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The Influence of Organic Manures on Zinc Availability in Saline Soils

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ABSTRACT: In Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti, an incubation experiment performed to investigate the upshot of manures on zinc availability in saline soils. In this study, $ZnSO_4.7H_2O$ @ 25 kg ha^{-1} were incubated with FYM, vermicompost, coir-pith, and poultry manure for one month before application in a completely randomised design with ten treatments and three replications (CRD). At 15 days interval after incubation the soil samples were collected, i.e. 0, 15, 30, 45, and 60 days and examined for zinc. 1:20 ratio of $ZnSO_4$ and vermicompost (T6) resulted in increased iron release throughout the incubation period compared to that of control. Zinc release varied from 0.60 mg kg^{-1} to 0.79 mg kg^{-1} in this treatment. Increased release of Zinc at the proportion of 1:20 $ZnSO_4$ to vermicompost, followed by poultry manure, FYM, and coir pith application.

Keywords: Organic manures, $ZnSO_4$, saline soil, FYM, Poultry manure, Coir pith.

INTRODUCTION

Zinc deficiency is a serious issue in wet land soil conditions. Zinc can be found in soil in a wide range of chemical forms, including ionic or organically complexed in soil solution, on exchange sites of reactive soil components, complexed with organic matter, occluded in oxides and hydroxides of Al, Fe, and Mn, and entrapped in primary and secondary minerals. Zinc in soluble organic complexes and exchange positions are crucial to preserving a zinc level sufficient for wetland conditions (Singh and Umashankar 2018). In arid to sub humid regions, saline soils are typically formed from basic rocks. The majority of black soils derived from trap basalt, lime stone and sand stone in Thoothukudi region are saline in nature. Salinity is a distinctive soil characteristic that influences physicochemical properties, nutrient availability, and plant growth.

There are number of interaction reactions between free and native lime as well as added plant nutrients, which eventually pave way for micronutrient deficiency in crops. The higher concentration of soluble salts (Cl^-, SO_4^-, Mg^{++}, Ca^{++} and Na^+) in saline soil led to the zinc deficiency. As a result, there is necessitating for comprehensive research in genesis, development, classification, and extent of salinity.

The high pH conditions and high calcium concentration in most saline soils are to held responsible for the low availability of zinc and fixation is rate higher declining crop growth and yield in such soils (Alloway, 2004). In saline soils with high pH, zinc deficiencies and zinc precipitation occur as insoluble amorphous soil zinc and/or $ZnSiO_4$, minimising available zinc in soil. Surface adsorption of zinc on $CaCO_3$ may perhaps also decrease the quantity of zinc in solution. Clay mineral adsorption of Zn, sesquioxides, organic matter, and $CaCO_3$ increase with increase in pH. Releasing pattern and availability of zinc content from soluble salts can be enhanced with application of organic matter in saline soil (Chidananadappa, 2003).

SOM content is one of the most variable pedosphere properties, ranging from 0.2% in salt-affected sandy soils of arid and semi-arid climate zones to > 99% in highly organic Histosols from uplands in humid and boreal climates of the Northern hemisphere (Ondrasek and Rengel, 2012). SOM account for only a small fraction (1-4%) of cultivated top soils, but it is one of the most complex, dynamic, and multifunctional soil components.

Zinc can be found in diverse of chemical forms in soil. The contributions of various forms of zinc to the available pool differ considerably based on the physical and chemical properties of soils. Its solubility in soil solution is governed by a number of factors that interact. Several equilibria competing reactions, including solution, complexation, precipitation, and occlusion by the solid-solution phase matrix will be affected by variables. As a consequence, effective zinc management is vital for sustaining crop productivity and keeping a healthy nutrient balance in soils. When Zn is supplied as zinc sulphate, it is converted to Zn(OH) and $Zn(OH)_2$ at pH 7.7 and 9.0, $ZnCO_3$ in alkali soils, zinc phosphate in high phosphorus applications, and zinc sulphide in reduced conditions (Suganya *et al.*, 2020).

Zinc supplementation plays a critical role in rescuing the plant from zinc deficiency (Suganya *et al.*, 2015). Mineralization occurs in a slow face naturally, addition of organic materials tends to enhance the mineralization process fastly paving way for availability of nutrients at the effective crop demand period that boost the growth, development and quality of edible produce. Soil organic matter is an important secondary source of trace elements. Most micronutrients are enfolded in complex organic compounds and may be inaccessible to plants. However, as organic matter decomposes, they became a valuable source of micronutrients which are gradually released into available forms of plant nutrients (Choudhary *et al.,* 2008).

Zinc which is proned to higher fixation rate is reduced scene organic matter decomposition secrets organic and inorganic acids that alters the pH as well as comprises of ions that tends to bind with fixation site resulting in high availability of zinc for crop uptake (Lekasi *et al.,* 2005).

MATERIAL AND METHODS

The current study, titled Influence of different manures on periodic availability of zinc in saline soil, was conducted in Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti during Rabi season in the year 2018. A farmer's field in Karisalkulam Village, Kovilpatti block, Thoothukudi district, the surface soil sample (0-15 cm depth) were collected. As per the treatment of $ZnSO_4.7H_2O$ incubated with FYM, vermicompost, poultry manure and coir pith for 1 month before application in required quantity.

