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Establishment of Critical level of Zinc in soil and soybean crop grown on Vertisol by graphical method

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Abstract: *A pot culture experiment was conducted for establishment critical limit of zinc in soil and soybean crop at Department of Soil Science and Agricultural Chemistry, Marathwada Agricultural University, Parbhani during Kharif 2010 with objective to establish critical limit of zinc in soil and for soybean crop as well as to study the effect of zinc application on growth, yield and uptake of nutrients in soybean crop. The experimental soil was alkaline in nature, electrical conductivity of the soil was in safe limit for crop growth. The organic carbon status was low to medium and soil was moderately calcareous in nature.*

Soybean positively responded for application of Zn @ 7.5 kg Zn ha^{-1}as well as 10 kg Zn ha^{-1}, both treatments were equally effective for improving growth and yield attributes. The concentration of Zn as well as its uptake was increased with increasing levels of zinc application. Soil available nitrogen, phosphorus and potassium have shown positive balance at physiological maturity of the crop and increased dose of zinc helped to restore the zinc status of soil. The critical limit of zinc in soil and soybean crop was established as 0.95 mg kg^{-1} and 45.00 mg kg^{-1}, respectively. These critical limits may be utilized for separating zinc responsive and non responsive soybean crop in Vertisol.

(***Key world:*** *Soil and plant Zinc, Bray,s concept ,critical level by graphical method)*

I. Introduction

Soil testing fertilizer recommendation is a common practice for efficient use of fertilizers. The reliability of a soil test and critical limit to make accurate prediction of crop response to applied nutrient vary with soils and crops. Most of the information on critical limit of nutrient, since the introduction of concept of the critical limit by Cate and Nelson (1965) is based on the results of pot culture experiments.

Soil tests have been used only to separate out deficient soil form non deficient soil. Cate and Nelson (1965) used critical concentration approach for characterizing deficiency or sufficiency of a particular nutrient which further related with the critical concentration approach of a nutrient in question.

The soils vary greatly in the total content of nutrients because of the wide variation in the nature of the parent material and the influence of soil forming processes under different climatic conditions, soil texture, pH, organic matter content, $CaCO_3$, type of clay minerals and interaction among nutrients markedly regulate the availability of nutrient in soils.

There is a need to know critical concentration of nutrient in plants similar to soil test. However, no one critical concentration can be used for all crops and varieties under variable soils and environmental conditions. The variability in critical level for nutrient concentration in plants would be associated with various factors. Among the important plant factors, crop and crop cultivars, stage of crop growth, plant part sampled nature of experiment and nutrients interactions indicated significant variation in critical level of micronutrient. Thus, the threshold value of micronutrient in soil and plant assume greater importance in monitoring the sustainability related to soil micronutrient reserve. Large numbers of efforts have been made to establish critical values of nutrient for soil and crop.(Malewar et al.,(1999).

II. Material And Methods

A pot culture experiment was conducted with three soils collected from Parbhani district. The soils varied from <0.6 mg/kg low, 0.6 to 1.12 mg/kg medium, and > 1.12 mg/kg high. Five groups of soil were made from soil having low available zinc. Three groups of soils were made from soil having medium available zinc and two groups were made from the soil having high in available zinc. So in all there was 5, 3 and 2 soil groups of low, medium and high zinc, respectively. Each group of soil was treated with five levels of zinc application (0, 2.5, 5, 7.5, 10 kg Zn/ha) and grouped in three categories low 'Z' (25 pots), medium 'Z' (15 pots) and high 'Z' (10 pots). In all there were 50 pots in one replication. There were 2 replication totaling 100 pots for experiment.

The processed soil were analyzed for pH, EC, Organic carbon, calcium carbonate, available N, available P and available K DTPA extracted zinc by standard methods and it is shown in below table.

