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Effect of Foliar Nutrition on Growth and Uptake of Macro and Micronutrients of *Kharif* Groundnut (*Arachis hypogaea* L.)

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A B S T R A C T

A field experiment was conducted at Post Graduate Research Farm, College of Agriculture, Kolhapur during *Kharif* season of 2017-18 to know the effect of foliar nutrition on growth and uptake of macro and micro nutrients by groundnut (*Arachis hypogaea* L.) and post harvest status of soil. The experiment was laid out in a randomized block design with three replications and seven treatments in which treatments comprised of seven treatments *viz.*, absolute control, GRD, GRD+ water spray, GRD+19:19:19 spray (2 %), GRD+$Ca(NO_3)_2$ spray (2 %), GRD+Micro. gr.II spray (0.25 %) and GRD+Schoenite spray (1 %), respectively. The foliar nutrition was done at 45 and 60 DAS. Among the foliar treatments, significantly highest plant height (21.26 cm $plant^{-1}$), number of nodules (95 $plant^{-1}$) and number of branches (9.10 $plant^{-1}$) was recorded by treatment 2 % foliar spray of $Ca(NO_3)_2$. The total uptake by groundnut crop at harvest of all the macro (N, P, K, Ca, Mg and S) and micro nutrients (Fe, Mn, Cu, Zn and B) *viz.*, nitrogen (142 kg ha^{-1}), phosphorus (23.33 kg ha^{-1}), potassium (82 kg ha^{-1}), calcium (63 kg ha^{-1}), magnesium (65 kg ha^{-1}), sulphur (21.90 kg ha^{-1}), iron (2621 g ha^{-1}), manganese (748 g ha^{-1}), zinc (302 g ha^{-1}), copper (190 g ha^{-1}) and boron (64.9 g ha^{-1}) was highest in treatment 2 % foliar spray of $Ca(NO_3)_2$. The available nutrient status after harvest of crop did not differ significantly due to different treatment of foliar spray.

Introduction

Groundnut (*Arachis hypogaea* L.) is an annual legume. India ranks 2nd in production after China with 33 per cent of world's total production. It is the 13th most important food crop, 4th important source of vegetable oil and 3rd main source of vegetable protein in the world. As regards the nutritional value of groundnut, its seed contain high quality of edible oil about 48 %, easily digestible protein about 26 % with carbohydrates content of about 20 % (Singh and Basu, 2004). Groundnut is called a self-fertilizing crop, nevertheless, it is very exhaustive crop compared to other legumes because a very little portion of the plant residue is left in the soil after harvest (Varade and Urknde, 1982).

An average crop of groundnut yielding 19 q ha^{-1} removes about 170 kg N, 30 kg P, 110 kg K, 39 kg Ca and 15 kg S from the soil (Aulakh *et al.*, 1985). Therefore, cultivation of groundnut depletes the soil fertility rapidly

unless the crop is adequately fertilized. So, balanced use of macro and micronutrients is must for enhancing the groundnut production.

Groundnut being an oilseed crop and considered as heavy feeder of nutrients. To realize the higher yields, it is very much essential to supply adequate but balanced amounts of major and micronutrients. The nutrient requirement of groundnut is high especially at pegging and pod development stages. The requirement at these stages cannot be fulfilled merely by soil application alone and need to be supplemented through foliar nutrition. Applied fertilizers are subjected to different losses *viz.,* nitrogenous fertilizer is subjected to leaching losses along with other basic cations.

Secondly, the bulk of the applied P fertilizer is fixed and is rendered unavailable to plants. Thirdly, the use efficiency of applied micronutrients is also low due to their precipitation into insoluble forms. Because of these reactions, the use efficiency of applied fertilizer is low and 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. Foliar absorption is most effective when plants grow vigorously and the rate of absorption is generally higher in younger points of branches or stem tips (Mitsui 1967).

Foliar application of nutrients is feasible, economically viable and environmentally friendly approach of nutrient management. It is often the most effective and economical way to correct plant nutrient deficiencies at critical growth stages. Reports indicate that foliar application promoted root absorption of the same nutrient or other nutrients through improving root growth and increasing nutrients uptake (El-Fouly and El-Sayed, 1997). It has the advantage of low application rates, uniform distribution of fertilizer materials and quick response to applied nutrients. Therefore, keeping the above view the present investigation was planned to study the effect of different foliar treatments on growth and uptake of macro and micro nutrients by groundnut and post-harvest nutrient status in soil.

