Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 07(F), pp. 33708-33710, July, 2019

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

IMPACT OF ZINC FERTILIZATION ON AVAILABLE NUTRIENTS IN ZINC DEFICIENT SOIL

Muthukumararaja. T and Sriramachandrasekharan M.V

Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar- 608002

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1007.3730

ARTICLE INFO

Article History:

Received 13th April, 2019
Received in revised form 11th May, 2019
Accepted 8th June, 2019
Published online 28th July, 2019

Key Words:

zinc, nutrients, rice

ABSTRACT

A pot experiment was conducted during 2011 in a net house at Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University to studies on impact of zinc fertilization on available nutrient zinc deficient soil. The result of experiment revealed that available nutrients increased with zinc levels at all stages of crop growth. Nutrient content decreased while nutrient uptake increased with advancement of rice crop. The available nutrients was highest at 7.5 mg Zn kg^{-1}. However the response of nutrient content and uptake in rice crop was higher in Entisol than Vertisol Availability of nutrients in soil (N, P, K and Zn) differed significantly on addition of zinc at all stages of crop growth. The highest availability of N, P and K was with 5.0 mg Zn kg^{-1} while available zinc was highest with 7.5 mg Zn kg^{-1}.

INTRODUCTION

Soil is the main reservoir of nutrients from which plants absorb them directly for their growth and proper development. Zinc is absorbed by plants generally in divalent form. However, the availability of Zn from soil depends on soil physico-chemical properties. Zinc deficiency has been reported on a variety of soils ranging from arid to tropical climate due to difference in their Zn bioavailability and total Zn content in soil is not a true indicator of its bioavailability to the growing plants (Xian, 1989). Zinc may bind with various organic and inorganic soil components present in different agro - ecological zones of the world (Catlett *et al*., 2002). Soil factors, which contributes to low Zn bioavailability, are low Zn content in soil, high pH, calcareousness, low organic matter, salt affected soil, highly weathered and coarse textured soil, clay content and type of clay minerals (Singh *et al*., 2005). Zinc deficiency had been reported in almost 49 countries of the world (Alloway, 2004). In India, Zn deficiency is expected to increase from 42 per cent in 1970 to 63 per cent by 2025 due to continuous depletion of soil Zn fertility under intensive cropping (Singh, 2011). Considering yield responses, as much as 78 per cent of soils were found low in Zn as there was a shift in Zn response and upto 69 per cent field trials showed increased response upto 500 kg ha^{-1} to Zn compared to only 43 per cent trials responding in early seventies (Singh *et al*., 2011). In Tamil Nadu, 53 per cent of soils are found deficient in Zn (Tandon, 1995). Katyal and Rattan (1993) reported that Zn deficiency in South Indian soils most commonly seen in soils under Vertisol and Alfisol. Zinc deficiency is a major concern due to changes in soil redox potential in submerged soils (Mortvedt *et al*., 1991) and precipitation of Zn with free sulphide (Mikkelson and Shiou, 1977) resulting in less Zn availability. Continuous rice cultivation over centuries in certain tract of India depleted available Zn. This low zinc availability is a constraint to rice production in many areas (Dobberman and Fairhurst, 2000). Response of rice to Zn has been reported by several workers in India (Muthukumararaja *et al*., 2019; Shivay and Prasad, 2012). The present study is to evaluate the available nutrients in soil after application of zinc fertilization in zinc deficient soil.

MATERIALS AND METHODS

With a view to study the impact of zinc fertilization on available nutrients in zinc deficient soil of two different texturally soils was carried out during the year 2011 in a pot experiment in a net house of Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University. Bulk surface soil samples (0-15 cm) from two soil series (Kondal and Padugai) were collected air dried, powdered with wooden mallet. The experimental soil was clay loam and sandy clay loam in texture with pH 7.63;7.30, EC 0.70;0.81dS m^{-1}, organic carbon 5.70;8.20 g kg^{-1} (low), medium in $KMnO_4$-

Corresponding author:* **Muthukumararaja. T
Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar- 608002

