ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 10, Issue, 09, pp.73562-73565, September, 2018

DOI: https://doi.org/10.24941/ijcr.32057.09.2018

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

EVALUATION OF CRITICAL LIMIT OF ZINC IN SOIL AND PLANT

*Indira Sarangthem, Devarishi Sharma, L., Nivedita Oinam and Punilkumar, L.

Professor and Head, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Central Agricultural University, Imphal

ARTICLE INFO

Article History:
Received 09th June, 2018
Received in revised form
24th July, 2018
Accepted 15th August, 2018
Published online 30th September, 2018

Key Words:

Pisum sativum L.,
Critical limit of Zn, Soil, Plant.

ABSTRACT

An experiment was conducted during 2016-2017 to study the critical limit of Zinc in soil and plant. Pea (Pisumsativum L.) cv. Rachna was taken as the test crop . The treatments consisted 0, 2.5 and 5.0 kg Zn ha-1 as ZnSO4.7H2O and Recommended dose of Nitrogen, Phosphorus and Potashas urea, single super phosphate and muriate of potash, were used. Each treatment was replicated thrice. Application of 5.0 kg Zn ha-1 gave the highest yield of pea. Dry matter yield, zinc content and zinc uptake by the plant also increases as the level of zinc increases. According to the graphical procedure of Cate and Nelson (1965) using a scatter diagram, the critical limit of available zinc was 0.69 mg kg-1 whereas the critical concentration of zinc in 50 days old pea plant tissue was 0.21 per cent.

Citation: ***Indira Sarangthem, Devarishi Sharma, L., Nivedita Oinam and Punilkumar, L.* 2018.** "Evaluation of critical limit of zinc in soil and plant", *International Journal of Current Research*, 10, (09), 73562-73565.

INTRODUCTION

Pea (*Pisumsativum*L.) is an important pulse crop of India grown during *rabi* season. In India, it is grown mainly as winter vegetable in the plains of north India and as summer vegetable in the hills. The pea is a member of the Leguminosea (legume family). There are two types of cultivated pea, the garden pea and field pea. The garden pea also known as table pea are harvested while the pods are still green and consumed as vegetable. Field peas on the other hand are harvested after the seeds are fully matured and dried. Zinc is one of the important micronutrients essential for plants, animals and human health. It is needed in very small amount but from the nutritional point of view, it is indispensable like any other essential nutrients. Almost half of the soils in the world are deficient in zinc. Indian soils are generally low in zinc. The field scale Zn deficiency in rice in *tarai* soil was first reported by Nene in 1966 in India. Zinc is the most deficient micronutrient in Indian soils (49%), and its deficiency afflicts nearly 1/3rd of the acid soils of the country. The deficiency is even more severe (60%) in acidic soils of North-Eastern India (Kumar *et al.,* 2016), which might be one of the reasons behind lower crop productivity in the region. Adequate zinc fertilization is therefore, crucial to exploit the yield potential of crops.

***Corresponding author: Indira Sarangthem,**
Professor and Head, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Central Agricultural University, Imphal.

In order to increase productivity, correction of Zn deficiency is therefore, necessary which in turn requires the precise evaluation of available zinc in soil. Critical limit of a nutrient in soils refers to a level below which the crops will readily respond to its application. It can also be considered as the desirable range of values for a selected soil indicator that must be maintained for normal functioning of the soil ecosystem health. Within this range, the soil and plants performs its specific functions in natural ecosystems. The critical limits/levels are quite often employed for a wide variety of soils and crops, even though these critical limits may be different not only for soils, crop species but also for different varieties of a given crop (Singh and Aggarwal, 2007). The general critical levels of Zn deficiency in soils and crops falls in the range 0.6 – 1.0 mg kg^{-1} (DTPA-extractable) and 10-20 mg kg^{-1} in dry matter, respectively (Katyal and Rattan, 2003) but vary with soils and crops.In order to apply zinc fertilizers for better efficiency of yield, it is also important to know the critical limit of Zn in the soil. Critical limit of a nutrient in soils refers to a level below which the crops will readily respond to its application. Although, Zn is widely used as a fertilizer but efficient and economical method to correct its deficiency on a long term basis and in a specific cropping system is desirable. The information on Zn fertilizer use emanating from soil testing laboratories should be based on the critical limits of extractable Zn for different crops and soils. This also save numerous amount of fertilizers being wasted by the farmers while growing the crops.