Materials and Methods

The field experiment was conducted during *kharif* season of 2017-18 at Post Graduate Research Farm, College of Agriculture, Kolhapur ($16^0$42’ N latitude, $74^0$14’ E longitude and 548 m AMSL) in sandy clay loam soil (57.90 % sand, 24.20 % silt and 17.90 % clay) containing available N (173 kg ha^{-1}), phosphorus (26.8 kg ha^{-1}), potassium (247 kg ha^{-1}), exchangeable calcium (20.8 cmol (p+) kg^{-1}) and magnesium (8.4 cmol (p+) kg^{-1}), available sulphur (10.9 mg kg^{-1}), available micronutrients Fe (4.92 mg kg^{-1}), Mn (3.19 mg kg^{-1}), Zn (1.10 mg kg^{-1}), Cu (2.04 mg kg^{-1}) and available boron (1.79 mg kg^{-1}).

The status of organic carbon content (0.47 %) was moderate. The soil reaction was slightly alkaline (pH 7.67) and EC was normal (0.23 dS m^{-1}). The total rainfall received during the period of field experiment was 1056.50 mm in 63 rainy days. The relative humidity during the crop period was in the range of 83.57 to 92.28 per cent at morning and 36.28 to 83.28 at evening. The minimum temperature varied from 12.5^0C to 22.81^0C, while maximum temperature was in the range of 25.95^0C to 34.10^0C. The evaporation during experimentation ranges between 0.8 to 7.84 mm hr^{-1}. The experiment was laid out in the randomized block design. The treatments consisted of seven foliar spray *viz;* absolute

control, GRD, GRD+water spray, GRD+19:19:19 spray (2 %), GRD+$Ca(NO_3)_2$ spray (2 %), GRD+Micro. gr.II (0.25 %) and GRD+Schoenite spray (1 %). The groundnut was sown on 28.06.2017 with a spacing 30 cm x 15 cm. After experimental layout FYM and gypsum was applied as per the treatments well in advance before dibbling of groundnut seeds and well mixed in surface soil. All the recommended dose of N and P_2O_5 (25:50 kg ha^{-1}) was applied to all treatments through Urea and Single Super Phosphate.

Nutrient content and uptake was measured at harvest and soil samples (0-15 cm) were collected after harvest. The total nitrogen was determined by Microkjeldhal method (Parkinson and Allen, 1975), phosphorus by Vanadomolybdate yellow method (Jackson, 1973), potassium by Flame photometry (Chapman and Pratt, 1961), exchangeable calcium and magnesium by Versenate titration method (Cheng and Bray, 1951), sulphur by Turbidimetry method (Tabatabai and Bremner 1970), micronutrients by Atomic absorption spectrophotometry (Zoroski and Burau, 1977) and boron by Azomethine-H method (John *et al.,* 1975). Collected soil samples were analyzed for pH using pH meter (1:2.5; soil: water) i.e., Potentiometry method (Jackson 1973), electrical conductivity (1:2.5; soil: water) by Conductometry method (Jackson 1973), organic carbon by Wet oxidation method (Nelson and Somners, 1982), available nitrogen by Alkaline permanganate method (Subbiah and Asija, 1956), phosphorus by Olsen method (Olsen and Dean 1965), potassium by Flame photometry method (Knudsen *et al.,* 1982), exchangeable calcium and magnesium by Versenate titration method (Page *et al.,* 1982), sulphur by Turbidimetry method (William and Steinberg, 1959), micronutrients by Atomic absorption spectrometry (Lindsay and Norvell, 1978) and boron by Azomethine-H method (John *et al.,* 1975).

Results and Discussion

Effect on growth parameters of groundnut

The growth parameters of groundnut *viz.*, the highest plant height (21.26 cm) was recorded by treatment 2 % foliar spray of $Ca(NO_3)_2$ which was at par with 2 % foliar spray of 19:19:19 (19.71 cm) and 0.25 % foliar spray of Micro. grade II (18.63 cm). The treatments with foliar spray of water and Schoenite (1 %) were at par with each other which were however significantly superior over GRD (17.23 cm) and absolute control (16.83 cm) (Table 1). The results are in close conformity with the observations recorded by Sarkar *et al.,* (1999) and Sarkar and Pal (2006), who also reported response of groundnut to the applied foliar nutrition.

The effect of foliar spray of fertilizers had recorded non-significant differences in number of nodules among treatments. The treatment foliar spray of 2 % $Ca(NO_3)_2$ recorded highest volume for number of nodules (95 $plant^{-1}$). The number of nodules ranged between 91-95 nodules $plant^{-1}$ respectively (Table 1). The results are in close proximity with the results obtained in groundnut by Mohan and Rao (1989).

