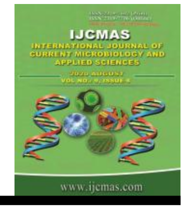
Int.J.Curr.Microbiol.App.Sci (2020) *9*(8): 2579-2585

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 8 (2020)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2020.908.295

Effects of Organic and Inorganic Zn Sources on Zn Fractions and their Availability in Inceptisol

S. S. Bairagi, A.V. Patil, D.D. Sawale, V.V. Patil* and A.B. Jadhav

Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

**Corresponding author*

Keywords

Zinc, Fractions, Organic, Inorganic and Inceptisol

Article Info

Accepted:
22 July 2020
Available Online:
10 August 2020

A B S T R A C T

A study was undertaken to assess the changes in Zn-fractions in Inceptisol (*Typic Haplustept*) amended with or without organic and inorganic Zn fertilizer incubated at ambient temperature for 90 days. In fractions *viz*., WSEx, COMP, ABD, CBD, Res, Total and DTPA extractable Zn increased significantly upto 45 days and thereafter declined with increase in incubation time in all treatments. Among the treatments application of Vermicompost @ 5 t ha^{-1} along with Zn @ 5 mg kg^{-1} soil through $ZnSO_4$ $7H_2O$ recorded significantly higher values for Zn fractions followed by FYM @ 10 t ha^{-1} Zn @ 5 mg kg^{-1} soil. The per day release of Zn fractions were recorded maximum due to application of vermicompost @ 5 t ha^{-1} + 5 mg Zn kg^{-1} soil followed by FYM @ 10 t ha^{-1} + 5 mg kg^{-1} soil.

Introduction

Zinc in soil exists in various chemical forms. Contribution of different forms of zinc to available forms varies widely depending upon physical and chemical properties of soils. Several soil factors mutually interact to govern its solubility in soil solution. Acknowledge of which of these forms control the distribution of zinc between active soil Zn and constituent's soil. Availability of zinc (Zn) for plants is associated with the distribution of this nutrient among soil fractions. Zinc deficiency in soils suggests that both native and applied Zn react with the inorganic and organic phases in the soils, which influences plant-availability of Zn. If the status of zinc is known in a particular soil it will be easy to estimate the quantity of zinc to apply for a particular crop for maximum yield. Availability of Zn for plants was reported to be associated with the distribution of this nutrient among soil fractions. Therefore understanding the distribution of Zn among various fractions of soil will help to characterize chemistry of Zn in soils and possibly its availability for plant uptake (Viets, 1962)[15].

Residual and oxide bound Zn is known to be more stable while as exchangeable and water soluble Zn fractions are more soluble

(Rahmani *et al.,* 2012) [12]. The extent to which each fraction present and the transformations are in equilibrium between fractions is influenced by soil properties such as pH, texture and soil organic matter (Ramzan *et al.,* 2014)[13]. Information and studies on Zn in these areas were limited only to DTPA extractable Zn. The present investigation is an attempt in this direction to generate wide data base of different Zn fractions in Inceptisol.

Materials and Methods

A Incubation study was conducted during 2018-19 at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune-411005. The bulk soil (0-15cm) was collected and dried, ground to passed through 2.0 mm sieve. The experiment was laid out in completely randomized block design with six treatments, four replications and five incubation periods *viz.*,0,30,45,60 and 90 days. The bowls having capacity 2.5 kg soil. The soil used in the experiment was an Inceptisol (*Typic Haplustept*). Some physical and chemical properties of studied soil and organic manures are analyzed by adopting standard analytical methods by Jackson (1973)[4], Lindsay and Norvell (1978)[6], Zososki and Burau (1977)[16] and Gorsuch (1970)[2] are presented in table 2 and 3. The treatment for experiment *viz.*, T_1- Control, T_2- FYM @ 10 t ha^{-1}, T_3- Vermicompost @ 5 t ha^{-1}, T_4- Zinc sulphate @ 5 mg $kg^{-1,}$ T_5- Zinc sulphate + FYM @ 10 t ha^{-1} and T_6- Zinc sulphate + Vermicompost (VC) @ 5 t ha^{-1}.

As per the treatment, required quantity of FYM, vermicompost and zinc through $ZnSO_4.H_2O$ was thoroughly mixed with 2.00 kg soil and moisture at field capacity was maintained on gravimetric basis with double distilled water. Destruction sampling method was adopted to complete an incubation study.