Table.1 Initial chemical properties of experimental soil:

Zinc status	P^H	EC (dSm^{-1})	Org.C (%)	$CaCO_3$ (%)	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)	DTPA Zn (Mg/kg)
Low	7.96	0.81	0.814	2.7	194.8	0.40	650.2	0.6
Medium	7.84	1.08	1.03	2.6	188.3	5.30	700.4	0.8
High	7.88	0.50	0.506	2.6	190.4	7.00	740.9	1.12

It was determined by using plant digest obtained from digestion by HNO_3 an $HClO_4$ and measurements were taken on atomic absorption spectrophotometer as described by Lindsay and Norvell (1978). A completely randomized design (factorial experiment) with two replication was adopted.

In order to assess the response of zinc to the applied zinc in deficient, marginal and high zinc content soil, pot culture experiment was conducted and the data emerged out from the experiment on soil zinc concentration, threshold yield (yield of no zinc application), plateue yield (yield at 120 kg $ZnSO_4$/ha) and leaf zinc concentration comparing the critical limits were utilized as per procedure outlined by Cate and Nelson (1965).

$$\text{Bray's yield (\%)} = \frac{\text{(yield without zinc)}}{\text{(yield with zinc)}} \times 100$$

The critical values were read from X axis where the cross intercept (Cate and Nelson, 1965) and graphically analyzed as per the method given by Cate and Nelson employs a clear plastic overlay having a pair of perpendicular line drawn on it and worked out the critical limit of soil and plant.

III. Result And Discussion:

The data pertaining showed that out 20 soils, ten soils were rated for low category for zinc, five were marginal and five soils were high in zinc as per Cate and Nelson (1965).

The data indicated on available soil zinc content, threshold yield (yield at 0 kg Zn application), plateau yield (yield at 10 kg Zn application) and relative percent yield (threshold yield /plateau yield x100) are presented in table 2.

The graphical representation in the form of XY scattered graph points is depicted in Fig.3 and 4. The points obtained from relative total dry matter yield percentage and available zinc are divided into two populations from the positioned clear plastic overlay perpendicular line drawn on it which by intersecting X axis produce four quadrants showed perfect correlation and the critical limit emerged out 0.95 mg kg^{-1} for soybean growing soil. Mehra et al. (2004) reported that the soil containing DTPA- Zn ranging from 0.50 to 0.60 mg kg^{-1} were taken for studying the response and critical limit for DTPA – Zn .

The data pertaining to plant zinc concentration threshold yield, plateau yield and relative dry matter yield in percentage are presented in Table 1 and depicted in Fig. 3 and 4. The points obtained and depicted in Fig. 3 and 4 from relative total dry matter yield percentage and zinc nutrient concentration in soybean crop are scattered in two positive quadrants and were separated with 65.00 per cent yield horizontal line revealed that the critical limit of soybean comes to 45 mg kg^{-1} dry matter. From the above results the critical limit to available zinc for Vertisol soil be considered as 0.95 mg kg^{-1}, while for soybean crop it should be considered as 45 mg kg^{-1} dry matter as critical zinc concentration for separating the zinc responsive crop and non responsive ones.

Kuldeep Singh (1986) reviewed that the critical level of Zn concentration in plant below which plant response to Zn application may be expected was found to be 15.4 ppm in cluster bean. Nayyar and Singh (1997) showed that the critical deficiency level (CDL) in youngest fully expanded leaf associated with a 10 per cent reduction in yield of soybean and green gram was computed to be 22.1 and 22.3 kg ha^{-1}, respectively.

IV. Conclusion

The results of the present investigation shows the critical limit of DTPA Zinc in Vertisols and soybean crop was established as 45 mg kg^{-1} and 0.95 mg kg^{-1}. It is concluded that to use these critical limit separating zinc responsive and non-responsive crop in Vertisols clayey soil.

