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Effect of different manures on periodical availbility of zinc and iron in calcareous soil

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Abstract

Incubation study was conducted to study influence of manures on availability of zinc, iron in calcareous soils at College of Agriculture, Pune - 05. The experiment consisted of 9 treatments with 3 replications in which $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} and $FeSO_4 \cdot 7H_2O$ @ 25 kg ha^{-1} were incubated with fresh cow dung slurry, FYM, vermicompost and press mud cake for 1 week before application. For incubation study, the soil samples were collected at 15 days interval i.e. 0, 15, 30, 45, 55 days after incubation and analyzed for iron and zinc. Incubation study was conducted by discard method. The experiments was led out in completely randomized design (CRD).

The application of fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1} (T2) registered significantly higher release of iron throughout the incubation period over control. The release of iron in this treatment ranged from 5.14 mg kg^{-1} to 6.74 mg kg^{-1}. The application of (T1) fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $ZnSO_4 \cdot 7H_2O$ @ 20 kg ha^{-1} showed significantly higher release of zinc in calcareous soil from 0 day to 55 days of incubation. The release of zinc was ranged from 0.58 mg kg^{-1} to 0.77 mg kg^{-1}. The fresh cow dung slurry (1:4) @ 500 L ha^{-1} registered higher values of zinc and iron followed by FYM, vermicompost and press mud cake application.

Keywords: Manures, zinc, iron, calcareous soil

Introduction

Normally the calcareous soils occur in arid to sub humid climate and derived from basic rocks. The majority of the medium black soils of Saurashtra regions are calcareous in nature derived from trap basalt, lime stone and sand stone under semi arid climate. The calcareousness is a unique property of soil, which affects the Physico-chemical properties, nutrient availability and plant growth. Such soils are difficult to manage from fertility point of view. The interactions between free lime and native as well as added plant nutrients bring out a number of reactions, which finally lead to the unavailability of micronutrients to the crops. Thus, there is a need for in depth study of genesis, development, classification, extent of calcareousness and effect of $CaCO_3$ on iron and zinc.

The availability of zinc and iron decreases with increase in soil pH. The pH induced zinc and iron deficiencies in calcareous soils at high pH and precipitation of zinc and iron as insoluble amorphous soil zinc and soil iron and /or $ZnSiO_4$ and $FeSiO_4$, which reduces available zinc and iron in soil. Zinc and iron adsorption on the surface of $CaCO_3$ could also reduce solution zinc and iron. Adsorption of zinc and iron by clay mineral, Fe/Al^-oxides, organic matter and $CaCO_3$ increases with increase in pH (Chidanandappa, 2003) [1].

Zinc and iron in soils exist in various chemical forms. Contribution of different forms of zinc and iron to available pool vary widely depending upon physical and chemical properties of soils. Several factors mutually interact to govern its solubility in soil solution. These factors influence equilibria of several competing reactions such as solution, complexation, precipitation and occlusion by the matrix of solid and solution phase. So the efficient management of micronutrients (zinc and iron) is vital to sustain the productivity of different crops and to maintain a healthy balance of nutrients in soils.

When organic materials added to the soil mineralize to release nutrients slowly and the rate of nutrient mineralization increases as the plant growth progresses. As the plant matures, it is expected that a good soil would have released adequate nutrients for optimum plant growth (Lekasi *et al*. 2005) [5]. Organic matter is an important secondary source of trace elements in soil. Most micronutrients are held tightly in complex organic compounds and may not be readily available to plants. However, they can be an important source of micronutrients when they are slowly released into a plant available form as organic matter decomposes (Choudhary *et al*. 2008) [2].

Material and Methods

The present investigation entitled "Effect of different manures on periodic availability of zinc, iron in calcareous soils" was undertaken in *kharif* 2019 at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune-411005, Mahatma Phule Krishi Vidyapeeth, Rahuri.

The surface soil sample (0-22.5 cm depth) was obtained from Agronomy Farm, Division of Agronomy, College of Agriculture Pune.

As per treatment $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$ were incubated with cow dung slurry, FYM, vermicompost, press mud cake for 1 week before application in required quantity. Fresh cow dung slurry, FYM, vermicompost, press mud cake were applied as per treatment. Fresh cow dung slurry was prepared by using fresh cow dung and water in 1:4 proportion. Chemical properties of organic manures stated in table 1.