The zinc fractions were analyzed periodically at 0, 30th, 45th, 60th and 90th days of incubation by the sequential procedure of Murthy (1982)[8] modified by Mandal and Mandal (1986)[7]. Per day release of Zn fractions were computed by using formula:

$$\frac{\text{Zn fraction (mg kg}^{-1}\text{) at 45 day – Zinc fraction at 0 day}}{\text{45 days}}$$

The data obtained were statistically analyzed and appropriately interpreted as per the method given by Panse and Sukhatme (1985)[10].

Results and Discussion

Water Soluble Plus Exchangeable Zinc Fraction (WSEx-Zn)

The application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded higher WSEx-Zn content at 0 (1.06), 30 (2.3), and 45 (4.20) day of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application (1.04, 2.03, and 3.85 mg kg^{-1}) respectively**.** The application of $ZnSO_4$ along with vermicompost recorded significantly highest value throughout the incubation period and it was superior over rest of the treatments. The common peak of WSEx-Zn was attained at 45th days for the control as well as other treatments. However, Zn application either with vermicompost or FYM resulted into higher WSEX-Zn content might be due to higher concentration of Zn in organic manures. It was evidenced from Fig. 1, that for raising the WSEx-Zn fraction due to different treatments, the trend in decreasing order was $ZnSO_4$ + VC > $ZnSO_4$ + FYM > $ZnSO_4$> VC > FYM > Control. The increased in WSEx-Zn forms due to application of vermicompost or FYM along with $ZnSO_4$ due to complexation or chelating action thereby prevent fixation in soil (Latha *et al.*, 2001)[5].

Table.1 Effect of different organic and inorganic sources of zinc on per day release of different zinc fractions upto 45th day of incubation in Inceptisol

Treatment	Zn fractions (mg kg^{-1})					Per day release of total fractions (mg kg^{-1})
	WSEx-Zn	COMP-Zn	ABD-Zn	CBD-Zn	Res- Zn	
T_1 - Control	0.0118	0.0409	0.0409	0.0454	0.0543	0.1934
T_2- FYM	0.0198	0.0460	0.0460	0.0908	0.1371	0.3397
T_3 - vermicompost	0.0204	0.0598	0.0598	0.1127	0.1769	0.4297
T_4 -$ZnSO_4$	0.0214	0.1082	0.1082	0.1893	0.2334	0.6606
T_5 -$ZnSO_4$ + FYM	0.0775	0.1343	0.1343	0.2100	0.2716	0.8278
T_6 -$ZnSO_4$ + vermicompost	0.0852	0.1926	0.1926	0.2236	0.2960	0.9899

Table.2 Initial soil properties

Soil properties	Value
Sand (%)	19.2
Silt (%)	24.10
Clay (%)	56.10
Textural class	Clay
Field capacity (%)	36.71
pH (1:2.5;Soil:Water)	8.33
EC (dSm^{-1})	0.22
Organic carbon (g kg^{-1} soil)	4.10
$CaCO_3$ equivalent (%)	6.20
Available nitrogen (kg ha^{-1})	178.74
Available phosphorus (kg ha^{-1})	19.50
Available potassium (kg ha^{-1})	367
DTPA extractable Zn (mg kg^{-1})	0.60
DTPA extractable Fe (mg kg^{-1})	3.57
DTPA extractable Mn (mg kg^{-1})	2.11
DTPA extractable Cu (mg kg^{-1})	3.28
WSEx-Zn (mg kg^{-1})	0.36
COMP-Zn (mg kg^{-1})	2.85
ABD-Zn (mg kg^{-1})	7.58
CBD-Zn (mg kg^{-1})	5.57
Res- Zn (mg kg^{-1})	38.35
Total Zinc (mg kg^{-1})	54.35

Table.3 Chemical composition of organic manures

Characteristic	FYM	Vermicompost
pH	8.15	7.54
EC (dSm^{-1})	2.27	2.53
Organic Carbon (%)	20.5	23.20
Total N (%)	1.29	1.82
Total P (%)	0.45	0.92
Total K (%)	0.31	0.79
Fe ($mg\ kg^{-1}$)	167.84	181.68
Mn ($mg\ kg^{-1}$)	44.4	79.16
Zn ($mg\ kg^{-1}$)	48.84	65.94
Cu ($mg\ kg^{-1}$)	10.48	20.50
C/N Ratio	15.89	12.74
C/P Ratio	45.55	25.21