Table 1 lists the chemical properties of organic manures. The experimental soil had a clay texture and a pH of 8.1, an EC of 0.19 dSm^{-1}, organic carbon of 4.7 g kg^{-1}, $CaCO_3$ equivalent 14.2 per cent, available nitrogen of 142 kg ha^{-1}, available phosphorus of 6.29 kg ha^{-1}, available potassium of 483 kg ha^{-1}, and DTPA extractable Zn, Fe, Mn, and Cu of 0.51 mg kg^{-1}, 3.2 mg kg^{-1}, 9.12 mg kg^{-1}, and 6.64 mg kg^{-1}. Periodically after incubation at 15 days interval, soil samples were collected, i.e. 0, 15, 30, 45, and 60 days and analysed for zinc content. The discard method was used for the incubation study.

Table 1: Organic manures analysis.

Sr. No.	Parameters	FYM	Vermicompost	Coir-pith	Poultry manure
1.	pH	8.15	7.54	7.9	8.2
2.	EC dSm^{-1}	2.27	2.53	1.5	2.14
3.	OC %	19.75	24.46	12.89	15.1
4.	N %	1.29	1.82	1.12	3.89
5.	P %	0.23	0.45	0.26	2.13
6.	K %	0.21	0.42	0.18	3.41
7.	Fe (mg kg^{-1})	2485	2670	2464	1436
8.	Zn (mg kg^{-1})	267.3	410	308	573
9.	Mn(mg kg^{-1})	212	497	266	538
10.	Cu (mg kg^{-1})	57.3	187	109	165
11.	C:N	15.31	13.44	11.51	7:1

Discard method: The plastic containers are filled with 120 grams of soil along with the proposed ratio of organics and zinc sulphate as per treatment schedule. The experimental design comprises of 10 treatments which is replicated thrice making a total of 30 incubating medium. Totally 150 were made since the sampled containers were discarded at every sampling intervals (0, 15, 30, 45 and 60 days). The entire setup was made to incubate for a period of 60 days in room temperature. The releasing partten was estimated from the discarded samples collected during 0, 15, 30, 45 and 60 days after preparation of the incubating medium

The experiment was designed in a completely randomised Design (CRD).

The soil samples were analysed for pH, EC, available nutrients and micronutrients by following the standard procedures furnished in Table 2. The treatment comprises *viz.,*

The results were statistically analysed and appropriately interpreted using Panse and Sukhatme's method (1985).

T_1 : Absolute control
T_2 : Zinc sulphate (25 kg ha^{-1})
T_3 : 1 : 10 ratio of $ZnSO_4$ and FYM
T_4 : 1 : 20 ratio of $ZnSO_4$ and FYM
T_5 : 1 : 10 ratio of $ZnSO_4$ and Vermicompost
T_6 : 1 : 20 ratio of $ZnSO_4$ and Vermicompost
T_7 : 1 : 10 ratio of $ZnSO_4$ and Coir-pith
T_8 : 1 : 20 ratio of $ZnSO_4$ and Coir-pith
T_9 : 1 : 10 ratio of $ZnSO_4$ and Poultry manure
T_{10} : 1 : 20 ratio of $ZnSO_4$ and Poultry manure

Table 2: Methods of analysis of soil samples.

Sr. No.	Analyses	Method	Reference
Physico-chemical properties			
1.	Soil reaction (pH)	Potentiometry (soil-water suspension of 1:2 ratio)	Jackson (1973)
2.	Electrical Conductivity (EC)	Conductometry (soil- water suspension of 1:2 ratio)	Jackson (1973)
Chemical properties			
1.	Soil Organic Carbon	Chromic acid wet digestion method	Walkley and Black (1934)
2.	Available Nitrogen	Alkaline permanganate method	Subbiah and Asija (1956)
3.	Available Phosphorus	0.5 M $NaHCO_3$	Watanabe and Olsen (1965)
4.	Available Potassium	Neutral Normal NH_4OAC method	Standford and English (1949)
5.	Available Fe, Zn, Mn and Cu	DTPA extraction (ICP-OES)	Lindsay and Norvell (1978)

RESULT AND DISCUSSION

A. Influence of different treatments on release of Zinc in saline soil

Table 3 summaries the data on zinc release influenced by different treatments in saline soil. $ZnSO_4.7H_2O$ @ 25 kg ha^{-1} enriched with vermicompost (T_6) application at a ratio of 1:20 resulted in the highest available zinc of 3.52 mg kg^{-1}, followed by T_5 (1:10 ratio of $ZnSO_4.7H_2O$ and Vermicompost) and Vermicompost (3.31 mg kg^{-1}) and T_{10} (1:20 ratio of $ZnSO_4$ and Poultry manure - 3.28 mg kg^{-1}).