N 281;284 kg ha^{-1}, high in Olsen-P 23.2;26.5 kg ha^{-1}, high in NH_4OAc-K 306;318 kg ha^{-1} and low in available DTPA-Zn 0.75;0.70 mg kg^{-1} .The experiment was laid out in FCRD with three replication. The experiment consisted of two factors viz., Factor A – Zinc levels (mg kg^{-1}) Zn_0 - Control (no zinc),Zn_1- 2.5,Zn_2- 5.0 and Zn_3- 7.5 and Factor B – Soil S_1 – Kondal series (Typic Haplusterts) – Vertisol: S_2 – Padugai series (Typic Ustifluvents) – Entisol. Before planting and application of fertilizers, the soil in all the pots were well puddled. All the pots were treated with basal dose of RDF (150:50:50 N, P_2O_5, K_2O kg ha^{-1}) in the form of urea, SSP and MOP and mixed with the soil. Zinc was applied as $ZnSO_4.7H_2O$ in the form of solution which was mixed thoroughly with soil. Three seedling of rice variety ADT 43 was planted pot^{-1}. The soils in the pots were kept at submergence throughout the crop period. At each stage, soil samples were collected from 24 pots (8x3) and analysis of nutrient (N, P, K and Zn) in soil sample.

RESULTS AND DISCUSSION

Available nitrogen

Addition of graded dose of zinc, soils and their interaction significantly influenced available nitrogen over control at all stages of crop growth (Table 1).

Table 1 Effect of zinc application on available nitrogen (kg ha^{-1}) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	295.8	299.2	297.5	271.7	274.3	273.0	250.6	253.2	251.9
2.5	324.0	325.7	324.8	292.6	298.2	295.4	274.8	281.5	278.1
5.0	339.5	340.6	340.0	308.0	310.6	309.3	289.4	295.3	292.3
7.5	342.6	345.3	343.9	310.6	315.4	313.0	292.1	298.3	295.2
Mean	325.4	327.7		295.7	299.6		276.7	282.0	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	3.57	3.87	4.96	3.03	3.53	4.66	2.46	2.94	3.99
CD (p=0.05)	7.43	8.06	10.32	6.32	7.36	9.70	5.12	6.11	8.31

Available nitrogen in soil gradually declined with advancement of crop growth. Available nitrogen in soil increased with zinc levels and the highest available nitrogen at tillering stage (343.9 kg ha^{-1}), panicle initiation (315.4 kg ha^{-1}) and harvest stage (295.2 kg ha^{-1}) with 7.5 mg Zn kg^{-1}. Irrespective of the stages, available nitrogen was higher in Entisol than Vertisol. The interaction effect between Zn levels and soils showed that application of 5.0 mg Zn kg^{-1} to Entisol registered the highest available nitrogen at all stages of crop growth. The maximum amount of available nitrogen, was noticed with 7.5 mg Zn kg^{-1} .Increase in availability of major nutrients on zinc addition could be due to synergistic effect of Zn on these nutrients (Senthilkumar *et al*., 2006). The indirect effect of increasing the availability of major nutrients by the addition of Zn derives support from the significant positive relationship of $KMnO_4$-N with DTPA-Zn ((r=0.92** (TS), r=0.95** (PI) and r=0.97** (HS)).

Available phosphorus

Perusal of data in Table 2 showed the significant influence of zinc and soils on available phosphorus at all stages of crop growth over control. Available phosphorus declined with advancement of crop growth.Available phosphorus improved with addition of Zn upto 5.0 mg kg^{-1} and declined thereafter with addition of 7.5 mg Zn kg^{-1}. The highest available phosphorus in soil with 5.0 mg Zn kg^{-1} was 35.5 kg ha^{-1} (tillering stage), 30.3 kg ha^{-1} (panicle initiation) and 29.1 kg ha^{-1} (harvest stage). At all stages of crop growth, available phosphorus was higher in Entisol than Vertisol. Deb *et al.* (1986) observed synergistic effect between P and Zn at lower concentration of Zn. The existence of mutual synergistic influence of Zn on Olsen-P was very well reflected by the relationship with DT

Table 2 Effect of zinc application on available phosphorus (kg ha^{-1}) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	26.6	28.3	27.5	21.0	22.6	21.8	19.0	20.2	19.6
2.5	32.1	34.7	33.4	27.1	29.5	28.3	26.0	28.2	27.1
5.0	34.2	36.7	35.5	29.0	31.6	30.3	28.3	29.9	29.1
7.5	30.9	33.8	32.3	26.5	28.7	27.6	25.2	27.0	26.1
Mean	30.9	33.4		25.9	28.1		24.6	26.3	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	0.48	0.60	0.83	0.41	0.48	0.71	0.35	0.47	0.67
CD (p=0.05)	1.00	1.26	1.74	0.85	1.00	1.49	0.73	0.98	1.40

Available potassium

Zinc levels and soils brought significant enhancement in available potassium in soil over control at all stages of crop growth (Table 3).

