International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 887-889

Received: 21-09-2018
Accepted: 24-10-2018

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Ameliorative effect of organic acids spraying in groundnut on physico - chemical characteristics of calcareous soils

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Abstract
Results of Ameliorative effect of organic acids spraying in groundnut on physico - chemical characteristics of calcareous soils have been discussed. A potculture experiment was conducted in Agricultural College, Bapatla, Andhra Pradesh during *kharif* 2015-16. The experimental soil was calcareous (collected from Vertisol profile), alkaline reaction and low in organic carbon. The treatments comprised of control (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); hydroxyl amine hydrochloride (T_7) were replicated thrice in completely randomized design (CRD) with three replications. Foliar application of organic acids were applied to the respective pots at peak flowering, peg penetration and pod formation stage of the crop growth. The results showed that pH was markedly influenced by the imposed treatments but no significant effect on electrical conductivity (EC), soil organic carbon and cation exchange capacity (CEC), but slight increment was noticed in organic acids treated pots over control.

Keywords: organic acids, groundnut, physico- chemical properties, calcareous soils

Introduction
Calcareous soils cover over 30 per cent of the earth's land surface. Nutrient management in calcareous soils differ from that in non-calcareous soils because of the effect of soil pH on soil nutrient availability and chemical reactions that affect the loss or fixation of almost all nutrients. Iron deficiency is common in soils that have a high $CaCO_3$ due to reduced solubility at alkaline pH values. Root exudation of organic acid anions (e.g. citrate, malate, and 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. As the pH increased to 6.5 soluble ferrous iron (Fe^{2+}) tended to become oxidized to ferric iron (Fe^{3+}), which being insoluble under normal and alkaline conditions led to iron deficiency? The soluble iron level reached a minimum in pH range between 6.5 and 8.0 (Lindsay, 1972) [2].

Material and Methods
The representative soil samples up to 15 cm depth were collected during the month of August 2015. Soil pH was determined in 1:2.5 (soil: water) suspension using a pH meter (Jackson, 1973) [1]. Electrical conductivity was determined using conductivity meter in the supernatant solution used for pH measurement (Jackson, 1973) [1]. Organic carbon was estimated by Walkey and Black's wet oxidation method by knowing amount of chromic acid used to oxidize the organic matter in finely ground soil using sulphuric acid as a source of heat through heat of dilution and by titrating the unused chromic acid against ferrous ammonium sulphate using diphenylamine as indicator. The procedure followed as described by Jackson (1967). The adsorbed cations on the exchange complex are displaced with sodium acetate (NaOAc) by leaching the soil with NaOAc solution. The excess of NaOAc is removed by washing the soil with isopropyl alcohol. Further, the adsorbed sodium on the soil is replaced by treating the soil with neutral normal ammonium acetate (NH_4OAc) and the displaced Na in the leachate is measured by flame photometer. The amount of Na measured is an index of CEC of the soil. The procedure followed as described by Richards (1954) [5].

Results and Discussion

Physico-chemical Properties

The data presented in the table 1 revealed that there was significant difference in soil pH among the treatments at all stages of crop growth. However slight reduction in the pH was observed in soils supplied with foliar application of organic acids. At flowering stage pH values ranged from 8.08 which was recorded in the control pot to 7.83 recorded in T_5 (oxalic acid @ 0.125%) which was on par with T_4 (acetic acid @0.25%). Treatments supplied with foliar spray (T_3 and T_6) were at par with each other and significantly superior to the treatments supplied with hydroxyl amine hydrochloride, $FeSO_4.7H_2O$ and control. At peg penetration stage the lowest pH value (7.81) was found in the treatment supplied with oxalic acid @ 0.125% which was at par with the treatments were received by acetic acid @ 0.25%, citric acid @ 0.25% and ascorbic acid @0.25 treated pots. The highest value (8.08) was found in control. At harvest stage of the crop growth numerically lowest pH value (7.80) was in T_5 (oxalic acid @ 0.125 %). The treatments T_4 (acetic acid @0.25%), T_3 (citric acid @ 0.25%) and T_6 (ascorbic acid @ 0.25 %) which were on par with each other and significantly superior to rest of the treatments. The highest was observed in control (8.09). Among the treatments, lowest pH (7.83, 7.81 and 7.80) has recorded in treatment receiving oxalic acid @ 0.125% at flowering, peg penetration and harvesting stages of crop growth. This might be due to acid sprays which reduced pH of soil (Zhou *et al*., 2003. Yuan *et al*., 2007. Ramireddy and Basavaraj, 2012 and Najafi and Jalali, 2015) [3, 4, 7, 8].