The application of $ZnSO_4.7H_2O$ @ 25 kg ha^{-1} in conjunction with FYM, vermicompost, coir pith, and poultry manure could significantly increase zinc release compared to that of control. The zinc release pattern in saline soil disclosed that treatment T_6 ($ZnSO_4.7H_2O$ @ 25 kg ha^{-1} and vermicompost at a 1:20 ratio) released significantly more zinc (0.60 mg kg^{-1}) than the control. Nevertheless, at 0 days of incubation, zinc release was exactly equivalent to T_5 (0.59 mg kg^{-1}), T_{10} (0.58 mg kg^{-1}), and T_9 (0.57 mg kg^{-1}). The application of zinc with manures ultimately results in a progressive increase in zinc release in saline soil. The zinc release varied from 0.60 mg kg^{-1} to 0.79 mg kg^{-1}. This zinc release, however, was comparable to a treatment in which $ZnSO_4.7H_2O$ @ 25 kg ha^{-1} was applied in conjunction with vermicompost, press mud cake, and FYM. However, increased release of zinc was substantially larger in all the treatment combinations than in T_9 and T_1. This data revealed that applying $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} in accordance with fresh cow dung slurry, vermicompost, FYM, coir pith, and poultry manure was effective in terms of zinc release in saline soil. The zinc release ranged from 0.60 mg kg^{-1} to 0.79 mg kg^{-1}. This could be attributed to the release of organic acids from their sources, which could have facilitated in increasing zinc availability in saline soil. Increased release of Zn has been attributed to (i) Zn-rich manures and (ii) organic acids in manures may act as Zn-chelating agents for the plant. These findings are consistent with those reported by Garcia-Mina *et al.*, (2004). Organic matter in the soil frequently tends to increase zinc availability, presumably by complexing the substances that fix Zn. The contribution of organic matter to micronutrient binding, particularly Zn binding, is strongest when kaolinite is the dominant clay mineral and lowest when montmorillonite is prevalent. These findings are consistent with the findings reported by Mandal and Das (2013).

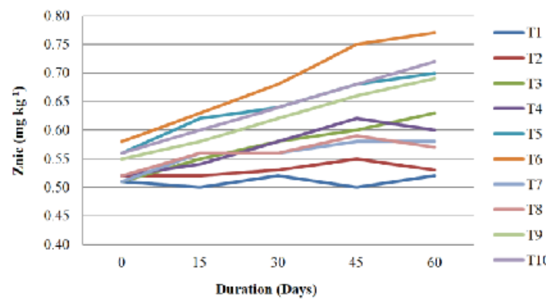

Fig. 1. Influence of different treatments on release of zinc in saline soil.

Vermicompost increased nutritional status through increasing nutrient availability and mineralization of soil nutrients. The combined application of zinc at 1:20 ratio of vermicompost boosted the zinc availability resulting in better uptake of nutrients due to the secretions of organic chelating ligands, compounds like humic acid and fulvic acid and ployphenols that aids in reducing the losses of nutrients by leaching, precipitation and fixation was proved from the earlier findings of Dhinagaran *et al.* (2021).

Table 3: Influence of different treatments on release of zinc in saline soil.

Tr. No.	Treatment	Zinc (mg kg^{-1})					
		0 day	15 day	30 day	45 day	60 day	Cumulative effect
T_1	Absolute control	0.53	0.52	0.54	0.52	0.54	2.65
T_2	Zinc sulphate (25 Kg ha^{-1})	0.54	0.54	0.55	0.57	0.55	2.75
T_3	1 : 10 ratio of $ZnSO_4$ and FYM	0.53	0.57	0.60	0.62	0.65	2.97
T_4	1 : 20 ratio of $ZnSO_4$ and FYM	0.54	0.56	0.60	0.64	0.62	2.96
T_5	1 : 10 ratio of $ZnSO_4$ and Vermicompost	0.59	0.64	0.66	0.70	0.72	3.31
T_6	1 : 20 ratio of $ZnSO_4$ and Vermicompost	0.60	0.66	0.70	0.77	0.79	3.52
T_7	1 : 10 ratio of $ZnSO_4$ and Coir-pith	0.53	0.58	0.58	0.60	0.60	2.89
T_8	1 : 20 ratio of $ZnSO_4$ and Coir-pith	0.54	0.58	0.58	0.61	0.59	2.90
T_9	1 : 10 ratio of $ZnSO_4$ and Poultry manure	0.57	0.60	0.64	0.68	0.71	3.20
T_{10}	1 : 20 ratio of $ZnSO_4$ and Poultry manure	0.58	0.62	0.66	0.70	0.72	3.30
	SEd	0.01	0.01	0.02	0.02	0.02	
	CD (0.05)	0.03	0.04	0.05	0.06	0.05	

CONCLUSION

The use of $ZnSO_4.7H_2O$ in combination with vermicompost, poultry manure, FYM, and coir pith at a 1:20 ratio was found to be beneficial for zinc release in saline soil. It was unearthed that combining $ZnSO_4.7H_2O$ with vermicompost, poultry manure, FYM, and coir pith improved the micronutrient status of saline soil. Micronutrients addition had doubled the volume of zinc available in the soil.

FUTURE SCOPE

The organic chelated, organic nano fertilizers impact on different releasing pattern in problematic soils, nutrient availability and their uptake efficiency of zinc in food crops need to be assessed for sustaining healthy diet.

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