Agric. Sci. Digest., 38(4) 2018: 285-288
Print ISSN:0253-150X / Online ISSN:0976-0547

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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Influence of secondary and micronutrients on primary nutrient uptake by groundnut (*Arachis hypogaea* L.)

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Received: 01-08-2018 Accepted: 12-10-2018 DOI: 10.18805/ag.D-4798

ABSTRACT

Groundnut is an important edible oilseed crop of our country and edible oil economy primarily depends upon groundnut production. Secondary and micronutrient fertilization is essential for enhancing the productivity of groundnut crop. Calcium, Magnesium and Sulphur requirements are highest in oil seed crops followed by pulses and least in cereals. The response of groundnut to secondary and micronutrients was studied on sandy loam soils. Combined foliar application of secondary and micronutrients along with RDF recorded significantly highest pod yield of 2654 kg ha^{-1} and haulm yield of 3603 kg ha^{-1} as compared to RDF (1500 and 2551 kg ha^{-1} of pod and haulm yield, respectively) and also the highest uptake of primary nutrients (N, P and K) by haulm and pod at harvest which might be because of highest dry matter production with the combined application of all the nutrients.

Key words: Groundnut, Micronutrients, Uptake, Yield.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) also known as peanut is a crop of global importance. It is widely grown in the tropics and subtropics, being important to both small holder and large commercial producers. 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. Achieving the higher production and productivity of groundnut mainly depends on the judicious management of fertilizers. Intensive cropping leads to deficiency of secondary and micronutrients, which is the main constraint for low yield of groundnut. For getting optimum yield, all the secondary and micronutrients are required in appropriate quantities, because their dearth can hinder groundnut response to major nutrients. The use efficiency of applied fertilizers is low in soil application because of fixation and leaching losses, so soil application of nutrients may not produce desirable yields. Under these conditions foliar application seems to be promising for ensuring use efficiency of applied nutrients. Foliar spray enables plants to absorb the applied nutrients from the solution through their leaf surface and thus, may result in the economic use of fertilizer. Keeping this in view, the present investigation was planned to study the effect of secondary and micronutrients foliar spray with recommended levels of nitrogen, phosphorus, potassium on yield and uptake of major nutrients (N, P and K) by groundnut.

MATERIALS AND METHODS

A field experiment was conducted on 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}) and available sulphur (30 kg ha^{-1}) were sufficient in availability. Micronutrients availability (Fe, Mn, Zn, Cu, B and Mo) was more than their critical limits. Weather during the crop period (from 12.11.2015 to 29.02.2016) was normal without any marked deviation from mean of the experimental site. 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+ 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). The experiment was laid on randomised block design with three replications. Urea, single super phosphate

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and muriate of potash were used for the supply of NPK and was applied as basal dose at the time of sowing in furrows made 5 cm away from the seed rows, Whereas secondary nutrients and zinc was supplied through $CaNO_3$, $MgNO_3$, wettable 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 x 10 cm on 12.11.2015. Seed treatment was done with *Trichoderma viride* @ 10 grams per kilo gram seed as prophylactic measure against seed born diseases. All the cultural practices were taken up as per the recommendations made by ANGRAU. The nitrogen content in dry matter samples was estimated by modified Micro Kjeldahl method after digesting the powdered plant sample with H_2SO_4 and H_2O_2. For P and K estimation plant material was digested in a diacid mixture. Aliquots of this diluted digest were used for the determination of P and K by adopting standard procedures. The uptake of nitrogen, phosphorus and potassium at harvest by pod and haulm sample was calculated as follows.

Uptake of nutrient (kg ha^{-1}) =

$$\frac{\text{Nutrient content (\%)}}{100} \times \text{Dry matter yield (kg ha}^{-1}\text{)}$$

RESULTS AND DISCUSSION

Yield: Different combinations of secondary and micronutrients had significant effect on yield and harvest index of groundnut (Table 1).

Pod yield: 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}) treatment increased the pod yield to the tune of 76.93 per cent over RDF: 20-40-50 kg N-P_2O_5-K_2O ha^{-1} (T_2) (1500 kg ha^{-1}). Increase in pod yield was probably because of high dry matter accumulation which subsequently improved the number of filled pods per plant. Further, it might be due to better lateral root growth favouring 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). With regard to individual secondary nutrient along with RDF treatments, RDF + foliar application of one per cent sulphur (T_5) recorded higher pod yield than RDF + foliar application of one per cent $CaNO_3$ (T_3) and RDF+ foliar application of one per cent $MgNO_3$ (T_4). This might be due to multiple role of sulphur in metabolism and efficient partitioning and translocation of metabolites. Among RDF along with micronutrient sources and without secondary nutrients treatments, 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}) and an increase to the extent of 41.23 per cent in haulm yield was noted over recommended dose of fertilizer (T_2) (2641 kg ha^{-1}). Higher haulm yield was due to the easy transfer of nutrients through foliar spray and auxins assimilation could have created the stimuli in the plant system Naiknaware *et al.* (2015). Foliar application of secondary and micronutrients had comparative advantage over RDF: 20-40-50 kg N-P_2O_5-K_2O ha^{-1} (T_2) except with RDF+ foliar application of one per cent $MgNO_3$ (T_4). Among the RDF and individual foliar application of secondary nutrient treatments, RDF + foliar application of one per cent $CaNO_3$ (T_3) recorded superior haulm yield than RDF+ foliar application of one per cent $MgNO_3$ (T_4), but 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). With regard to micronutrient foliar spray along with RDF and without secondary nutrient combination treatments, 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). Highest harvest index proved the fact that plant performance was improved not only in respect to photosynthetic capacity but the mobilization of photosynthates for yield formation was also greatly favoured.