The experimental soil was clay in texture and having field capacity 36.69%, pH 8.3, EC 0.18 dSm^{-1},organic carbon 0.45%, $CaCO_3$ equivalent 13.5%, available nitrogen 133 kg ha^{-1}, available phosphorus 6.36 kg ha^{-1},available potassium 471 kg ha^{-1}, DTPA extractable Zn, Fe, Mn, Cu was 0.54 mg kg^{-1}, 3.3 mg kg^{-1}, 10.59 mg kg^{-1}, 6.48 mg kg^{-1} respectively.

The experiment consisted of 9 treatments with 3 replications. For incubation study, the soil samples were collected at 15 days interval i.e. 0, 15, 30, 45, 55 days after incubation and analyzed for iron and zinc. Incubation study was conducted by discard method. The experiment was led out in completely randomized design (CRD).

Treatment Details

1. Fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}
2. Fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}
3. FYM @10 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}
4. FYM @10 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}
5. Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}
6. Vermicompost @ 2.5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}
7. Press mud cake @ 5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}
8. Press mud cake @ 5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}
9. Control (without $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$)

The results were statistically analyzed and appropriately interpreted as per the method given by Panse and Sukhatme (1985).

Result and Discussion

A) Influence of Different Treatments on Release of Iron in Calcareous Soil

The data on release of iron as influenced by different treatments are reported in table 2. The application of fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1} (T2) recorded maximum cumulative effect (30.63 mg kg^{-1}) followed by T4 i.e. FYM @10 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1} (25.72 mg kg^{-1}).

It could be seen from the data that there was significant effect of addition of $FeSO_4.7H_2O$ @ 25 kg ha^{-1}along with fresh cow dung slurry, FYM, vermicompost, press mud cake in comparison to control where no $FeSO_4.7H_2O$ @ 25 kg ha^{-1} was added into soil. This increase in release of iron was noted up to 55 days of incubation.

Among all the treatments, treatment T2 fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}registered significantly higher release of iron throughout the incubation period. Further it was also noted that application of $FeSO_4.7H_2O$ @25 kg ha^{-1} in combination with either vermicompost, press mud cake or FYM could increase release of iron significantly as compared to control where $FeSO_4.7H_2O$@ 25 kg ha^{-1} was not applied.

The increase in release pattern of iron at 0 day was ranged from 3.26 mg kg^{-1} (T9) to 5.14 mg kg^{-1} (T2), at 15 days. Iron registered in T9 was 3.21 mg kg^{-1} while in T2 it was 5.89 mg kg^{-1}. The release of iron was higher at 55 days of incubation in T2 (6.74 mg kg^{-1}) and in T9 (3.24 mg kg^{-1}).

The increase in iron due to cow dung slurry, vermicompost, press mud cake, FYM might be due to their chelating effect as these are responsible for release of different organic acids which might have acted as chelating agents and not allowing the released iron to precipited with calcium in soil. The organic acids or compounds produced during the decomposition of organic matter react with iron and form soluble organo-iron complexes, which prevent the iron from fixation by soil constituents was also noticed by Katyal and Sharma (1991) [4].

B) Influence of Different Treatments on Release of Zinc in Calcareous Soil

The data on release of zinc as influenced by different treatments in calcareous soil are reported in table 3.The application of fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} (T1) recorded maximum cumulative effect (3.41 mg kg^{-1}) followed by T3 i.e. FYM @10 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} (3.2 mg kg^{-1})and T7 i.e. press mud cake @ 5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} (3.2 mg kg^{-1}).

The data clearly indicated that application of $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} along with fresh cow dung slurry, vermicompost, press mud cake and FYM could improve release of zinc significantly than control where no $ZnSO_4.7H_2O$ @ 20 kg $ha^{-1}$was applied in soil.

The perusal of data on release pattern of zinc in calcareous soil indicated that treatment T1 (fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}) showed significantly higher release of zinc (0.58 mg kg^{-1}) over control. However, the release of zinc was at par with T3 (0.56 mg kg^{-1}), T7 (0.56 mg kg^{-1}), T5 (0.55 mg kg^{-1}) at 0 days of incubation. There was progressive increase in release of zinc in calcareous soil.

Among these different treatments, treatment T1 (fresh cow dung slurry (1:4) @ 500 L ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}) showed significantly higher release of zinc in calcareous soil from 0 day to 55 days of incubation. The release of zinc ranged from 0.58 mg kg^{-1} to 0.77 mg kg^{-1}. However, this release of zinc was at par with treatment where $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} was applied in combination with vermicompost, press mud cake and FYM. However, increase in release of zinc was significantly higher in all combinations over T9, control treatment.