Table 1. Effect of Zn application on dry matter yield, Zinc concentration and its uptake by plants

Soil samples	DTPA extractable Zn	Dry matter yield (g/pot) Zn level (kg ha^{-1})			Bray's % Zn yield	Zn conc. in plants (%) Zn level (kg ha^{-1})			Zn uptake by plant (mg/pot) Zn level (kg ha^{-1})			Bray's % Zn uptake
		0	2.5	5.0		0	2.5	5.0	0	2.5	5.0	
1	1.06	1.98	2.04	2.32	85.15	0.23	0.23	0.23	4.55	4.69	5.34	85.21
2	0.66	1.45	1.82	1.99	72.79	0.21	0.21	0.26	3.02	3.82	5.17	58.33
3	1.08	1.27	1.30	1.46	87.32	0.25	0.26	0.27	3.19	3.38	3.94	80.85
4	0.57	0.63	1.27	1.43	44.10	0.08	0.16	0.19	0.50	2.03	2.72	18.57
5	0.75	1.58	1.99	2.19	72.17	0.20	0.21	0.24	3.16	4.18	5.26	60.14
6	1.14	1.25	1.64	1.64	76.52	0.20	0.23	0.25	2.51	3.77	4.10	61.22
7	0.86	1.54	1.87	1.92	80.32	0.24	0.25	0.26	3.70	4.68	4.99	74.14
8	0.83	1.58	1.69	1.85	85.33	0.21	0.22	0.24	3.32	3.72	4.44	74.66
9	0.63	1.24	1.28	2.38	52.20	0.18	0.22	0.26	2.24	2.82	6.19	36.14
10	1.38	1.44	1.62	1.77	81.64	0.22	0.24	0.25	3.18	3.89	4.43	71.84
11	1.17	1.22	1.45	1.48	82.31	0.21	0.23	0.24	2.56	3.34	3.55	72.02
12	0.59	1.61	1.93	1.99	80.66	0.23	0.23	0.25	3.69	4.44	4.98	74.21
13	0.85	1.80	1.87	2.32	77.51	0.21	0.22	0.24	3.78	4.11	5.57	67.82
14	0.76	1.53	1.89	1.96	77.82	0.17	0.18	0.22	2.59	3.40	4.31	60.13
15	0.72	1.38	1.55	1.69	81.85	0.26	0.27	0.28	3.60	4.19	4.73	76.00
16	1.09	1.81	1.85	2.03	89.33	0.22	0.19	0.22	3.99	3.52	4.47	89.33
17	0.91	1.39	1.39	1.59	87.23	0.25	0.21	0.24	3.47	2.92	3.82	90.87
18	0.83	1.76	1.86	2.03	86.47	0.22	0.22	0.24	3.86	4.09	4.87	79.27
19	0.71	1.47	1.51	1.66	88.25	0.22	0.25	0.26	3.22	3.78	4.32	74.68
20	1.68	2.14	2.21	2.39	89.75	0.26	0.26	0.30	5.58	5.75	7.17	77.78
Mean	**0.91**	**1.50**	**1.70**	**1.90**	**78.94**	**0.21**	**0.22**	**0.25**	**3.28**	**3.82**	**4.72**	**69.16**
CD at 5% for Zn = 0.044 CD at 5% for soil = 0.017 CD at 5% for Zn x Soil = 0.076						CD at 5% for Zn = 0.006 CD at 5% for soil = 0.002 CD at 5% for Zn x Soil = 0.010			CD at 5% for Zn = 0.100 CD at 5% for soil = 0.039 CD at 5% for Zn x Soil = 0.173			

In view of the above, an attempt was made to study the critical limit of zinc in soil and pea plant which is a major pulse grown widely in the state of Manipur for optimum yield.

MATERIALS AND METHODS

Surface soil samples (0-15cm) for twenty soil samples were collected from paddy cultivated valley fields of Manipur. The soil samples were thoroughly air dried in shade, ground in wooden mortar and pestle and passed through 2 mm sieve. Soil available zinc was determined using Atomic Adsorption Spectrophotometer (ASS) as described by Lindsay and Norvell (1978). The pot culture experiment was carried out under net house with the objectives of studying the critical level of the plant during December, 2016-February, 2017. Soils from 20 paddy cultivated valley fields of Manipur were used and the processed samples (<2mm) were analyzed for their physico-chemical properties using the standard procedure. The soil samples were completely air dried in the shade, ground in the mortar. Plastic pots of 4kg capacity were used for the experiment. The pots were filled with 3 kg of collected soils separately with due labelling and arranged in completely randomized design (CRD with the treatment of 2.5 and 5.0 Zn kg ha^{-1}.The fertilizer requirements of each of the treatments were calculated on the basis of 3 kilograms of soil per pot and were mixed with soil thoroughly. The recommended dose of NPK @ 20:40:30 was applied through Urea, Single super phosphate and Muriate of potash, respectively to each pot. Zinc fertilizer was applied in the form of zincsulphateheptahydrate ($ZnSO_4.7H_2O$).Each treatment was replicated thrice. Pea (*cv.* Rachna) was sown at the end of December, 2016. Ten seeds were sown in each pot, which were thinned downed to 5 after germination. Normal water management was done. The crop was harvested at 50 days of growth. Plants were washed to removed dirt with running tap water followed by distilled water and were dried in an oven at 65 °C for 48 hours and the dry matter yield was recorded.

