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Efficacy of Organic acids on Groundnut (*Arachis hypogaea* L.) in Calcareous soils

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ABSTRACT

A potculture experiment was conducted at Agricultural college, Bapatla, Andhra Pradesh to study the'Efficacy of organic acids on groundnut in Calcareous soils" during kharif season of 2015-16. The soil was calcareous (collected from Vertisol profile), alkaline, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium. All the micronutrients except iron were sufficient in the soil with values above their critical limits. The treatments comprised of control (T_1); Ferrous sulphate ($FeSo_4.7H_2o$) @ 0.25% (T_2); citric acid @ 0.25% (T_3); acetic acid @ 0.25% (T_4); oxalic acid @ 0.125% (T_5); ascorbic acid @ 0.25% (T_6); hydroxyl amine hydrochloride (T_7) were replicated thrice in completely randomized design (CRD). Foliar application of organic acids were imposed to the respective pots at peak flowering, peg penetration and pod formation stage of the crop growth. The dry matter production and nutrient uptake of S and Fe was found to be higher in $FeSO_4.7H_2O$ @ 0.25% (T_2) imposed treatment, which was at par and followed by treatment supplied with citric acid @ 0.25% (T_3), significantly superior to control.

Key words: *Calcareous soils, organic acids, dry matter production, nutrient uptake.*

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INTRODUCTION

Groundnut is one of the most important oilseed crop; India occupies the first position in area and in second position with regards to production of groundnut in the world. In Indian oil seed scenario groundnut is the largest component and occupies 45 per cent of the total oil seeds area while contributing 55 per cent of total production. Calcareous soils cover over 30 per cent of the earth's land surface. Nutrient management in calcareous soils was quite differ from that in normal soils because of the effect of lime content and soil pH on soil nutrient availability and chemical reactions that affect the loss or fixation of nutrients. Root exudation of organic acid anions (e.g. citrate, malate, oxalate) is thought to represent one of the main strategies used by plants to enhance nutrient mobilization and acquisition under phosphorus and micronutrient limiting conditions. Organic acids have been shown to induce the dissolution of insoluble ferric oxyhydroxides in soil in the absence of plants, their ability to mobilize iron in a complex rhizosphere environment remains largely unknown.

MATERIALS AND METHODS

A potculture experiment was conducted to study the "Influence of organic acids in amelioration of iron chlorosis in groundnut (*Arachis hypogaea* L.)" during *kharif*, 2015 at Agricultural College, Bapatla. The experiment comprised of seven treatments *viz*., control (recommended dose of fertilizer only) (T_1); $FeSO_4.7H_2O$ @ 0.25% (T_2); citric acid @ 0.25% (T_3); acetic acid @ 0.25% (T_4); oxalic acid @ 0.125% (T_5); ascorbic acid @ 0.25% (T_6) and hydroxyl amine hydrochloride (T_7) laid in CRD with three replications. The soil was calcareous (collected from Vertisol profile), alkaline, low in organic carbon (0.45%), available nitrogen (196 kg ha^{-1}), medium in available P_2O_5 (14.49 kg ha^{-1}), high in available K_2O (520.01 kg ha^{-1}) and sufficient in all micro nutrients except iron. Foliar application of organic acids were applied to the respective pots at immediately after noticing the iron chlorosis, peg penetration and pod formation stage of the crop growth. Entire phosphorus was applied as basal dose in the form of single super phosphate, nitrogen and potassium were applied in 3 and 2 splits, respectively in the form of urea and muriate of potash as per the recommended dose. The representative plant samples were collected at

different growth stages of crop during the month of August 2015. The dry matter production was measured from the mean of five plants taken from the each treatment. The samples were shade dried, followed by hot air oven at 60 ^{0}C. Then the dry weights were recorded and expressed in g pot^{-1}. The uptake of nutrients at different growth stages of crop was worked out by using the following formulae. Macronutrients uptake was expressed as mg pot^{-1} and micronutrient uptake was expressed in µg pot^{-1}.
Macronutrient Uptake (mg pot^{-1}) =

$$\frac{\text{Nutrient concentration (\%)} \times \text{Dry matter yield (g /pot)}}{100} \times 1000$$

Micronutrient Uptake (µg pot^{-1}) = Nutrient concentration (ppm) × Dry matter yield (g pot^{-1})

Fisher's method of analysis of variance was followed for analysis and interpretation of the data as suggested by Panse and Sukhatme (1978). The level of significance used in 'F' test at 0.05 level of probability was worked out for significance. The data presented in the respective tables are the mean values of three replications at different crop growth stages.