It could be observed from this data that application of $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} along with fresh cow dung slurry, vermicompost, press mud cake and FYM was effective in respect of release of zinc in calcareous soil. This might be due to release of organic acids from their sources which could have helped to restrict calcium to precipitate zinc in calcareous soil. Increased Zn has been attributed to (i) manures containing significant amounts of Zn and (ii) organic acids from manures that may serve as Zn-chelating agents for the plant. These results are in accordance with findings reported by Stevenson and Ardkani (1972) [8]; Garcia-Mina *et al.* (2004) [3].

The presence of organic matter in the soil very often promotes the availability of zinc presumably by complexing the substances that fix Zn. The contribution of organic matter to micronutrient particularly Zn binding is highest when the predominant clay minerals is kaolinite and lowest when it is montmorillonite. These finding confirms the result reported by Mandal and Das (2013) [6].

Table 1: Organic manures analysis

Sr. No	Parameter	Cow dung slurry	FYM	Vermicompost	Press mud cake
1	pH	7.5	8.15	7.54	7.9
2	EC dSm^{-1}	0.83	2.27	2.53	1.5
3	OC %	19	19.75	24.46	12.89
4	N %	0.53	1.29	1.82	1.12
5	P %	0.105	0.23	0.45	0.26
6	K %	0.046	0.21	0.42	0.18
7	Fe (mg kg^{-1})	2262	2485	2670	2464
8	Zn (mg kg^{-1})	449.2	267.3	410	308
9	Mn(mg kg^{-1})	139	212	497	266
10	Cu (mg kg^{-1})	88.8	57.3	187	109
11	C:N	35.84	15.31	13.44	11.51

Table 2: Influence of different treatments on release of iron in calcareous soil

Tr. No.	Treatment	Iron (mg kg^{-1})					
		0 day	15 day	30 day	45 day	55 day	Cumulative Effect
T1	Fresh cow dung slurry (1:4) @ 500 L ha^{-1} +$ZnSO_4.7H_2O$ @20 kg ha^{-1}	3.51	3.85	4.25	4.32	4.35	20.28
T2	Fresh cow dung slurry (1:4) @ 500 L ha^{-1} +$FeSO_4.7H_2O$ @ 25 kg ha^{-1}	5.14	5.89	6.18	6.68	6.74	30.63
T3	FYM @10 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	3.50	3.72	3.96	4.06	4.11	19.35
T4	FYM @10 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	4.12	4.67	5.19	5.84	5.90	25.72
T5	Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	3.56	3.68	3.81	4.02	4.12	19.19
T6	Vermicompost @ 2.5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	4.18	4.94	5.02	5.15	5.19	24.48
T7	Press mud cake @ 5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	3.42	3.68	4.10	4.35	4.38	19.93
T8	Press mud cake @ 5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	4.10	4.80	4.98	5.06	5.16	24.1
T9	Control (without $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$)	3.26	3.21	3.25	3.22	3.24	16.18
	SE+	0.18	0.22	0.09	0.24	0.13	-
	CD(0.05)	0.55	0.66	0.26	0.71	0.37	-

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

Tr. No.	Treatment	Zinc (mg kg^{-1})					
		0 day	15 day	30 day	45 day	55 day	Cumulative effect
T1	Fresh cow dung slurry (1:4) @ 500 L ha^{-1}+$ZnSO_4.7H_2O$ @20 kg ha^1	0.58	0.63	0.68	0.75	0.77	3.41
T2	Fresh cow dung slurry (1:4) @ 500 L ha^{-1} +$FeSO_4.7H_2O$ @ 25 kg ha^{-1}	0.52	0.54	0.58	0.62	0.60	2.86
T3	FYM @10 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	0.56	0.60	0.64	0.68	0.72	3.20
T4	FYM @10 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	0.51	0.55	0.58	0.60	0.63	2.87
T5	Vermicompost @ 2.5 t ha^{-1}+ $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	0.55	0.58	0.62	0.66	0.69	3.10
T6	Vermicompost @ 2.5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	0.51	0.56	0.56	0.58	0.58	2.79
T7	Press mud cake @ 5 t ha^{-1} + $ZnSO_4.7H_2O$ @ 20 kg ha^{-1}	0.56	0.62	0.64	0.68	0.70	3.20
T8	Press mud cake @ 5 t ha^{-1} + $FeSO_4.7H_2O$ @ 25 kg ha^{-1}	0.52	0.56	0.56	0.59	0.57	2.80
T9	Control (without $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$)	0.52	0.52	0.53	0.55	0.53	2.65
	SE+	0.01	0.01	0.02	0.02	0.02	-
	CD(0.05)	0.03	0.04	0.05	0.06	0.05	-