Table 1: Influence of organic acids on soil pH at different growth stages of groundnut

Treatments	pH		
	Flowering	Peg penetration	Harvesting
T_1 : Control (Recommended Dose of Fertilizers only)	8.08	8.08	8.09
T_2 : $FeSO_4.7H_2O$ @ 0.25%	7.99	7.96	7.95
T_3 : Citric acid @ 0.25%	7.86	7.83	7.81
T_4 : Acetic acid @ 0.25%	7.84	7.82	7.81
T_5 : Oxalic acid @ 0.125%	7.83	7.81	7.80
T_6 : Ascorbic acid @ 0.25%	7.91	7.89	7.87
T_7 : Hydroxyl amine hydrochloride @ 0.25%	7.96	7.93	7.92
SEm±	0.05	0.06	0.06
CD @ 0.05	0.15	0.17	0.18
CV (%)	1.06	1.21	1.29
Initial	8.08		

The data presented in table 2 indicated that EC of soil at flowering, peg penetration and harvesting stage of the crop growth was not significantly influenced with the treatments imposed. But there was a marginal increase in the EC in soils treated with foliar application of organic acids. At flowering, peg penetration stage of crop growth EC was ranged from 0.39, 0.41 dsm^{-1} in control to 0.42, 0.43 dsm^{-1} in treatment that received oxalic acid @ 0.125% (T_5). At harvest EC was ranged from 0.40 dsm^{-1} in control to 0.42 dsm^{-1} in treatment that received acetic acid @ 0.25% (T_4). However, there was no significance difference among the treatments. The non-significant influence could be due to non-saline nature of organic acids.

Table 2: Influence of organic acids on soil EC (dsm^{-1}) at different growth stages of groundnut

Treatments	EC (dsm^{-1})		
	Flowering	Peg penetration	Harvesting
T_1 : Control (Recommended Dose of Fertilizers only)	0.39	0.41	0.40
T_2 : $FeSO_4.7H_2O$ @ 0.25%	0.40	0.41	0.41
T_3 : Citric acid @ 0.25%	0.41	0.40	0.40
T_4 : Acetic acid @ 0.25%	0.41	0.43	0.42
T_5 : Oxalic acid @ 0.125%	0.42	0.43	0.40
T_6 : Ascorbic acid @ 0.25%	0.41	0.42	0.41
T_7 : Hydroxyl amine hydrochloride @ 0.25%	0.39	0.41	0.41
SEm±	0.01	0.01	0.01
CD @ 0.05	NS	NS	NS
CV (%)	2.73	2.79	2.44
Initial	0.38		

The data pertaining to cation exchange capacity (CEC) of soils at harvest stage of crop growth are presented in table 3. At harvest CEC ranged from 67.12 (cmol (p^+) kg^{-1}) in control to 69.45 (cmol (p^+) kg^{-1}) in treatment that received ascorbic acid @ 0.25% (T_6). However, there was no significant difference in CEC among the treatments at harvest stage of the crop growth and a marginal increment in the CEC was observed in the soils treated with foliar application of organic acids.

Table 3: Influence of organic acids on Cation exchange capacity of soil at harvest stage of groundnut

Treatments	Cation exchange capacity (cmol(p^+) kg^{-1})
T_1 : Control (Recommended Dose of Fertilizers only)	67.12
T_2 : $FeSO_4.7H_2O$ @ 0.25%	68.49
T_3 : Citric acid @ 0.25%	69.07
T_4 : Acetic acid @ 0.25%	67.66

T_5 : Oxalic acid @ 0.125%	67.37
T_6 : Ascorbic acid @ 0.25%	69.45
T_7 : Hydroxyl amine hydrochloride @ 0.25%	68.14
SEm±	2.23
CD @ 0.05	NS
CV (%)	5.67
Initial	36.21

The data in table 4 indicated that soil organic carbon of soil at harvest stage of crop growth was not significantly influenced with the treatments imposed. However there was a slight increment in soil organic carbon in the soils treated with foliar application of organic acids. At harvest stage, slight increment in soil organic carbon was noticed in soils treated with foliar application of organic acids ranged from 0.47% in control to 0.49% in treatments that received citric acid @ 0.25% (T_3), ascorbic acid (T_6) followed by acetic acid @ 0.25% (T_3) & hydroxyl amine hydrochloride @ 0.25% (T_7) treated pots. The lowest soil organic carbon was observed in the soils treated recomended doses of fertilizers only.

Table 4: Influence of organic acids on soil organic carbon (%) at harvest stage of groundnut

Treatments	Organic carbon (%)
T_1 : Control (Recommended Dose of Fertilizers only)	0.47
T_2 : $FeSO_4.7H_2O$ @ 0.25%	0.47
T_3 : Citric acid @ 0.25%	0.49
T_4 : Acetic acid @ 0.25%	0.48
T_5 : Oxalic acid @ 0.125%	0.47
T_6 : Ascorbic acid @ 0.25%	0.49
T_7 : Hydroxyl amine hydrochloride @ 0.25%	0.48
SEm±	0.01
CD @ 0.05	NS
CV (%)	5.59
Initial	0.45

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