RESULTS AND DISCUSSION

Dry matter Production

The dry matter production (Table 1) at flowering stage ranged from 16.27 to 27.76 g pot^{-1} in control and $FeSO_4.7H_2O$ @ 0.25%, respectively. The highest (27.76 g pot^{-1}) dry matter production was observed in T_2, which received with $FeSO_4.7H_2O$ @ 0.25% followed by T_3- 20.41 g pot^{-1} (citric acid @ 0.25%). The treatment (T_3) citric acid @ 0.25% which was on a par with ascorbic acid @ 0.25% (T_6-18.64 g pot^{-1}) and both were significantly superior to control. Among organic acids used as foliar spray, citric acid @ 0.25% (T_3) recorded highest dry matter production when compared to remaining treatments except $FeSO_4.7H_2O$ @ 0.25% (T_2). The dry matter production at peg penetration stage ranged from 32.73 to 44.28 g pot^{-1}. The highest (44.28 g pot^{-1}) dry matter production was observed in T_2 ($FeSO_4.7H_2O$ @ 0.25%), which was statistically on a par with treatments supplied with citric acid @ 0.25% (T_3- 41.11 g pot^{-1}) and were significantly superior to control.

Pod Yield

Pod yield (Table 1) was significantly influenced by all the treatments. Pod yield ranged from 24.86 to 33.51 g pot^{-1}. The highest pod yield of 33.51 g pot^{-1} was recorded with the application of $FeSO_4.7H_2O$ @ 0.25% (T_2) followed by acetic acid @ 0.25% (T_4- 29.45 g pot^{-1}). The treatment T_4 which was on a par with T_3 (citric acid @ 0.25%) and T_3 which was on a par with T_6 (ascorbic acid @ 0.25%), T5 (oxalic acid @ 0.125%) and T_7 (hydroxyl amine hydrochloride @ 0.25%) while significantly lowest pod yield of 24.86 g pot^{-1} was recorded in control (T_1). These results were in accordance with Singh and Dayal (1992).
Organic acids were found to be significant in increasing pod yield over control. Tiffin (1967) reported that negatively charged Fe-containing compounds were essential for efficient iron movement through the xylem and citrate is the natural carrier of iron. These organic acids have an impact on many aspects of the physiology of iron deficient plants including excretion from roots and to supply the ferric chelate reductase enzymes with enough reducing power. This mechanism could be very important for plants growing in calcareous soils where an absolute Fe- deficiency doesn't takes place in presence of bicarbonate ion which is common in these soil conditions.

Haulm Yield

The results indicated that haulm yield (Table 1) ranged from 31.24 to 42.47 g pot^{-1}. The highest haulm yield was observed in the treatment T_2 (42.47 g pot^{-1}) followed by T_3 (37.19 g pot^{-1}), while T_3 was on a par with T_4 treatment and T_4 was on a par with T_6. The lowest haulm yield was observed in treatment received with oxalic acid @ 0.125% (31.24 g pot^{-1}).
Biological yield of groundnut at all the stages of the crop growth was increased from flowering to harvest. Timely availability of nitrogen from inorganic source and less subjected to losses might have increased the photosynthetic surface, greater chlorophyll content, enhanced intermodal length contributed to larger dry matter accumulation and better crop growth. Significantly higher dry matter was recorded with the treatment received foliar application of $FeSO_4.7H_2O$ @ 0.25% (T_2). These results were in confirmation with Ramireddy and Basavaraj (2012).

Nutrient uptake

Sulphur

The data pertaining to uptake of sulphur presented in table 2 revealed a significant influence of treatments on sulphur uptake. At flowering and peg penetration the uptake varied from 43.93 to 97.16

and 72.01 to 119.56 mg pot^{-1}, respectively. The highest sulphur uptake was recorded by the treatment which received with $FeSO_4.7H_2O$ @ 0.25% and significantly superior to remaining treatments at flowering stage. At peg penetration stage the highest uptake (119.56 mg pot^{-1}) of sulphur was noticed in treatment supplied $FeSO_4.7H_2O$ @ 0.25% which was superior to rest of treatments and control. The treatments T_5 (oxalic acid @ 0.125%), T_6 (ascorbic acid @ 0.25%) and T_3 (citric acid @ 0.25%) which were on a par with each oher.

The sulphur uptake at harvest by pod and haulm was significantly lower in control (T_1-Recommended Dose of Fertilizer) 132.80 & 57.18 mg pot^{-1} respectively, while higher was recorded in the pots supplied with $FeSO_4.7H_2O$ @ 0.25% (T_2-216.60 & 110.58 mg pot^{-1}) followed by citric acid @ 0.25% (167.36 & 81.75 mg pot^{-1}). In pod, the treatment received with citric acid @ 0.25% was at par with treatments supplied with acetic acid @ 0.25% (160.51) and ascorbic acid @ 0.25% (160.27 mg pot^{-1}). While, in haulm, foliar spray of citric acid @ 0.25% (T_3-81.75 mg pot^{-1}) was on a par with ascorbic acid @ 0.25% (T_6-75.43 mg pot^{-1}), acetic acid @ 0.25% (73.63 mg pot^{-1}) and oxalic acid @ 0.125% (T_5-71.65 mg pot^{-1}) treated pots. Inspite of lower sulphur content in plant, $FeSO_4.7H_2O$ @ 0.25% treatment recorded higher sulphur uptake due to higher dry matter production. Application of organic acids have significant increase in sulphur uptake among the treatment when compare to control.