Nutrient Uptake: Significantly highest uptake of nitrogen (104.23 kg ha^{-1}), phosphorus (12.62 kg ha^{-1}) and potassium (40.95 kg ha^{-1}) at harvest (Table 2) was found with RDF + foliar application of one per cent each of $CaNO_3$, $MgNO_3$ and sulphur + micronutrient mixture @ 0.2 per cent(T_{10}). The highest uptake was due to increase in growth that ascribed to better root formation which in turn activated

Table 1: Effect of secondary and micronutrients on yield (kg ha^{-1}) of groundnut.

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
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**

Table 2: Effect of secondary and micronutrients on primary nutrients uptake (kg ha^{-1}).

Treatments	**Nitrogen**		**Phosphorus**		**Potassium**	
	Haulm	**Pod**	**Haulm**	**Pod**	**Haulm**	**Pod**
T_1: Control	11.48	15.17	1.26	1.98	9.15	2.31
T_2: 20-40-50 kg N-P_2O_5-K_2O ha^{-1}	19.25	31.31	1.83	3.23	18.28	6.86
T_3: T_2 + foliar application of 1% $CaNO_3$	26.48	49.26	2.84	4.16	22.67	7.49
T_4: T_2 + foliar application of 1% $MgNO_3$	24.65	39.47	2.34	3.69	21.54	6.97
T_5: T_2 + foliar application of 1% Sulphur	25.34	54.19	3.08	4.92	23.53	7.55
T_6: T_2 + foliar application of 1% each of $CaNO_3$, $MgNO_3$ and Sulphur	34.64	57.63	4.28	5.81	26.80	8.88
T_7: T_2 +foliar application of $ZnSO_4$ @ 0.2%	28.33	48.09	3.32	4.66	22.18	7.80
T_8: T_6 +foliar application of $ZnSO_4$ @ 0.2%	38.31	58.75	4.87	6.16	28.47	9.84
T_9: T_2 + foliar application of micronutrient mixture @ 0.2%	36.82	55.24	3.89	5.32	26.97	8.49
T_{10}: T_6 + foliar application of micronutrient mixture @ 0.2%	40.76	63.47	5.41	7.21	30.29	10.66
SEm±	**1.15**	**1.23**	**0.14**	**0.15**	**0.53**	**0.18**
CD (P=0.05)	**3.44**	**3.70**	**0.42**	**0.46**	**1.59**	**0.53**

higher absorption of nutrients from soil and improved metabolic activity inside the plant (Laxminarayana, 2004). For all the nutrients, it was lowest in the control. When comparing the pod and haulm uptake of nutrients (N, P and K) at harvest, the uptake of N and P was more in pod compared to haulm, this might be due to translocation of nutrients from leaves to pod and presence of higher amount of proteins in kernel (Manasa *et al.*, 2015). With regard to K uptake, the haulm retains the major part of these nutrients accumulated during vegetative growth indicating its utilization for structural and developmental processes and allowed little translocation towards reproductive parts, hence kernel contain less amount of these nutrients (Yakadri and Satyanarayana,1995).

With regard to individual secondary nutrient foliar spray along with RDF treatments, haulm uptake of nitrogen was higher with RDF + foliar application of one per cent $CaNO_3$ (T_3) which might be due to more dry matter production and was on par with RDF+ foliar application of one per cent $MgNO_3$ (T_4) and RDF + foliar application of one per cent sulphur (T_5), Whereas pod uptake of nitrogen and phosphorus with RDF + foliar application of one per cent sulphur (T_5) treatment was significantly superior overthe other two treatments. Phosphorus haulm uptake, potassium haulm and pod uptake were higher with RDF + foliar application of one per cent sulphur (T_5) treatment which was on par with RDF + foliar application of one per cent $CaNO_3$ (T_3) and significantly superior over RDF+ foliar application of one per cent $MgNO_3$ (T_4) treatment.

Among micronutrient foliar spray along with RDF treatments, RDF + foliar application of micronutrient mixture @ 0.2 per cent (T_9) recorded significantly superior uptake of primary nutrients (N, P and K) by pod and haulm over RDF + foliar application of $ZnSO_4$@ 0.2 per cent (T_7). This might be due to micronutrients involvement in activation of many enzymes and helps in uptake of nutrients. The uptake of nutrients is associated with the metabolic activities of the plant and depends on the concentration of nutrient ions in the plant system (Manasa *et al.*, 2015).

CONCLUSION

Groundnut responds to fertilizer application. Substantial increase in groundnut production can be achieved through effective nutrient management. For groundnut, which is a legume, main focus should be on nutrients. Intensive cropping leads to deficiency of secondary and micronutrients, which is the main constraint for low yield of groundnut. Foliar

application is feasible, economically viable and environment friendly approach of nutrient management. Foliar nutrition helps to maintain a nutrient balance within the plant, which may not occur with soil uptake. Experiment results revealed that NPK fertilizer soil application at recommended dose along with foliar application of secondary and micronutrients are required to increase the productivity and uptake of nutrients by groundnut.

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