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CRITICAL LEVELS OF MICRO AND SECONDARY NUTRIENTS IN SOILS AND CROPS FOR OPTIMUM PLANT NUTRITION

Agricultural Science

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ABSTRACT

Critical limits of deficiency of micronutrients in soils and plants are usually employed to advice on need of micronutrient fertilization. The aim of good nutrition plan is to keep all nutrients at the optimum level. Below the optimum concentration, conditions start developing into deficiency and above the optimum towards wasteful and then toxic levels. The soil critical levels established for Zn, Cu, Fe, Mn, B, Mo and S were 0.6, 0.2, 4.0, 2.0, 0.5, 0.2 and 10.0 mg kg-1, respectively. Diagnosis and prevention of nutrient deficiency and toxicity requires a further knowledge of symptomology with critical values of any particular element in plants too.

KEYWORDS:

Critical levels, Soils and plants, Secondary and micronutrients

Introduction

Green revolution has greatly increased the crop production in India, but continuous cultivation of high yielding crop varieties have led to depletion of native micronutrient soil fertility and now most of the soils are showing sign of fatigue for sustaining higher crop production. World over micronutrients gaining much importance not only for their role in sustaining higher crop yields but such increased nutritional deficiency in soil and seed is more affecting plant, animal and human health. Deficiency of Zn, Fe, Cu, Mn, B, Mo and S has been noticed in 48, 12, 4, 5, 33, 13 and 41 % of soils of India, respectively. Zinc deficiency in soils is further expected to increase from 49 to 63 % by the year 2025 as most of the marginal soils are being brought under cultivation. Besides this, hidden hunger of micronutrients is widely noticed leading to even entire failure of crops and reduced content of micronutrients in plant parts (Singh and Bahera, 2007). Efforts are on to improve the soil micronutrient fertility for achieving higher crop yields, nutritional security and ensuring quality produce rich in micronutrients.

Historically, no special efforts were made to supply secondary and micronutrients since these got added through other nutrient sources either as adjacent radicals or as contaminants or supplied through organic manures. With intensification of agriculture, usage of straight fertilizers and rising crop requirements due to increasing productivity levels, have heightened the secondary and micron utrient demand in soil fertility management and are increasingly becoming major constraint to achieve increased agricultural production including cereal and oil seed crops (Joshi et al., 2000).

The total and available micronutrient contents of Indian soils given by Rattan et al. (1999) are presented in table 1. Observed variability in the total micronutrient contents of Indian soils is a mirror of the diversity of the parent materials (Rocks and Minerals) from which these have originated. The available nutrient content at a given time is only a very small fraction of the total amount present. Katyal (2001) concluded that the total content of micronutrients is a poor predictor of their supplying power to the plants. Its soil available micronutrient pool that represents the native level of plant usable pool, it is more often the basis to decide the occurrence of deficiency or sufficiency status.

Table: 1 Total and available micronutrient contents of the benc hmark soils of India

Micronutrients	Total content (mg kg-1)	Available content (mg kg-1)		
	Range	Mean	Range	Mean
Zn	20 - 97	55	0.12 – 2.80	0.54
Fe	13000 - 80000	33000	3.40 – 68.1	20.5
Mn	38 – 1941	537	4.00 – 102.0	26.0
Cu	11 – 141	41	0.15 – 5.33	1.7
B	2.8 – 630	-	0.04 – 7.40	1.7
Mo	Traces – 12.3	-	Traces – 2.80	-

Rattan *et al.*, 1999

Critical limits of micro and secondary nutrients in soils

Elucidation of critical levels of micronutrients delineating the deficiency, optimum and toxic range is very important with respect to fertilizers application. The critical levels vary with the soil fertility states and the crop and the cultivator levels. Diagnosis and prevention of nutrient deficiency and toxicity requires a further knowledge of symptomology with critical values of any particular element in plants too (Mishra and Sharma, 1991).

Critical levels of micronutrients in soils greatly accepted in India are given in Table 2. Katyal and Rattan (2003) established critical levels for micronutrients in soils which is helpful in giving recommendations to farmers for different crops. The soil critical established for Zn, Cu, Fe, Mn, B, Mo and S were 0.6, 0.2, 4.0, 2.0, 0.5, 0.2 and 10.0 mg kg-1, respectively.