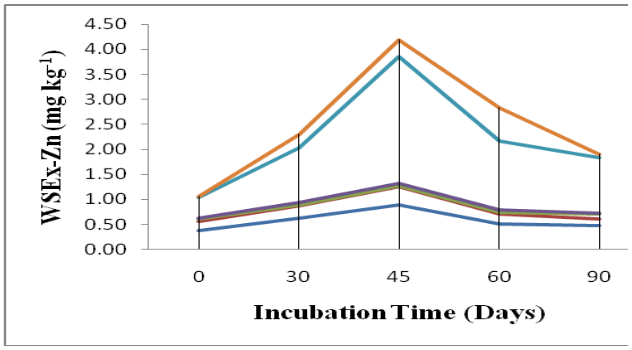


Fig. 1 :Effect of organic and inorganic sources of zinc on periodical changes of water soluble plus exchangeable zinc fraction (WSEx-Zn) in Inceptisol

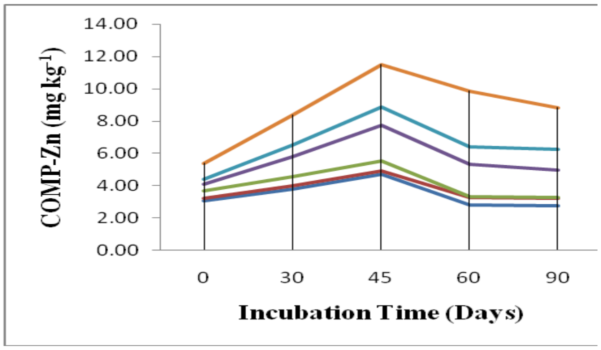


Fig. 2:Effect of organic and inorganic sources of zinc on periodical changes of complexed zinc fraction (COMP-Zn) in Inceptisol

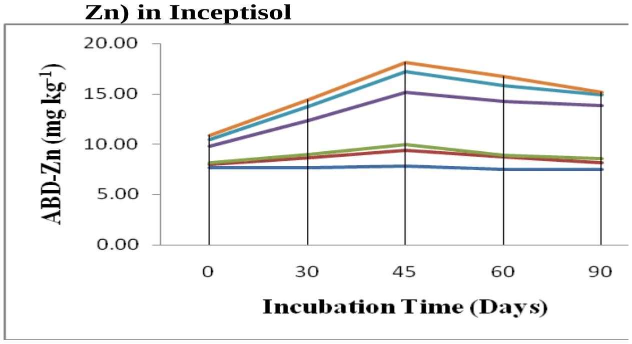


Fig.3:Effect of organic and inorganic sources of zinc on periodical changes of amorphous sesquioxide bound zinc fraction (ABD-Zn) in Inceptisol

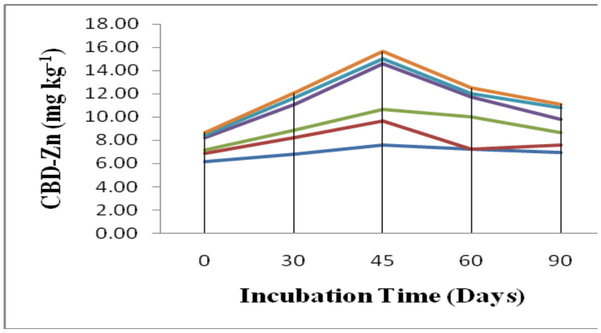


Fig. 4:Effect of organic and inorganic sources of zinc on periodical changes of crystalline sesquioxide bound zinc fraction (CBD-Zn) in Inceptisol

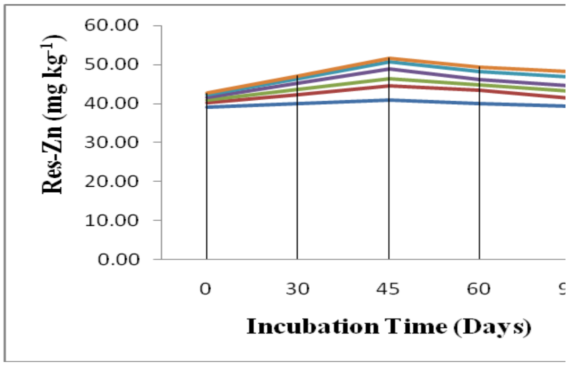


Fig. 5 :Effect of organic and inorganic sources of zinc on periodical changes of Residual Zinc Fraction (Res-Zn)in Inceptisol

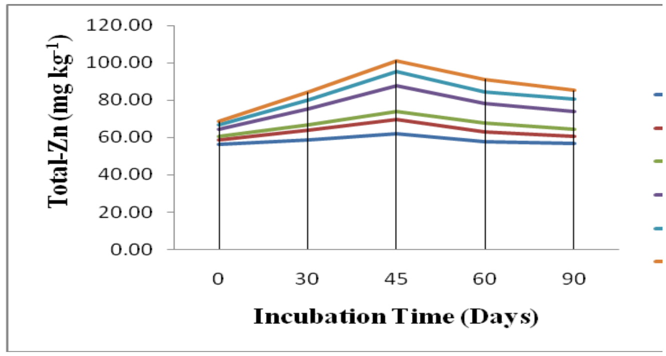


Fig. 6 :Effect of organic and inorganic sources of zinc on periodical changes of total Zinc (Total-Zn)in Inceptisol