Number of branches was observed to differ significantly due to foliar sprays of different fertilizers. Amongst the different foliar sprays treatment, 2 % $Ca(NO_3)_2$ spray had recorded significantly the highest number of branches (9.10) however, it was at par with 2 % 19:19:19 spray (8.43) and 0.25 % Micro. Grade II spray (7.88).

The lowest number of branches was recorded by the treatment GRD (6.88) followed by absolute control (5.83) (Table 1). The results are in close proximity by Sarkar and Pal (2006), who also reported response of groundnut to the applied foliar nutrition.

Table.1 Growth parameters of groundnut as influenced by different foliar treatments

Treatments	Plant height plant^{-1} (cm) 60 DAS	No. of nodules plant^{-1} 60 DAS	No. of branches plant^{-1}
T_1 - Absolute control	16.83	91	5.83
T_2 – GRD	17.23	92	6.88
T_3 – GRD + Water spray	17.73	93	7.11
T_4 – GRD + 19:19:19 spray of 2 %	19.71	95	8.43
T_5 – GRD + $Ca(NO_3)_2$ spray of 2 %	21.26	95	9.10
T_6 – GRD + Micro. grade II spray of 0.25 %	18.63	94	7.88
T_7 - GRD + Schoenite spray of 1 %	18.13	94	7.21
S.E. ±	0.863	4.6	0.497
CD at 5 %	2.658	NS	1.471

Table.2 Total macro nutrient uptake by groundnut crop at harvest as influenced by different foliar treatments

Treatments	Total nutrient uptake (kg ha^{-1})					
	N	P	K	Ca	Mg	S
T_1 – Absolute Control	79	12.16	53	45	45	14.77
T_2 – GRD	98	15.06	62	49	50	16.08
T_3 – GRD + Water spray	101	15.57	64	51	52	16.93
T_4 – GRD + 19:19:19 spray of 2 %	130	20.46	77	60	62	20.18
T_5 – GRD + $Ca(NO_3)_2$ spray of 2 %	142	23.33	82	63	65	21.90
T_6– GRD + Micro. gr. II spray of 0.25 %	119	18.78	71	55	56	18.26
T_7 – GRD + Schoenite spray of 1 %	110	17.03	67	53	54	17.79
S. E. ±	4.3	1.089	3.3	2.4	2.5	1.028
CD at 5 %	13.3	3.354	10.4	7.6	7.8	3.165

Table.3 Total micro nutrient uptake by groundnut crop at harvest as influenced by different foliar treatments

Treatments	Total nutrient uptake (g ha^{-1})				
	Fe	Mn	Zn	Cu	B
T_1 – Absolute Control	1661	484	174	112	34.9
T_2 – GRD	1903	554	212	130	44.9
T_3 – GRD + Water spray	1990	575	221	139	45.9
T_4 – GRD + 19:19:19 spray of 2 %	2452	701	279	174	59.5
T_5 – GRD + $Ca(NO_3)_2$ spray of 2 %	2621	748	302	190	64.9
T_6– GRD + Micro. gr. II spray of 0.25 %	2240	641	256	158	54.3
T_7 – GRD + Schoenite spray of 1 %	2074	607	238	147	50.0
S. E. ±	116.5	30.1	13.0	11.1	3.08
CD at 5 %	359.0	92.9	40.2	34.4	9.48

Table.4 Soil chemical properties and available nutrient status after harvest of crop as influenced by different foliar treatments

Treatments	pH	EC (dS m^{-1})	OC (%)	Available nutrients (kg ha^{-1})			Exchangeable nutrients (cmol (p+) kg^{-1})		S (mg kg^{-1})
				N	P	K	Ca	Mg	
T_1 – Absolute control	7.60	0.22	0.41	175	27.2	232	20.3	8.53	10.25
T_2 – GRD	7.62	0.23	0.43	177	29.1	236	20.9	8.63	10.35
T_3 – GRD + Water spray	7.63	0.23	0.44	178	29.1	239	21.1	8.70	10.48
T_4 – GRD + 19:19:19 spray of 2 %	7.68	0.25	0.49	182	30.5	247	22.1	9.80	10.78
T_5 – GRD + $Ca(NO_3)_2$ spray of 2 %	7.70	0.26	0.50	185	31.3	251	22.4	9.90	11.20
T_6 – GRD + Micro. grade II spray of 0.25 %	7.66	0.24	0.48	181	29.8	243	21.4	9.60	10.58
T_7 – GRD + Schoenite spray of 1 %	7.64	0.24	0.47	179	29.8	243	21.3	9.33	10.56
S.E. ±	0.254	0.014	0.029	8.4	1.52	15.9	1.17	0.469	0.541
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table.5 Micronutrient status after harvest of crop as influenced by different foliar treatments