Iron

The data pertaining to iron (Table 3) revealed a significant influence by imposed treatments. All the treatments supplied with foliar application of organic acids were significantly superior to control and plants treated with $FeSO_4.7H_2O$ @ 0.25% (T_2) at all the stages of the crop growth significantly influence the iron uptake. At flowering and peg penetration, the highest values (876.38 and 1846.51 μg pot^{-1} respectively) were noticed in T_2 while the lowest (492.33 and 1185.17 μg pot^{-1}) was in control (T_1). The iron uptake at harvest by pod and haulm was significantly higher (679.87 and 1206.92 μg pot^{-1}, respectively) in T_2 and lowest (438.91 and 788.50 μg pot^{-1}, respectively) was in control. The highest uptake was recorded in the pots treated with $FeSO_4.7H_2O$ @ 0.25% (T_2) might be due to the higher dry matter content.

In general the uptake of iron was increased considerably with foliar application of organic acids that showed the importance of organic acids in influencing the plants ability in absorption and translocation of nutrients. The increase in the uptake of cationic micronutrients with application organic acids might be due to release of micronutrients on mineralization and production of organic acids during their decomposition which aids in solubilisation of insoluble micronutrient compounds in soil due to supply of natural chelating agents which made it more available (Jokar and Ronaghi, 2015). On the whole, the critical study of the data related to nutrient content and uptake revealed favourable effect of organic acids on concentration and uptake of nutrients which might have resulted in augmenting protein content of the pod, thus improved the overall quality of the pod and haulm.

Table 1: Dry matter production (g pot $^{-1}$) of groundnut as influenced by different organic acids at different growth stages

Treatments	Flowering	Peg penetration	Harvesting	
			Pod yield	Haulm yield
T_1 : Control (Recommended Dose of Fertilizers only)	16.27	32.73	24.86	31.62
T_2 : $FeSO_4.7H_2O$ @ 0.25%	27.76	44.28	33.51	42.47
T_3 : Citric acid @ 0.25%	20.41	41.11	28.19	37.19
T_4 : Acetic acid @ 0.25%	18.32	40.51	29.45	36.48
T_5 : Oxalic acid @ 0.125%	17.58	40.09	25.59	31.24
T_6 : Ascorbic acid @ 0.25%	18.64	40.15	26.01	34.10
T_7 : Hydroxyl amine hydrochloride @ 0.25%	17.04	37.05	25.58	33.46
SEm±	0.63	1.33	0.88	1.14
CD (0.05)	1.89	3.99	2.64	3.42
CV (%)	5.60	5.82	5.49	5.61

Table 2 : Influence of organic acids on uptake of sulphur (mg pot^{-1}) by groundnut at different growth stages

Treatments	Flowering	Peg penetration	Harvest	
			Pod	Haulm
T_1 : Control (Recommended Dose of Fertilizer only)	43.93	72.01	132.80	57.18
T_2 : $FeSO_4.7H_2O$ @ 0.25%	97.16	119.56	216.60	110.58
T_3 : Citric acid @ 0.25%	59.19	98.66	167.36	81.75
T_4 : Acetic acid @ 0.25%	51.30	93.17	160.51	73.63
T_5 : Oxalic acid @ 0.125%	54.50	104.23	143.70	71.65
T_6 : Ascorbic acid @ 0.25%	61.51	100.38	160.27	75.43
T_7 : Hydroxyl amine hydrochloride @ 0.25%	46.01	81.51	147.22	63.95
SEm±	3.36	4.53	5.69	3.89
CD @ 0.05	10.18	13.74	17.26	11.80
CV (%)	5.84	5.20	6.11	5.63

Table 3 :Influence of organic acids on uptake of iron (µg pot^{-1}) by groundnut at different growth stages

Treatments	Flowering	Peg penetration	Harvest	
			Pod	Haulm
T_1 : Control (Recommended Dose of Fertilizer only)	492.33	1185.17	438.91	788.50
T_2 : $FeSO_4.7H_2O$ @ 0.25%	876.38	1846.51	679.87	1206.92
T_3 : Citric acid @ 0.25%	625.88	1733.90	639.97	1144.63
T_4 : Acetic acid @ 0.25%	573.89	1677.38	756.19	1217.07
T_5 : Oxalic acid @ 0.125%	528.82	1651.30	566.27	938.35
T_6 : Ascorbic acid @ 0.25%	565.44	1705.61	562.45	987.04
T_7 : Hydroxyl amine hydrochloride @ 0.25%	526.65	1563.87	629.07	1085.53
SEm±	19.58	28.41	25.41	26.67
CD @ 0.05	59.40	86.19	77.02	80.90
CV (%)	5.67	6.03	6.21	5.39

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