The dried plant samples were ground and sieved through 2 mm sieve and kept for analyzing nitrogen, phosphorus, potassium and zinc.

Bray's per cent yield of pea was calculated as

$$\text{Bray's per cent yield} = \frac{\text{Yield without fertilizer}}{\text{Maximum yield in fertilizer treated pots}} \times 100$$

The critical levels of both soil and plant were estimated by graphical procedure of Cate and Nelson (1965).

RESULTS

Dry matter yield of pea: The dry matter yield of Pea plant, cv. Rachna was affected by the application of zinc regardless of initial zinc status in the soils (Table 1). The results indicated that the dry matter yield of pea was greatly influenced by the different levels of zinc concentration. The dry matter yield in the control varied from 0.63 to 2.14 g/pot (mean 1.50 g) as compared with 1.27 to 2.21 g/pot (mean 1.70 g) in 2.5 kg Zn ha^{-1} and 1.43 to 2.39 g/pot (mean 1.90 g) in 5.0 kg Zn ha^{-1}, respectively. Application of zinc at the rate of 5.0 kg ha^{-1} was significantly superior to other zinc application. Application of zinc fertilization gradually increased the dry matter yield of pea. The lowest dry matter yield at no zinc applied pots was recorded in the soils of Phoijing village and the highest value was obtained at the field of Matai village irrespective of the nature of soils. It was recorded that dry matter yield of pea was highest at 5.0 kg Zn ha^{-1}. The highest dry matter yield (2.39g/pot) was recorded in the soils of Matai village and the lowest (1.43 g/pot) was observed in the soils of Phoijingvillage. The dry matter yield of pea due to different treatments of zinc was found significant at 0.05 or 0.01 level of probability.

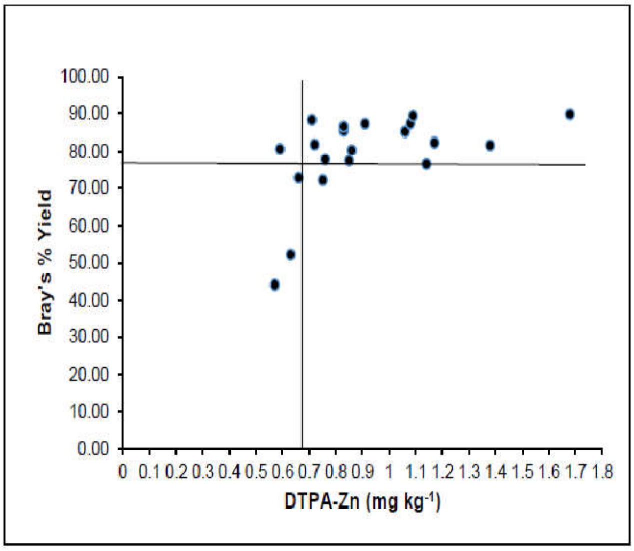

Fig. 1a. Scatter diagram showing relationship between Bray's per cent yield of pea and DTPA extractable zinc in soil

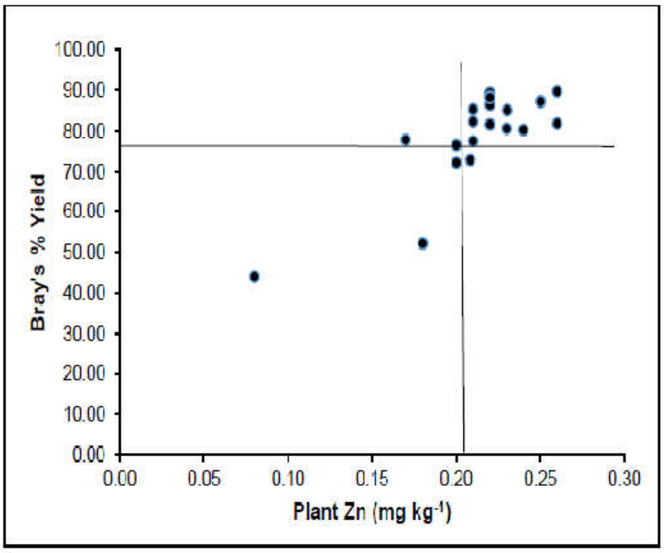

Fig. 1b. Scatter diagram showing relationship between Bray's per cent yield and tissue zinc concentration in pea

On the other hand, the dry matter yield of different soils collected from various locations and interaction between different soils and zinc were also found significant at 0.05 or 0.01 level of probability.

