The importance of Cu supplied at or before pegging for seed and pod yield of peanut on low Cu sand

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INTRODUCTION

Peanut (*Arachis hypogaea* L.) produces pods under ground after the pegs formed from fertilized flowers penetrate the soil. However, the mechanism of uptake and delivery of copper (Cu) into pods for seed development is still unknown. This hampers efforts to determine the optimum method, rate and time of application of Cu for peanut production. This study aimed to determine: (i) whether pods by themselves could absorb Cu from soil rather than rely on redistribution of Cu absorbed by roots; and (ii) effectiveness of Cu addition into soil before sowing relative to foliar spraying at flowering, pegging or podding.

METHODS

A low Cu sand (DPTA Cu: 0.17mg/kg) was collected from Lancelin, WA. Basal nutrients were applied as solutions to 10 kg aliquots of soil that had been air-dried, seived and throughly mixed. Basal fertilizers are applied at the following rates (mg/kg): KH_2PO_4 , 90.7; K_2SO_4, 174.3; $CaCl_2.2H_2O$, 98.0; $MnSO_4.4H_2O$, 14.7; $MgSO_4.7H_2O$, 23.3; H_3BO_3, 0.14; $CoSO_4.7H_2O$, 0.4 ; $Na_2MoO_4.2H_2O$, 0.2 [modified from Reuter et al. (1982)]. All nutrient solutions were prepared using analytical grade salts and the macronutrient solutions were purified in dithizone before use (Hewitt 1952).

The glasshouse experiment was conducted using peanut cv. Streeton with seven Cu treatments each with four replicates. The treatments were: T1: Control (no Cu); T2: spraying 10 mg Cu (~39.1mg $CuSO_4.5H_2O$)/L on leaves at start of flowering (30 DAS); T3: spraying 10 mg Cu/L on leaves at the start of pegging (50 days after sowing (DAS)); T4: spraying 10 mg Cu/L on leaves at the start of podding (70 DAS); T5: 1.3 mg $CuSO_4.5H_2O$ /kg to 9 kg of soil in the root zone (and none to the peg compartment) ; T6: 1.3 mg $CuSO_4.5H_2O$ /kg to 1 kg soil in the peg compartment (and none to the soil in the root zone); T7: 1.3 mg$CuSO_4.5H_2O$ /kg to soil in both the root and peg zone (mixed to all 10 kg of soil before sowing). Triple deionized water (TDW) was added to soil to reach field capacity (13 %, w/w) and was maintained daily.

RESULTS AND DISCUSSION

Application of Cu to the root zone soil produced the highest number of pegs (Table 1). Spraying Cu at flowering or pegging produced similar pod number to Cu applied at sowing to the root zone soil. By contrast, only Cu foliar application at flowering was as effective in producing the same pod weight as soil Cu application. Soil Cu application to the root zone and pod zone was required for maximum seed weight. Application of Cu to the pod zone only had no effect on peg number, pod number of the weights of pods and seeds (Table 1). Foliar application of Cu was most effective at flowering and pegging, but significantly less effective if delayed to podding stage.

Copper concentration in the young mature leaf was around 1.0 mg/kg in control soil, which is similar to where Cu was only applied in the pod compartment: both were Cu deficient (Nualsri 1977). By contrast, foliar spraying increased Cu in leaf to approximatly 2.0 mg/kg. However, even though applying Cu in soil increaed pod and seed weight, the concentration of Cu in the young mature leaf was 1.4 mg/kg which was not signigicantly different to the control. At harvesting time, the concentration of Cu in leaf was not significantly different among treatments (data not shown).

Table.1. Effect of Cu application methods and timing on plant Cu concnetrations, yield components and yield of peanut

Treatment	No of pegs/ plant	No of pods/ plant	Dry pod (g/ plant)	Dry seed weight (g/ plant)	Cu concentrat-ion (mg/kg) in leaf (podding -77 DAS)	Cu concentrat-ion (mg/kg) in seed (harvest -135 DAS)
Control	20.3 d	12.8 c	8.8 d	6.3 d	1.1 c	1.6 e
Cu spray at flowering	29.3 bc	21.3 ab	12.5 ab	9.0 b	1.9 a	2.5 cd
Cu spray at pegging	25.2 bcd	18.0 abc	11.8 bc	8.3 bc	1.8 a	2.9 bc
Cu spray at podding	23.0 cd	14.5 c	9.0 d	7.5 cd	2.0 a	3.8 a
Soil Cu application to roots only	32.0 ab	22.0 a	12.8 ab	8.5 bc	1.6 b	2.0 de (i)
Soil Cu application to pod only	24.8 bcd	15.8 bc	9.5 cd	6.8 d	1.0 c	1.5 e (ii)
Soil Cu application to root + pod	37.3 a	23.0 a	14.0 a	10.5 a	1.4 b	3.5 ab
LSD(0.05)	*7.9*	*5.6*	*2.0*	*1.3*	*0.29*	*0.75*

(i) Both in soil root zone and pod compartment have the same Cu concentration in seed
(ii) In root zone (no Cu added), Cu concentration of seed was 1.5 mg/kg; In the pod compartment (Cu added), Cu concentration of seed was 2.0 mg/kg

CONCLUSIONS

Application of Cu at 1.3 mg $CuSO_4.5H_2O$/kg soil increased peanut yield by 67 % on the low Cu sand. While applying Cu via foliar spraying improved peanut yield on deficient soil (increasing peanut yield by 43 %), its effectiveness was greatest at flowering and pegging and decreased with later spraying of Cu. Copper application into the pod compartment had no effect on leaf Cu or pod and seed weight but it did increase Cu concentration in seed (data not shown). This suggests that pod and seed development of peanut depends largely on Cu re-translocation from the root uptake of Cu rather than direct absorption from the soil through the pod wall. Re-translocation of leaf-applied Cu can also boost pod and seed Cu uptake and yield provided it is applied by the time of early pegging. Further studies are needed on the mobility of Cu within peanut plants and its implications for satisfying pod/ seed Cu requirements.

ACKNOWLEDGEMENTS

We are grateful to ACIAR for their contribution to provide funding for this research. We also acknowledge Dr Graeme Wright from the Peanut Company of Australia for supplying seeds and the rhizobium culture for this study.

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