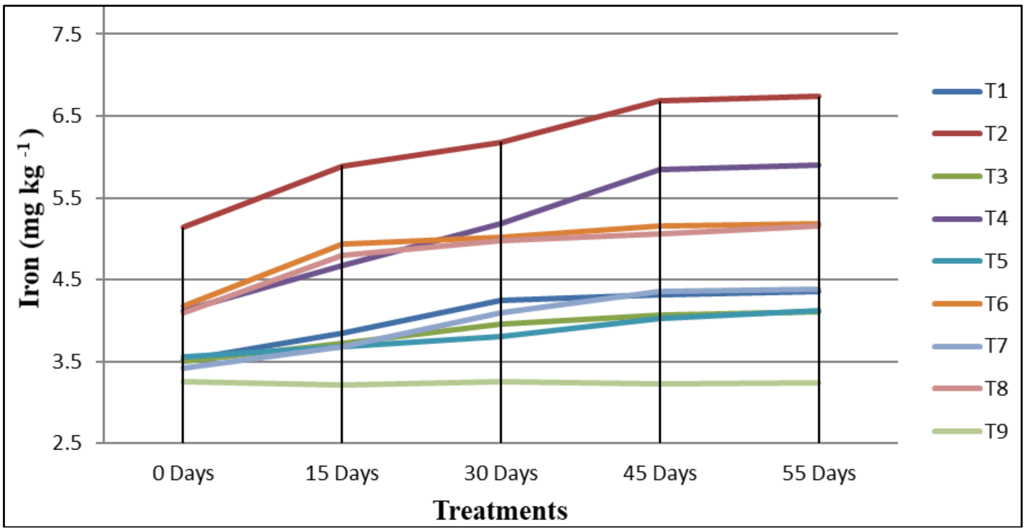

Fig 1: Influence of different treatments on release of iron in calcareous soil.

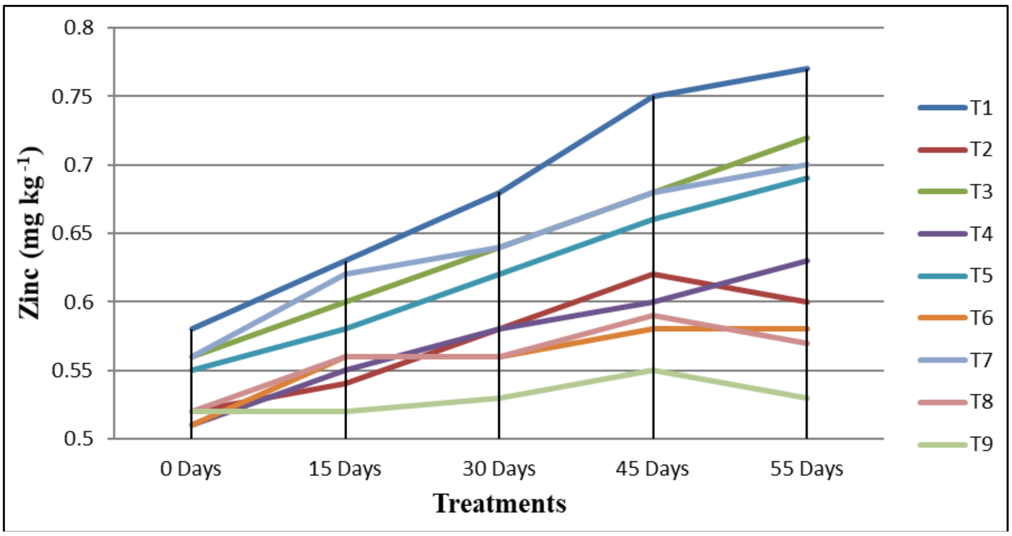

Fig 2: Influence of different treatments on release of zinc in calcareous soil

Conclusion

The application of $ZnSO_4.7H_2O$ @20 kg ha^{-1} and $FeSO_4.7H_2O$ @ 25 kg ha^{-1} along with either fresh cow dung slurry, FYM, vermicompost and press mud cake was found beneficial for release of zinc and iron respectively in calcareous soil. It was observed that addition of $ZnSO_4.7H_2O$ @ 20 kg ha^{-1} and $FeSO_4.7H_2O$ @ 25 kg ha^{-1} along with fresh cow dung, vermicompost, FYM and press mud cake helped to improve micronutrients status of calcareous soil. The addition of these micronutrients salts increased iron and zinc content of soil.

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