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Comparison of soil boron critical levels established by graphical and statistical approach in Cauliflower (*Brassica Olercicea*)

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Abstract
The results of pot experiment conducted on four soil groups containing available boron in low to high range under graded boron levels indicated that there was significant response of added boron to cauliflower. The magnitude of response was between 45 and 50 per cent. The critical soil boron concentrations established by graphical and statistical procedures were 0.52 and 0.51 mg/kg, respectively. Both the methods showed very closer values of critical soil boron concentrations. These critical limits for soil available boron would be useful to delineate boron deficiency in soils.

Additional keywords: Critical limit, soil boron, graphical and statistical methods

Introduction

A graphical procedure was developed for establishment of critical concentration of nutrient in soil and plant (Cate and Nelson 1965). Many times, it was criticized that graphical procedure is a rough estimation of separation of population in to two responsive and non-responsive soils. Cate and Nelson (1971), thus, developed statistical model to delineate the deficiency of nutrient in soils. Boron, plays an important role in crop nutrition. Cauliflower expresses its sensitivity which ultimately decides the crop yield potential and quality of curds. Critical level approach, though, used in field crops on large scale, it was rarely advocated in vegetable crops. Thus, an attempt was made to assess the soil boron concentration by graphical and statistical procedures using cauliflower as a test crop.

Materials and methods

Twenty bulk surface soil samples (0-30 cm) were collected from Sendra A, Sendra B, Khanapur and Balsa blocks of Central farm, Marathwada Agricultural University, Parbhani during 1995-96. These soils viz. very deep black, deep black, shallow black and light textured were classified as per USDA system in to Typic Haplusterts, Vertic Ustochrepts, Lithic Ustorthents and Typic Ustorthents, respectively. Out of 20 bulk samples, 12, 5 and 3 soils were low, marginal and high in content of hot water soluble boron as per ratings suggested by Badrinath *et al.* (1986). There were 4 levels of boron (0, 2.5, 5 and 7.5 mg/kg) and 20 soils having low to high hot water soluble boron. The treatments were replicated thrice. Thus, the total number of pots were 240. Requisite quantities of boron as per treatments were applied to 20 bulk samples. The recommended doses of N, P and K (100 : 50 : 50) were applied to all the soils. These were thoroughly mixed, moistened and allowed to equilibrate. Thirty kg each of treated soil was transferred to the polythene lined earthen pots (33x42 cm). This way, 240 pots were filled and experiment was framed in factorial randomized block design. Three cauliflower seedlings (Variety : Snowboll-16) were transplanted in each pot during winter season and allowed to grow up to 65 days i.e mid-bloom stage. The deionised water was used for irrigation as and when required. The above ground part of cauliflower plants were harvested at 65 days as suggested by Gupta and Cutcliffe (1987). Soils were analyzed for their physical and chemical properties (Jackson 1967) and hot water soluble boron by Azometine-H indicator proposed by Wolf (1971). The cauliflower dry matter yield was recorded treatment wise and data were subjected to compute Bray's per cent yield as *Yield without boron x 100.* Further, critical soil available boron was established by using suggested procedures by Cate and Nelson (1965, 1971).

Results and discussion

The hot water soluble boron ranges from 0.22 to 0.74 mg/kg in different soil groups indicating highest and lowest mean values of 0.72 and 0.31 mg/kg in Typic Haplusterts and Typic Ustorthents, respectively (Table 1). Similar trend of available phosphorus in soils was observed. All the soil groups had calcareous nature, moderately alkaline pH range with safe content of soluble salts. However, organic carbon differed moderately in its content in different soil groups showing highest and lowest mean values of 0.63 and 0.40 per cent in Vertic Ustochrepts and Typic Ustorthents, respectively.

Table 1. Available boron and other soil properties of experimental soils

Soil group and no. of samples	Available boron (mg/kg)	pH	EC dS m^{-1}	Organic carbon (%)	Free $CaCO_3$ (%)	Available P_2O_5 (kg ha^{-1})
Typic Haplusterts (VDB) (3)	0-71-0.74 (0.72)	8.1-8.5 (8.2)	0.38-0.57 (0.47)	0.55-0.58 (0.56)	7.0-10.5 (8.15)	28.12-40.32 (34.22)
Vertic Ustochrepts (DB) (5)	0.51-0.60 (0.55)	7.8-8.5 (8.1)	0.25-0.36 (0.30)	0.56-0.61 (0.63)	7.0-11.5 (9.25)	20.16-31.36 (25.76)
Lithic Ustorthents (SB) (5)	0.44-0.48 (0.46)	8.1-8.5 (8.3)	0.19-0.41 (0.30)	0.37-0.52 (0.44)	7.5-11.0 (9.25)	8.90-26.88 (17.92)
Typic Ustorthents (LT) (7)	0.22-0.40 (0.31)	7.8-8.2 (8.0)	0.20-0.41 (0.30)	0.31-0.49 (0.40)	8.0-13.5 (10.75)	11.20-18.40 (15.0)

