptake of nitrogen in combination treatments was due to the increased dry matter production from flowering to harvest. Yakadri and Satyanarayana (1995) [8] reported that there is a close relationship between nutrient uptake and dry matter production in groundnut. The highest uptake of nitrogen with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent (T_{10}) treatment was due to the increase in growth that ascribed to better root formation which in turn activated higher absorption of nitrogen from soil and improved metabolic activity inside the plant (Laxminarayana, 2004) [4].

With regard to secondary nutrients sources foliar spray along with RDF treatments, RDF + foliar application of one per cent sulphur (T_5) recorded higher uptake of nitrogen over RDF + foliar application of one per cent $CaNO_3$ (T_3) and RDF+ foliar application of one per cent $MgNO_3$ (T_4) at all the stages of crop growth except for haulm uptake at harvest which was higher with RDF + foliar application of one per cent $CaNO_3$ (T_3), which might be due to more dry matter production. However, all these three treatments were at par with other at 30 DAS and haulm uptake of nitrogen at harvest.

Between micronutrient foliar spray along with RDF treatments, RDF + foliar application of micronutrient mixture @ 0.2 per cent (T_9) recorded significantly superior uptake of nitrogen over RDF + foliar application of $ZnSO_4$ @ 0.2 per cent (T_7) at all the stages of crop growth. This might be due to micronutrients involvement in activation of many enzymes and helps in uptake of nitrogen.

Table 2: Nitrogen uptake (kg ha^{-1}) by groundnut as influenced by secondary and micronutrients

Treatments	30 DAS	60 DAS	90 DAS	At harvest	
				Haulm	Pod
T_1: Control	15.36	17.32	24.97	11.48	15.17
T_2: 20-40-50 kg N-P_2O_5-K_2O ha^{-1}	21.49	31.18	46.14	19.25	31.31
T_3: T_2 + foliar application of 1% $CaNO_3$	24.38	39.45	64.06	26.48	49.26
T_4: T_2 + foliar application of 1% $MgNO_3$	23.74	38.89	54.07	24.65	39.47
T_5: T_2 + foliar application of 1% Sulphur	24.46	43.25	69.79	25.34	54.19
T_6: T_2 + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur	25.74	59.06	74.73	34.64	57.63
T_7: T_2 +foliar application of $ZnSO_4$ @ 0.2%	19.57	50.30	66.04	28.33	48.09
T_8: T_6 +foliar application of $ZnSO_4$ @ 0.2%	27.04	60.92	76.16	38.31	58.75
T_9: T_2 + foliar application of micronutrient mixture @ 0.2%	22.97	54.21	74.04	36.82	55.24
T_{10}: T_6 + foliar application of micronutrient mixture @ 0.2%	27.24	64.72	80.77	40.76	63.47
SEm±	0.45	1.08	1.35	1.15	1.23
CD (P=0.05)	1.36	3.24	4.03	3.44	3.70

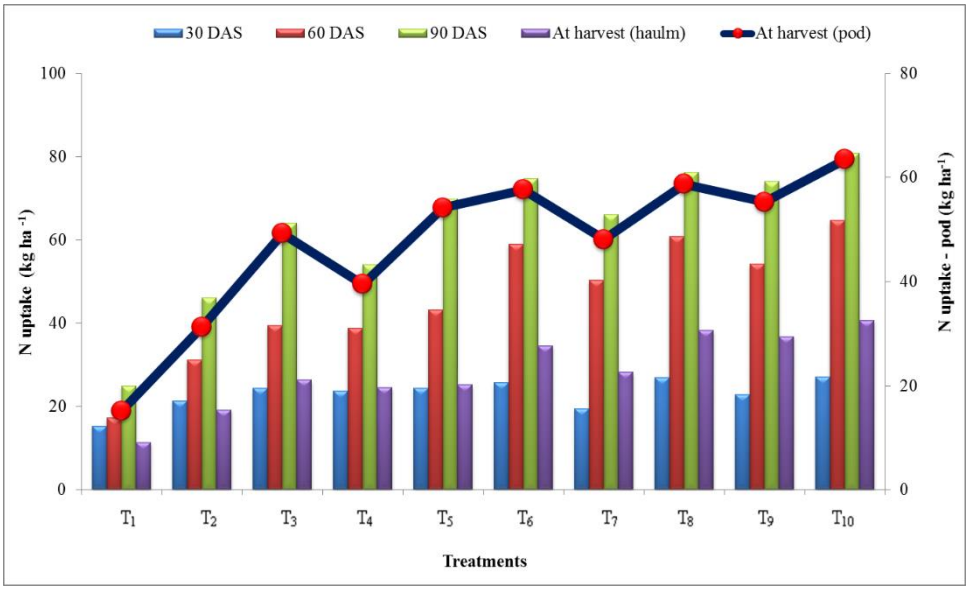

Fig 1: Nitrogen uptake (kg ha^{-1}) by groundnut at different growth stages as influenced by secondary and micronutrients

Conclusion

Combined foliar application of secondary and micronutrients along with recommended dose of fertilizer could be evolved as best combination for higher productivity and also recorded the higher nitrogen uptake. The rate of uptake was more between flowering to pod development stage but decreases at harvest.

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