Treatments	Micronutrients (mg kg^{-1})				
	Fe	Mn	Zn	Cu	B
T_1 – Absolute control	4.88	2.91	0.81	2.11	1.57
T_2 – GRD	4.97	2.95	0.92	2.13	1.68
T_3 – GRD + Water spray	5.02	3.00	0.93	2.22	1.73
T_4 – GRD + 19:19:19 spray of 2 %	5.09	3.18	1.06	2.36	2.10
T_5 – GRD + $Ca(NO_3)_2$ spray of 2 %	5.14	3.21	1.08	2.52	2.30
T_6 – GRD + Micro. grade II spray of 0.25 %	5.07	3.13	1.03	2.34	1.98
T_7 – GRD + Schoenite spray of 1 %	5.06	3.06	0.95	2.26	1.78
S.E. ±	0.325	0.214	0.078	0.134	0.151
CD at 5 %	NS	NS	NS	NS	NS

Effect on nutrient uptake by groundnut at harvest

The nutrient uptake is a function of biomass and nutrient concentration in plant. Higher nutrient uptake was reflected in higher biomass production and increased sink size. The highest uptake of nitrogen (142 kg ha^{-1}), phosphorus (23.33 kg ha^{-1}), potassium,(82 kg ha^{-1}), exchangeable calcium (63 kg ha^{-1}) and magnesium (65 kg ha^{-1}), sulphur (21.90 kg ha^{-1}), iron (2621 g ha^{-1}), manganese (748 g ha^{-1}), zinc (302 g ha^{-1}), copper (190 g ha^{-1}) and boron (64.9 g ha^{-1}) was recorded by the treatment foliar spray of 2 % $Ca(NO_3)_2$ which was at par with 2 % 19:19:19: spray and significantly superior over all other treatments (Table 2 and 3). The results are in close conformity with the observations recorded by Taylor *et al.,* (1985), Shelake *et al.,* (2011), Aslihan *et al.,* (2011), Nasef *et al.,* (2006) and Yildirim *et al.,* (2007) who also reported response of groundnut to different foliar sprays.

Foliar application resulted in greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Increased production of dry matter and its efficient translocation to the economic parts ultimately reflected on the final pod yield. The role of foliar application of nutrients on physiology of crop plants is well established.

Therefore, better availability and uptake of nutrients could be assigned as the proper reason for significant increase in dry matter production and its accumulation in foliar spray treatments. The similar observations were earlier recorded by Shivakumar Malladada (2005) and Dalei *et al.,* (2014). The accumulation of phosphorus was more because of foliar application of major nutrients which leads to increased absorption of nutrients. The greater mobilization of phosphorus in the presence of nitrogen may also be a reason for higher uptake of P as reported by Hocking and Pinkerton (1993) and Manasa (2013). Calcium is an essential element for growth of young tissues, roots and fruits and also nitrate can be directly available for plant and results in an increase of calcium uptake.

Effect on post-harvest soil status

The soil properties *viz*; pH, EC and organic carbon of soil after harvest of crop did not differ significantly due to different treatments of foliar spray.

The data revealed that the highest residual values of available nitrogen (185 kg ha^{-1}), phosphorus (31.3 kg ha^{-1}), potassium (251 kg ha^{-1}), exchangeable calcium (22.4 cmol (p+) kg^{-1}), magnesium (9.90 cmol (p+) kg^{-1}) and sulphur (11.20 mg kg^{-1}) and available micronutrients iron (5.14 mg kg^{-1}), manganese (3.21 mg kg^{-1}), zinc (1.08 mg kg^{-1}), copper (2.52 mg kg^{-1}) and boron (2.30 mg kg^{-1}) in the soil after the harvest of crop was recorded by treatment foliar spray of 2 % $Ca(NO_3)_2$ (Table 4 and 5). The crop growth also had favourable effect on the microbial activity resulting in higher values recorded by this treatment. The soil chemical properties after harvest of groundnut were not much more influenced by different foliar treatments.

From the above investigation it can be inferred that groundnut requires higher amount of nutrients during pegging and pod development stages. The foliar application of 2 % $Ca(NO_3)_2$ had recorded the highest uptake of total N, P, K, S and exchangeable Ca, Mg and micronutrients Fe, Mn, Zn, Cu and B content after harvest of groundnut crop. The available N, P, K, S and exchangeable Ca, Mg and micronutrients Fe, Mn, Zn, Cu and B content after harvest revealed no significant differences in nutrient content of soil after harvest.

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