VDB = Very deep black soils, DB = Deep black soils SB = Shallow black soils; LT = Light texture soils
* Figures in parenthesis indicate average values

The results on initial hot water soluble boron (available B) in soils, dry matter yield at no boron and 5 mg/kg boron and Bray's per cent yield are tabulated in table 2. The dry matter yield of cauliflower increased with the increasing levels of boron particularly in soils low to marginal in hot water soluble boron. The data in table 2 were subjected to establish critical soil boron by adopting the procedure described by Cate and Nelson (1965). In graphical presentation (Fig. 1), boron soil test values were plotted on X-axis and Bray's per cent yield values on Y-axis. A plastic cross overlay was moved in such a way that the opposite quadrants upper right and lower left should have maximum coverage of points. The intercepting point touches to the X-axis which was to be considered as a critical level of soil available boron. This critical value divides soils as highly responsive and non-responsive to boron application. The maximum Bray's per cent yield (66.8 per cent) corresponds to the critical soil available boron value of 0.52 mg/kg, below which high response of added boron to crops is expected.

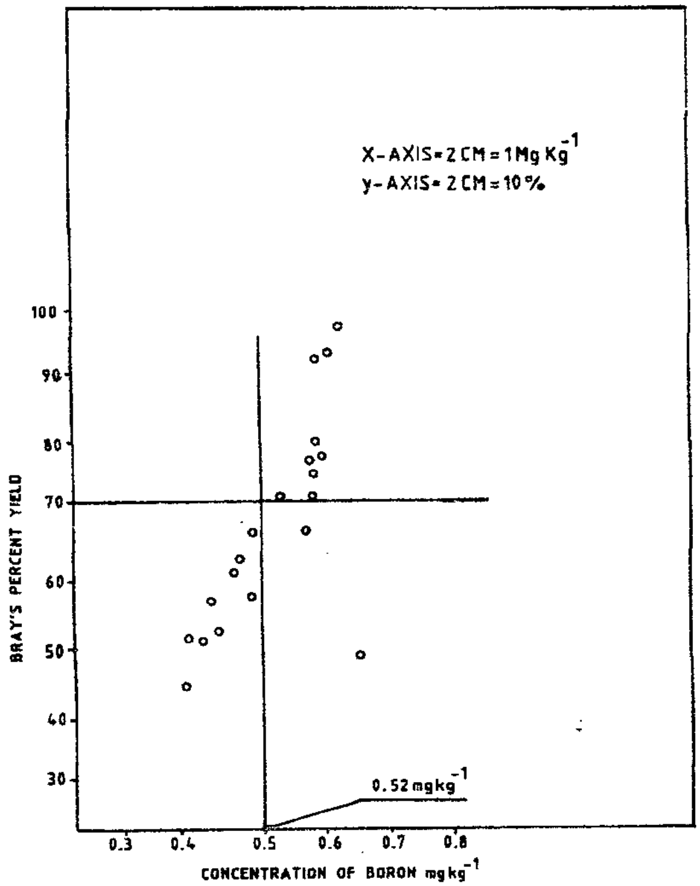

Fig. 1. Scatter diagram between Bray's per cent yield and soil test value by Graphical method.

Table 2. Soil available boron, Bray's per cent yield and response of added boron to dry matter yield of cauliflower

Sr. No.	Soil location & survey No.	Soil available boron (mg/kg)	Dry matter yield		Bray's per cent yield
			No boron	5 mg/kg boron	
1.	Sendra A (21)	0.412	37.50	80.75	43.43
2.	Sendra A (18)	0.435	37.50	78.00	48.07
3.	Sendra A (23)	0.425	38.50	78.75	49.23
4.	Sendra A (132)	0.451	40.25	77.50	51.93
5.	Sendra A (129)	0.460	39.75	77.50	51.12
6.	Sendra B (13)	0.452	42.75	77.75	54.34
7.	Sendra B (14)	0.481	46.75	78.25	59.36
8.	Sendra B (52)	0.503	43.75	78.05	56.08
9.	Sendra B (72)	0.488	47.75	76.50	62.41
10.	Sendra A (19)	0.525	51.75	77.50	66.77
11.	Sendra A (135)	0.545	54.00	77.00	70.12
12.	Sendra A (119)	0.583	52.25	78.50	66.56
13.	Khanapur (82)	0.592	56.75	78.50	72.29
14.	Khanapur (93)	0.596	58.50	77.25	75.72

Sr. No.	Soil location & survey No.	Soil available boron (mg/kg)	Dry matter yield		Bray's per cent yield
			No boron	5 mg/kg boron	
15.	Balsa (21)	0.600	59.25	78.25	75.71
16.	Balsa (18)	0.603	58.25	76.25	76.34
17.	Balsa (31)	0.605	60.00	76.25	78.08
18.	Khanapur (96)	0.615	60.00	64.50	93.05
19.	Khanapur (94)	0.620	60.00	64.00	93.75
20.	Khanapur (91)	0.635	61.00	63.75	95.80

Further, data on available soil boron corresponding to corrected sum of squares for the population, postulated critical level and predictability value (R^2) are computed as per statistical model described by Cate and Nelson (1971) and given in table 3. The R^2 values range between 0.3043 and 0.6962. The highest R^2 value recorded was 0.6962. On X-axis soil values are plotted against R^2 values on Y-axis (Fig. 2). On the basis of highest predictability (R^2) value, two populations can be easily partitioned which correspond to the postulated critical level i.e. 0.51 mg/kg (Fig. 2).