Table 3 Effect of zinc application on available potassium (kg ha^{-1}) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	317.5	330.2	323.8	288.2	306.1	297.1	276.1	288.1	282.1
2.5	341.8	355.4	348.6	318.4	336.4	327.4	307.8	315.0	311.4
5.0	359.4	372.6	366.0	342.8	353.0	347.9	321.3	328.1	324.7
7.5	361.8	376.3	369.0	346.0	356.2	351.1	322.0	333.0	327.5
Mean	345.1	358.6		323.8	337.2		613.6	316.0	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	3.92	4.93	6.82	2.51	3.10	5.91	2.32	2.54	6.31
CD (p=0.05)	8.16	10.26	14.20	5.23	6.45	12.30	4.83	5.30	13.13

Available potassium declined with advancement of crop growth. Available potassium increased with zinc levels and the highest available K was noticed with 7.5 mg Zn kg^{-1} which was comparable with 5.0 mg Zn kg^{-1}. The addition of 7.5 mg Zn kg^{-1} recorded 369.0 kg ha^{-1} (tillering stage), 351.1 kg ha^{-1} (panicle initiation stage) and 327.5 kg ha^{-1} (harvest stage) available potassium in soil. Irrespective of the stages of crop growth, available potassium was higher in Entisol than Vertisol. The maximum amount of available potassium was noticed with 7.5 mg Zn kg^{-1} . The enhanced available K in soil due to zinc was adequately supported by significant and positive relationship between NH_4OAC-K with DTPA-Zn (r-0.92** (TS), r=0.95** (PI) and r=0.97** (HS)). Duraisamy (1979) reported application of zinc increased K content in soil at all stages of crop growth.

Available zinc

On close examination of the data in Table 4, indicated that available zinc in soil was significantly influenced by graded dose of zinc and soils over control at all stages of crop growth.

Table 4 Effect of zinc application on available zinc (mg kg^{-1}) at different stages of rice crop

Zn levels (mg kg^{-1})	Tillering stage		Mean	Panicle initiation stage		Mean	Harvest stage		Mean
	S_1	S_2		S_1	S_2		S_1	S_2	
0	0.60	0.64	0.62	0.50	0.53	0.51	0.43	0.47	0.45
2.5	1.26	1.40	1.33	1.06	1.27	1.16	0.90	1.12	1.01
5.0	1.34	1.63	1.47	1.16	1.48	1.32	0.98	1.27	1.12
7.5	1.35	1.66	1.50	1.20	1.50	1.35	0.99	1.28	1.13
Mean	1.14	1.33		0.98	1.20		0.82	1.03	
	Zn	S	Zn x S	Zn	S	Zn x S	Zn	S	Zn x S
SEd	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.01	0.03
CD (p=0.05)	0.03	0.04	0.07	0.03	0.04	0.06	0.02	0.03	0.06

PA-Zn (r=0.87** (TS), r=0.89** (PI), r=0.91** (HS)).

Available zinc in soil progressively declined with advancement of crop growth. Available zinc improved with graded dose of zinc applied. The highest available zinc was noticed at tillering stage (1.50 mg kg^{-1}), panicle initiation stage (1.35 mg kg^{-1}) and harvest stage (1.13 mg kg^{-1}) with 7.5 mg Zn kg^{-1} which was comparable with 5.0 mg Zn kg^{-1}. The least available zinc in soil was noticed in control. The best treatment on an average caused 152 per cent increase in available zinc over control. At all stages of crop growth, available zinc was higher in Entisol than Vertisol. The maximum amount of available zinc was noticed with 7.5 mg Zn kg^{-1} . Increase in availability of major nutrients on addition of Zn was reported by Pedda Babu *et al.* (2006). The availability of zinc present in the soil or applied as fertilizer is governed by the net effect of physical, chemical and biological reactions in soil (Kumar and Qureshi, 2012). Increase in available zinc could be due to increased dose of zinc applied to soil. In the present study, the highest available zinc was noticed with 7.5 mg Zn kg^{-1}. Keram *et al.* (2012) reported significant increase in DTPA-Zn at higher level of zinc applied.