Table: 2 Critical levels of deficiency of micronutrients in soils usually adopted in India for delineation purposes

Nutrient	Extractant	Critical level (mg kg-[1])
Zn	DTPA	0.4-1.2 (0.6)
Fe	DTPA	2.5-4.5
	Ammonium acetate	2.0
Cu	DTPA or Ammonium acetate	0.2
Mn	DTPA	2.0
B	Hot water	0.5
Mo	Ammonium oxalate	0.2
S	0.15 % CaCl2 2H2O	10

Katyal and Rattan, 2003; Tandon, 1999

Based on several field and green house experiments, Singh (1998) established relationship between crop yield response and available micronutrient content in soil. Critical levels for Zn, Cu, Fe and B has been established which were given in Table 3.

Table 3: Critical concentration of available micronutrients and sulphur for soils

Nutrient	DTPA extractable micronutrient content (mg kg-1)			
	Very low	Low	Marginal	Adequate
Sulphur	<5.00	5.00-10.00	10.0-15.0	>15.00
Zn	<0.30	0.30-0.75	0.60-1.50	>1.50
Cu	<0.10	0.10-0.20	0.20-0.40	>0.40
Fe	<2.50	2.50-4.50	4.50-7.50	>7.50
Mn	<1.00	1.00-2.00	2.00-4.00	>4.00
B	<0.25	0.25-0.50	0.50-0.75	>0.75
Mo	<0.05	0.05-0.10	0.10-0.20	>0.20

Singh (1998)

The amount of nutrient extracted under a set of conditions is termed as available nutrient or also the soil test value. Singh (1998) categorized soil as (i) low, medium or high in available nutrient content (ii) deficient, marginal or sufficient and (iii) above or below the critical level of availability. The main point is that soils which test low, deficient, or below the critical level, will usually need a nutrient application to support satisfactory crop yields. If the critical level is well founded and adequately validated, the probability of crop response to the application of a nutrient should be high when values are below the critical level and low above the critical level. Most of the critical levels reported in India have not been adequately field tested and this continues to be one of the weak spots as far as practical application of these values is concerned.

Critical limits of micro and secondary nutrients in plants

A given critical limit is quite often employed for a wide variety of soils and crops, even though it is known that these critical limits may differ not only for soils and crop species but also for different varieties of a given crop. Commonly found concentrations of micronutrients in plant tissue are provided in Table 4.

Table 4: General micronutrient concentrations in plant dry matter

Micronutrient	Concentration dry matter basis	Remarks
Boron	2 – 100 ppm	Usually 20 ppm, much higher in dicots (legumes) than in monocots (cereals etc)
Copper	5 – 20 ppm	Usually, less than 5 – 20 ppm
Iron	50 – 150 ppm	Usually 100 ppm
Molybdenum	0.1 – 2 ppm	Uaually below 1 ppm
Zinc	20 – 100 ppm	Usually 20 – 50 ppm
Chlorine	0.2 – 2 %	Much above the actual required

Tandon, 1993

There is an optimum concentration level at which each nutrients is neither deficient, nor wasteful, nor toxic. The aim of good nutrition plan is to keep all nutrients at the optimum level. Below the optimum concentration, conditions start developing into deficiency and above the optimum towards wasteful and then toxic levels. As the supply of nutrient increases, so does plant growth till the nutrient concentration reaches an optimum level, beyond which no useful purpose is served. On the contrary, higher concentrations can lead to toxicity and can even kill the plant.

Critical levels of micronutrients in plants greatly accepted in India are given in Table 5. The critical levels may differ not only for soils and crops species but also for different varieties of a given crop (Sharma, 1996). Higher concentrations can lead to toxicity and can even kill the plant. Special care has to be taken with the application of B, Cu and Mo for which the difference between deficiency and toxicity level is narrow. Some toxic levels are reported by Jones (1992) for Cu (over 20 ppm), B (over 200 ppm), Zn (over 400 ppm) and Mn (over 500 ppm) in mature leaf tissues.

Table 5: Critical levels of deficiency of micronutrients in plants usually adopted in India for delineation purposes

Nutrient	Critical level in plant dry matter (mg kg-[1] dry matter)
Zn	10-20
Fe	50 (25-80)
Cu	4 (3-10)
Mn	20 (10-30)
B	20
Mo	0.1

Katyal and Rattan, 2003; Tandon, 1999

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