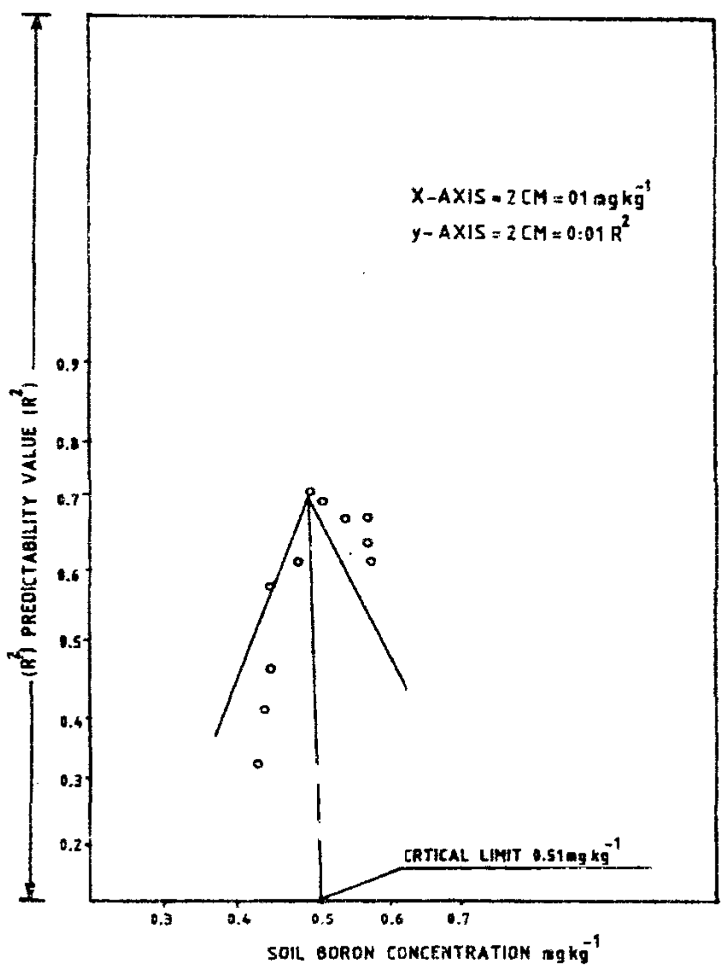

Fig. 2. Scatter diagram between B concentration and R^2 value.

Critical available boron values obtained from graphical (0.52 mg/kg) and statistical (0.51 mg/kg) approaches showed no difference and both the methods appeared to be equally precise in predicting the deficiency of boron in cauliflower growing soils. Sakal *et al.* (1985) also reported more or less similar critical soil available boron values by both the methods for blackgram.

Table 3. Soil available boron, Bray's per cent yield and predictability values (R^2)

Sr. No.	Soil boron in pupulation-1 X	Bray's % yield	Mean Bray's % yield in population-1	Corrected sum of squares of deviation from mean of population CSS-1	Mean Bray's per cent yield in population-2	Corrected sum of squares of deviation from mean of population CSS-2	Postulated critical level X	R^2 $\frac{TSS-(CSS1+CSS2)}{TSS}$
	0.412	43.43						
	0.425	49.20						
1	0.435	48.07	46.90	18.70	70.55	3241.33	0.430	0.3043
2	0.451	51.93	48.15	37.67	71.71	2872.96	0.443	0.3789
3	0.452	54.34	49.30	68.25	72.87	2872.96	0.443	0.4410
4	0.460	51.10	49.68	70.74	74.42	2044.04	0.456	0.5480
5	0.481	59.36	51.06	151.02	75.58	1799.61	0.484	0.5839
6	0.488	62.41	52.48	263.65	76.68	1611.57	0.495	0.5998
7	0.503	56.08	52.88	275.16	78.55	1148.52	0.514	0.6962
8	0.525	66.77	54.47	448.74	79.73	995.73	0.535	0.6917
9	0.545	70.12	55.71	667.10	80.80	893.10	0.564	0.6649
10	0.592	66.56	57.82	1011.75	84.50	543.77	0.587	0.6680
11	0.596	72.79	59.09	1308.89	85.44	462.57	0.594	0.6219
12	0.600	75.72	60.20	1566.42	87.39	348.88	0.595	0.5912
13	0.603	75.71	61.21	1811.95	90.14	197.63	0.600	0.4288
14	0.605	76.39						
15	0.615	78.08						
16	0.625	93.05						
17	0.625	93.75						

TSS = 4686.308; N = 20

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