CONCLUSION

The present study clearly indicated the highest availability of N, P and K was with 5.0 mg Zn kg^{-1} while available zinc was highest with 7.5 mg Zn kg^{-1}.

References

Alloway, B.J. 2004. Zinc in soils and crop nutrition. International Zinc Association, Burssels, Belgium, pp. 1-128.

Babu, M.V.S., G. Adinarayana, K.S.Rama, D. Balaguruvaiah and R.T. Yellamanda. 2006. Evaluation of nutrient status of rainfed chickpea growing vertisol of Anantapur district, Andhra Pradesh. Indian J. Dryland Agrl. Res. Dev., 21(1): 24-26.

Catlett, K.H., D.H. Heil, W.L. Lindsay and H.M. Ebinger. 2002. Soil chemical properties controlling zinc activity in 18 Colorado soil. Soil Sci. Soc. Am., 66: 1182-1189.

Deb, D.L., G.N. Gupta, M.B. Meighri, R.K. Rattan and A.K. Sarkar. 1986. Radio isotope aided micronutrient research for increasing fertilizers use efficiency. Fert. News, 31(2): 21-29.

Dobberman, A. and T.H. Fairhurst. 2000. Nutrient deficiencies and nutrient management. Potash and Phosphate Institute, PPI of Canada and International Rice Research Institute, Singapore, p. 192.

Duraisamy, P. 1979. Studies on the effect of amendments and zinc in soil chemical properties, yield and uptake of nutrient by rice var. Bhavani in an alkali soil. M.Sc.(Ag.) Thesis submitted to Tamil Nadu Agricultural University, Coimbatore.

Katyal, J.C. and R.K. Rattan. 1993. Distribution of zinc in Indian soils. Fert. News, 38(3): 15-26.

Keram, K.S., B.L.Sharma and S.D. Sawarkar. 2012. Impact of zinc application on yield, quality, nutrient uptake and soil fertility in a medium deep black soil (Vertisol). Int. J. Sci. Environ and Tech., 1(5): 563-571.

Kumar, M. and F.M. Qureshi. 2012. Dynamics of zinc factors, availability to wheat (*Triticum aestivum*) and residual effect on succeeding maize (*Zea mays* L.) in Inceptisols. J. Agrl. Sci., 4(1): 236-245.

Mikkelson, D.S. and Shiou. 1977. Zinc fertilization and behavior in flooded soils. Splant publication. 5.Commonwealth Bureau of soils. Commonwealth Agri. Bureau, England.

Mortvedt, J.J., F.R. Cox, L.M. Shuman and R.H. Welch. 1991. Micronutrient in Agriculture, 2nd Edition, Soil Sci. Soc. Am., Madison, Wisconsin, USA.

Muthukumararaja,T., N.Nandhakumar and M.V.Sriramachandrasekharan.2019.Effect of zinc and silicon fertilization on growth and yield of rice. Int. J. Applied Res., 5(3):91-94.

SenthilKumar, P.S.,S.Arunageetha, P. Savithri, R. Jagadeeshwaran and K.P. Raghunath.2006. Effect of Zn enraged organic manures and zinc solubilizer application on the yield, curcumin content and nutrient status of soil under turmeric cultivation. J. Applied Hort., 6(2): 82-86.

Singh, B.S., K.A. Natesan, B.K. Singh and K. Usha. 2005. Improving zinc efficiency of cereals under zinc deficiency. Curr. Sci., 88(1-10): 36-44.

Singh, A.K., M.K. Mena and R.C. Bharati. 2011. Sulfur and zinc nutrient management in rice-lentil cropping system. Int. Conference on "Life science research for rural and agricultural development", CPRS, Patna, Bihar. pp. 66-67.

Shivay, Y.S. and R. Prasad. 2012. Zinc coated urea improves productivity and quality of Basmati rice under zinc stress condition. J. Plant Nutr., 35(6): 928-951.

Tandon, H.L.S. 1995. Micronutrients in soils, crops and fertilizer, FDCO, New Delhi, India.

How to cite this article:

Muthukumararaja. T and Sriramachandrasekharan M.V.2019, Impact of Zinc Fertilization on Available Nutrients In Zinc Deficient Soil. *Int J Recent Sci Res.*10 (07), pp. 33708-33710. DOI: http://dx.doi.org/10.24327/ijrsr.2019.1007.3730

****