Table2. Relative yield, plateau yield, threshold yield and zinc concentration of soil and plant grand growth stage of soybean crop

Sr. No.	Initial soil zinc status (kg ha^{-1})	Zinc in plant (conc.)	Yield (g $plant^{-1}$)	Plateau yield (g $plant^{-1}$)	Relative yield (%)
1	0.40	15.50	9.19	15.0	61.26
2	0.50	18.00	10.2	16.0	63.75
3	0.52	22.25	10.1	16.0	63.12
4	0.56	24.09	9.7	15.3	63.39
5	0.57	25.00	98	12.0	81.66
6	0.60	27.00	9.5	15.6	60.89

7	0.74	28.00	10.0	16.1	61.80
8	0.78	30.00	10.0	16.3	61.41
9	0.80	32.00	10.2	16.1	63.07
10	0.81	34.00	10.4	15.4	67.53
11	0.82	36.00	12.0	18.8	63.82
12	0.83	38.00	12.5	20.0	62.50
13	0.86	39.00	12.6	19.7	63.95
14	0.87	41.25	11.2	18.0	62.22
15	0.90	40.00	12.3	19.9	61.80
16	0.90	48.25	13.4	19.8	67.67
17	0.98	49.29	15.2	19.6	77.55
18	1.00	49.50	13.1	19.5	67.17
19	1.20	50.02	12.9	20.0	64.50
20	1.21	50.01	14.2	20.2	70.29

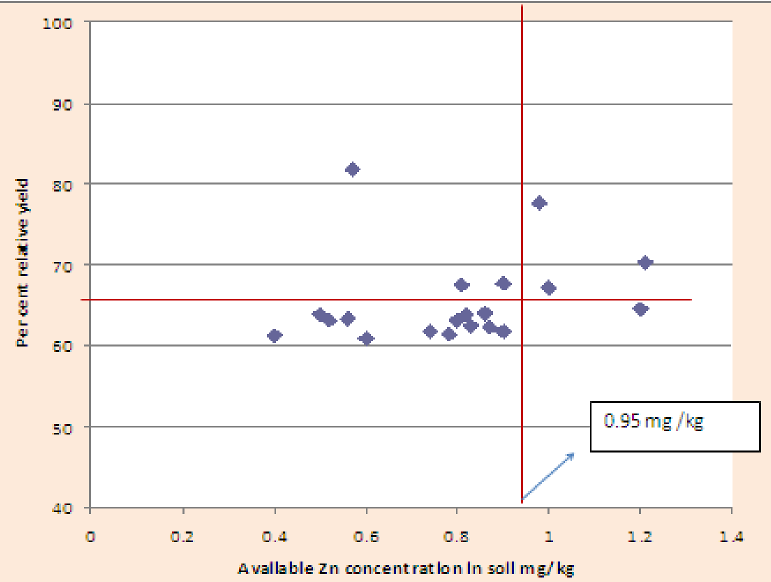

Fig. 3. Available soil Zn in relation to per cent relative yield of soybean crop

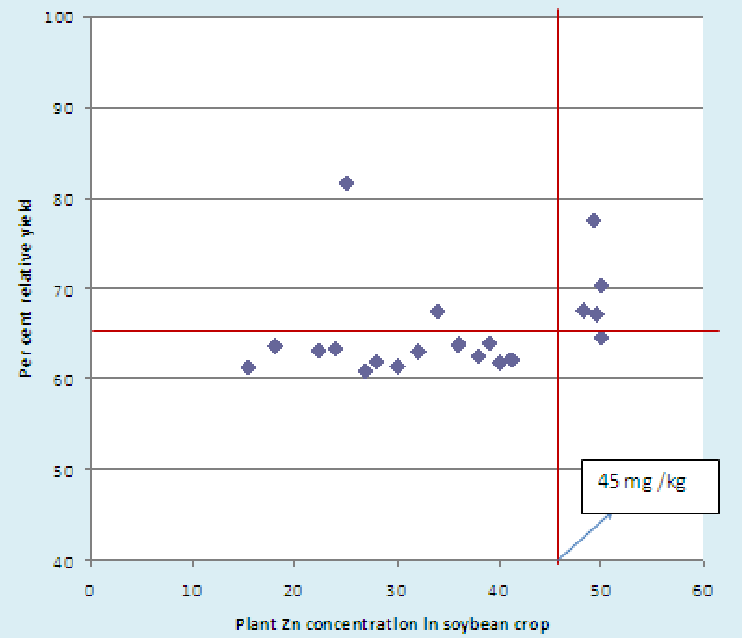

Fig. 4. Plant Zn concentration in relation to per cent relative yield of soybean crop

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