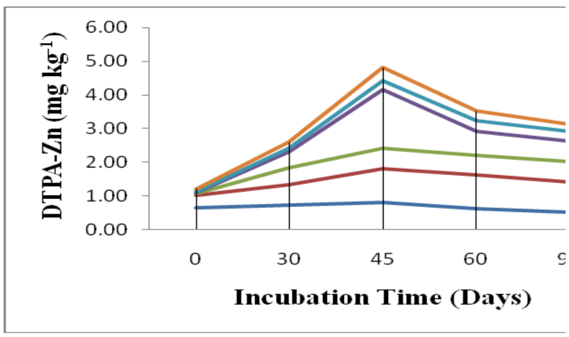


Fig. 7 :Effect of organic and inorganic sources of zinc on periodical changes of DTPA-Znin Inceptisol

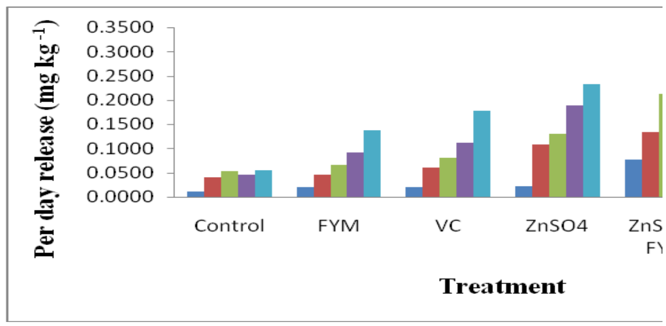


Fig. 9:Per day release of different zinc fraction upto 45th day of incubation

Complexed zinc fraction (COMP-Zn)

Periodical release of COMP -Zn at respective incubation period upto 90th day of incubation is presented in Fig. 2. The application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} significantly increased upto 45 days and thereafter it was declined which showed highest peak at 45 days (11.52 mg kg^{-1}) which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application. The high content of COMP -Zn fraction was attained at 45thdays of incubation in all the treatments and thereafter it declined significantly irrespective of all the treatments. Both the organic sources along with $ZnSO_4$ significantly superior over control and $ZnSO_4$ alone treatments. It might be due to organic matter provides more exchange sites for absorption of Zn (Prasad and Sakal, 1988)[11].

Amorphous sesquioxide bound zinc fraction (ABD-Zn)

The application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded higher ABD-Zn content at 45 (18.13 mg kg^{-1}) day of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application. The high availability of ABD -Zn fraction was attained at 45thdays of incubation in all the treatments. Thereafter it showed decline significantly irrespective of all treatment (Fig. 3). Among the only organic manures, the vermicompost recorded significantly higher values of ABD-Zn during the incubation period followed by FYM while, both the organic sources were significantly superior over control, which may be attributed to the enhanced release of zinc present in mineral fractions as a result of action of decomposition products of added organic matter and enhanced microbial activity (Datta *et al.*, 1989)[1].

Crystalline Sesquioxide Bound Zinc Fraction (CBD-Zn)

The results revealed that application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded significantly higher CBD-Zn content at 45 days of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application (Fig. 4). It might be due to humus content in vermicompost higher due to narrow C/N ratio than FYM which has more surface area and active sites to work like chelate which resulted in consistent increased in CBD-Zn upto 45th DAI *(*Pal *et al.*,1997)[9].

Periodical Changes of Residual Zinc Fraction (Res-Zn)

The data revealed that application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded significantly higher Res-Zn (51.67 mg kg^{-1}) at 45 days of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application. The high availability of Res-Zn fraction was attained at 45th days of incubation and thereafter it slowed down irrespective of all the treatments (Fig. 5). The increased in the Res-Zn content with time (upto 45th DAI) which could be due to conversion of some amount of labile zinc into non-labile forms. Similar findings were also reported by Ilavarasi *et al.*, (2019)[3]

Total Zinc (Total-Zn)

The data revealed that application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded significantly higher release at 0 (68.68 mg kg^{-1}), 30 (84.34 mg kg^{-1}) and 45 (101.14 mg kg^{-1}) day of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} application respectively (Fig. 6).