Zinc content: The zinc contents in pea plant at no zinc (control) pots are presented in Table 1. The zinc concentration in the pea plant ranged from 0.08 to 0.26 per cent (mean 0.21 per cent), 0.16 to 0.26 per cent (mean 0.22 per cent), 0.19 to 0.30 per cent (mean 0.25 per cent) for 0, 2.5, 5.0 kg Zn ha^{-1}, respectively. The results showed that the zinc content in the plants was influenced by different levels of zinc application. It was recorded that the zinc content in the pea plants was highest at 5.0 kg Zn ha^{-1} comparing to 0 (control) and 2.5 kg Zn ha^{-1}. The zinc content in the plant due to zinc application was significantly different at 0.05 or 0.01 level of probability. On the other hand, different soil samples from various places and interaction between the different soils and zinc treatments were also found significant at 0.05 or 0.01 level of probability.

Zinc uptake: The data (Table 1) revealed that total zinc uptake by pea plant was highest with zinc applied at the rate of 5.0 kg Zn ha-1 (4.72 mg/pot) which was significantly higher than the control (3.28 mg/pot) and 2.5 kg Zn ha-1 (3.82 mg/pot). On the other hand, pea plant accumulates the highest amount of zinc in the soils of Matai village (6.16 mg/pot) whereas the lowest amount of zinc accumulation was noticed in the soils of Phoijing village (1.75 mg/pot). The total zinc uptake by the pea plant at different zinc levels was found significant at 0.05 or 0.01 level of probability. On the other hand, different soils collected from various area were also found significant at 0.05 or 0.01 level of probability. There was also significant difference due to soils with the different levels of zinc treatment.

Critical limits of soils and plant: The critical limits of available Zn extracted by DTPA extractant was estimated according to the procedure (graphical method) outlined by Cate and Nelson (1965). The critical level of available Zn is that threshold level of Zn availability below which probability of obtaining adequate (economic) response to added Zn fertilizer is high.

In other words, critical limit (availability) of a particular nutrient is used to distinguish fertilizer (Zn in present case) responsive soils from the non-responsive ones. The critical limit of available Zn in present study was found to be 0.69 mg kg^{-1} (Fig. 1a.). It is expected that pea plant will respond to zinc application when the soils contain less than 0.69 mg kg^{-1} DTPA extractable zinc. Using the same graphical procedure of Cate and Nelson (1965), critical Zn concentration in pea plant (50 DAS) was found to be 0.21 per cent (Fig. 1b.). Below this concentration, plant could be regarded as Zn deficient at the specified growth period, and hence it would require external Zn application. The present findings were very close with the findings of Singh *et al*. (1999); Kumari *et al*. (2013) and Sakal *et al*. (1984).

Conclusion

Using the graphical method of Cate and Nelson (1965), the critical limits of available Zn in present study was found to be 0.69 mg kg^{-1}(Fig. 1a.). Using the same graphical procedure of Cate and Nelson (1965), critical Zn concentration in pea plant (50 DAS) was found to be 0.21 per cent (Fig. 1b.). Below this concentration, plant could be regarded as Zn deficient at the specified growth period, and hence, it would require external Zn application.

REFERENCES

Cate, R.B. and Nelson, L.A. 1965.Graphical procedure for critical limits of nutrients.*Proc. Soil Sci. Soc. Am*., 89: 658.

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

Kumar, M., Jha, A.K., Hazarika, S., Verma, B.C., Choudhury, B.U., Ramesh, T. and Devi, M.H. 2016. Micronutrients (B, Zn, Mo) for improving crop production on acidic soils of Northeast India. *National Academy Sci. Letters*, 39(2): 85-89.

Kumari, M., Yadav, K. and Nisha, K. 2013. Critical limits of zinc in soil and plants for maize in Diaraland soils of Bihar. *Environ. & Eco*., 31(2): 1107-1110.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, manganese and copper. *Soil Sci. Soc. Am. J*., 42: 421-428.

Sakal, R., Singh, A.P., Singh, B.P. and Sinha, R.B. 1984. Assessment of some chemical extract ants for available zinc in relation to response of rice to applied zinc in Sub-Himalayan hill and forest soils. *Plant and Soil*, 79: 417-428.

Singh, A.K., Nongkynrih, P. and Khan, S.K. 1999. Critical limit of zinc deficiency for predicting response of rice soils of Meghalaya. *J. Indian Soc. Soil Sci*., 47: 5567-569.

Singh, V.K. and Agrawal, H.P. 2007. Development of DRIS norms for evaluating nitrogen, phosphorus, potassium and sulphur requirement of rice crop. *J. Indian Soc. Soil Sci*., 55: 294-303.

****