Prevention and Correction of Zinc Deficiency of Groundnut in India

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INTRODUCTION

The groundnut (*Arachis hypogaea* L.) is an important legume food crop in India that is grown on about 8 m ha of land. The average productivity of groundnut in India is around 1300 kg ha^{-1} which used to be around 1000 kg ha^{-1} in the last decade. However, the demand of groundnut as oilseed and food crop is increasing. The low productivity in India is mainly due to the fact that the crop is mostly grown rain fed on dry lands and in semi-arid regions with low fertility and input management resulting in nutrient deficiencies particularly in Zn.

In India, about 50% of the groundnut soils show Zn deficiencies causing considerable yield losses (Singh 1999, Singh et al. 2004). Thus, pot and field studies on Zn were initiated at our institute about a decade ago. Some of the findings are summarized here.

METHODS

Pot and field experiments were conducted at the National Research Centre for Groundnut, Junagadh, India on a medium black, calcareous (21 % $CaCO_3$) soil with a pH of 7.8, 0.79 % organic carbon, and 0.51 mg kg^{-1} DTPA-extractable Zn. A basal dose of 30, 33 and 50 kg ha^{-1} of N, P and K, respectively, was mixed into the soil before sowing. The groundnut crop was grown under recommended practices, harvested at maturity. Pod and haulm yields, shelling percentage, percentage of sound mature seeds and 100-seed mass were recorded. The plant samples were analyzed for Zn using Atomic Absorption spectrophotometry (AAS).

Zn Requirement, Deficiency Symptoms and Yield Losses

A series of soil and sand culture pot experiments were conducted with various levels of Zn to determine Zn deficiency symptoms and the Zn levels best for growth and yield.

Micro-plot field experiments were conducted to establish sufficient and deficient Zn levels in plant and soils and the Zn requirements of commercial groundnut cultivars of India (Table1). Field experiments were also conducted to assess yield losses due to Zn deficiency in a calcareous soil with a DTPA-extractable Zn concentration of 0.51 mg kg^{-1}.

Comparison of Methods of Zn Application

Field experiments were conducted with two application modes (seed dressing and into soil in furrows) of Zn fertilizers $ZnCl_2$ and $ZnSO_4$ applied at 10 kg ha^{-1} (Table 2). The 2 kg ha^{-1} Zn (10 kg $ZnSO_4$) were applied to the soil in furrows, as foliar sprays (0.3% aqueous solution) and through drip irrigation (Feeding 0.5% aqueous solution through ventury) three times at 30, 50 and 70 DAS (Days after sowing).

RESULTS AND DISCUSSION

Zn Requirement, Deficiency and Yield Losses

The Zn deficiency in groundnut caused irregular mottling and yellow-ivory interveinal chlorosis in the upper leaves. Under severe deficiency, the entire leaflets became chlorotic. The wider strip of the leaflets differentiated Zn from Fe deficiency.

The micro-plot studies at various doses of Zn with four commercially grown groundnut cultivars revealed that the critical Zn level in the soil is 0.75 ppm for most cultivars. However, a significant yield increase was obtained by increasing soil Zn up to 1.18 ppm in GG 2 during both seasons and up to 1.41 ppm in ICGS 76 during the wet season (Table 1). In our earlier study, the critical Zn levels of the soil were between 0.5 and 0.7 ppm DTPA-extractable Zn (Singh 1999).

Zinc deficiency is the second most common deficiency after Fe-deficiency related chlorosis. In a field experiment, the yield losses due to deficient Zn were 13.3 to 20%. However, the application of 15 kg ha^{-1} $ZnSO_4$ increased pod yield by 41.6% compared to the control (Singh 1999).

Comparison of Methods of Zn Application

The effectiveness of soil and seed application of $ZnCl_2$ and $ZnSO_4$ were evaluated in the field where soil application showed a positive response with good germination and increased pod yield, pod number and oil content. However, both fertilizers were detrimental to groundnut seedlings when applied as seed dressing.

In another experiment, the application of Zn through drip irrigation increased chlorophyll content, pod numbers and yield. It also increased fertilizer-use efficiency and kept the soil loose for peg penetration and pod development. The drip irrigation application was superior over the other soil and foliar Zn applications (Table 2). The major advantages of Zn application with drip irrigation were precise application at appropriate times with desired concentration, uniform distribution, less damage to crop and soil and ultimately higher yield.

Table 1. Zinc concentration in the soil with respect to addition and corresponding pod yields of groundnut cultivars.

Zinc concentration (ppm)		Pod yield (kg ha^{-1})							
		Wet 2002				Dry 2003			
Zn Added	Soil Zn (mg kg^{-1})	GG2	JL24	ICGS76	GG20	GG2	JL24	ICGS76	GG20
0.2	0.51	1112	1390	1618	1600	1430	1471	1369	1371
0.4	0.65	1246	1672	1786	1850	1868	2023	1515	1602
0.6	0.75	1316	1790	1900	2056	2005	2140	2473	2155
0.8	1.18	1456	1864	2054	2018	2337	2162	2425	2209
1.0	1.41	1506	2026	2252	2050	2387	2077	2493	2301
LSD 0.05				110				140	

Table 2. Influence of Zn and Zn application methods of on the pod and haulm yields, shelling percent and 100-seed wt of groundnut variety GG 2.

Treatments	Pod yield (kg ha^{-1})		Haulm yield (kg ha^{-1})		Shelling (%)		100-seed wt (g)	
	RS	R	RS	R	RS	R	RS	R
T1-Control	2158	2329	3360	2567	65.1	63.4	35.0	34.2
T2-Zn, soil	2680 (24.2)	2503 (7.5)	3297	2767	65.8	65.4	37.9	35.9
T3-Zn, foliar	2342 (8.5)	2600 (11.6)	3638	3067	66.3	65.9	38.7	36.4
T4-Drip Water	2523 (16.9)	2521 (8.3)	3925	2900	71.3	65.1	40.2	38.2
T5-Zn, drip	2863 (32.6)	2816 (20.9)	3882	2967	74.3	66.7	41.1	36.5
LSD (0.05)	475	283	529	286	3.45	2.8	2.1	1.7

R is Rabi (Mid October to February) and RS is Rabi-summer crop (February to May). Figures in parentheses indicate percent increase over control

CONCLUSIONS

Soil application of 2 kg Zn ha^{-1} (10 kg $ZnSO_4$ ha^{-1}), basal or 50 % basal and 50 % at 30 days after emergence, is recommended for groundnuts in India. Zinc may be applied through drip irrigation in the areas wherever drip irrigation facility exists.

REFERENCES

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