DTPA extractable Zinc (DTPA-Zn)

The results showed that application of $ZnSO_4$ along with vermicompost @ 5 t ha^{-1} recorded significantly higher release of DTPA extractable Zn (4.82 mg kg^{-1}) at 45 day of incubation which was followed by $ZnSO_4$ with FYM @10 t ha^{-1} treatment. The availability pattern of DTPA-Zn fraction was slow during 30th days followed by faster rate. The highest peak of DTPA-Zn fraction was attained at 45thdays of incubation in all the treatments and thereafter it was slowed down (Fig. 7). The magnitude of DTPA-Zn was decreased in order: $ZnSO_4$ + VC > ZnSO4 + FYM > $ZnSO_4$ > VC > FYM > Control.

Per day release of different zinc fractions at 45th day of incubation

The per day release of WSEx-Zn, COMP-Zn, ABD-Zn, CBD-Zn and Res-Zn fraction for 0, 30 and 45 DAI was formulated and presented in table 1 and Fig. 8. The result revealed that application of $ZnSO_4$ along with vermicompost C reported higher values 0.0852, 0.1926, 0.1926, 0.2236, 0.2960 for WSEx-Zn, COMP-Zn, ABD-Zn, CBD-Zn and Res-Zn fraction than rest of the treatments. It might be due to higher content of zinc and narrow C/N ratio in vermicompost which enhance the availability of different zinc fractions (Shuman, 2005)[14].

In conclusion the application of Zn @ 5 mg kg^{-1}soil through $ZnSO_4.7H_2O$ (48.70 kg ha^{-1}) along with either vermicompost @5 t ha^{-1} or FYM @ 10 t ha^{-1} was found beneficial for higher release of water soluble plus exchangeable form of zinc (plant available) upto 45 days of incubation.

References

1. Datta D, Mandal B, Mandal LN. Decrease in availability of Zn and Cu in

acidic to near neutral soils on submergence. Soil Science. 1989; 147:187-195.
2. Gorsuch TT. "The Destruction of Organic Matter". Pergamon Press. Ltd., New York, 197; 143-144.
3. Ilavarasi R, Baskar M, Gomadhi G, Ramesh T. Dynamics of zinc in sodic soil with zinc enriched organics. International Journal of Current Microbiology and Applied Science. 2019; 8:2355-2361.
4. Jackson ML. Soil Chemical Analysis. Prentice Hall Pvt. Ltd., New Delhi. 1973; 69-182.
5. Latha MR, Savithri P, Indirani R, Kamaraj S. Influence of zinc enriched organic manures on the availability of micronutrient in soil. Madras Agriculture Journal. 2001; 88:165-167.
6. Lindsay WL, Narvell WA. Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Science Society of America Journal. 1978; 42:421-428.
7. Mandal LN, Mandal B. Zinc fractions in soils in relation to zinc nutrition of lowland rice. Soil Science. 1986; 142:141-148.
8. Murthy ASP. (1982) Zinc fractions in wetland rice soils and their availability to rice. Soil Science. 1982; 133:150-154.
9. Pal AK, Das PR, Patnaik SK, Mandal B. Zinc fractions in some rice growing soils of Orissa. Journal of Indian Society of Soil Science. 1997; 45:734-738.
10. Panse VA, Sukhatme PV. Statistical methods for Agricultural workers, Revised Edn. ICAER, New Delhi. 1985.
11. Prasad R, Sakal R. Effect of soil properties on different chemical pools of zinc in calcareous soils. Journal of the Indian Society of Soil Science. 1988; 36:246-251.
12. Rahmani B, Tehrani MM, Khanmirzaei A, Shahbazi K. Cadmium fractions and its uptake by the wheat plant in some calcareous soils of Iran. International Journal of Agriculture Research and Revie. 2012; 2:461-466.
13. Ramzan S, Auyoub B, Kirmani NA, Rasool R. Fractionation of zinc and their association with soil properties in soils of Kashmir Himalayas. International Invention Journal of Agricultural and Soil Science. 2014; 2:132-142.
14. Shuman LM. Micronutrients. Encyclopedia of Soils in the Environment. 2005; 479-486.
15. Viets FG. Chemistry and availability of micronutrients in soils. Journal of Agricultural Food Chemistry. 1962; 10, 174-178.
16. Zososki RJ. Burau, RG. A rapid nitric perchloric acid digestion method for multi element tissue analysis. Communication in Soil Science and Plant Analysis. 1977; 8:425-443.

How to cite this article:

Bairagi, S. S., AV. Patil, D. D. Sawale, V. V. Patil and Jadhav, A. B. 2020. Effects of Organic and Inorganic Zn Sources on Zn Fractions and their Availability in Inceptisol. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 2579-2585. doi: https://doi.org/10.20546/ijcmas.2020.908.295