Short Communication

Pak J Sci Ind Res 2003 ***46****(2) 139-140*

Nutrient Indexing of Maize in the Submontane Region of Indian Punjab

D S Benipal*, I M Chhibba and C L Arora

Department of Soils, Punjab Agricultural University, Ludhiana, India-141004

(Received 3 September 2001; accepted 15 April 2002)

Key words: Maize, Nutrient indexing, Punjab soil.

Maize is major kharif crop of the submontane region of the Punjab state of India. It is one of the most exhaustive crop as at a yield level of 2.69 t ha^{-1}, it removes 144 kg N and 46 kg P ha^{-1}. This crop has been found to respond significantly to the application of N, P and K in a long-term experiment at Punjab Agricultural University, Ludhiana (Brar & Pasricha 1998). Studies by Takkar *et al* (1976) and Chandi and Takkar (1982) have shown significant response of maize to the application of Zn also. Application of Sulphur (S) @ 20-25 kg ha^{-1} on coarse textured soils produced 0.7 to 1.3 t ha^{-1} additional grain yield of maize (Pasricha *et al* 1977; Singh & Chhibba 1991). Nevertheless, yield of the crop in majority of the fields is much lower than the expected levels. In order to explore if the poor nutrient supply could be one of the possible reasons for the lower yields, a survey of the soil and maize crop was carried out in the submontane belt of the state.

Maize leaf samples at pre-tasselling stage from 85 fields and surface (0-15 cm) soil samples were drawn from 163 maize growing fields well spread over the sandy tract in the submontane region. Soil samples, after air drying and grinding in a wooden pestle and mortar, were analyzed for different physico-chemical characteristics by using the standard methods (Jackson 1973) and for available S by using the methods of Williams and Steinbergs (1959) and Chesnin and Yien, (1950). Micronutrient cations (Zn, Cu, Fe and Mn) in the soil were extracted by DTPA method (Lindsay and Norvell 1978) and estimated on an atomic absorption spectrophotometer. The leaf samples were also washed, oven dried and well processed and then analyzed for various nutrients on Inductively Coupled Argon Plasma Emission Spectrophotometer (ICAP) and for S by digesting the samples in diacid mixture (HNO_3 and $HClO_4$ in 3:1 ratio) and estimating the S Content in the digests by turbidimetric method (Chesnin and Yien 1950).

The investigated soils were non-saline (EC 0.06 to 0.35 dSm^{-1}), alkaline (pH 7.1 to 8.4) and loamy sand in texture with low to medium content of organic carbon (0.07 to 0.67%). They had very low content of calcium carbonate (0-1.25%). As evident from the data in Table 1, the available S content in soils ranged from 0.5-18.0 mg kg^{-1} with a mean value of 7.1 mg kg^{-1}. On the basis of 10 mg kg^{-1} as the threshold value for available S (Kanwar 1963), 78 per cent of the samples had deficient content of available S. Such a high magnitude of S deficiency may be ascribed to the low organic carbon content and low suphate retention capacity owing to the coarse texture of majority of these soils. Contents of available Zn, Cu, Fe and Mn varied between 0.14-1.74, 0.06-1.5, 1.89-14.50 and 1.03-11.50 mg kg^{-1} with respective mean values of 0.38, 0.39, 5.61 and 5.74 mg kg^{-1} (Table 1).

Table 1

Nutrient status (mg kg^{-1}) of surface soils

Nutrient	Range	Mean	Critical level	Percent deficient sample
S	0.50-18.00	7.10	10.00	78
Zn	0.14-1.74	0.38	0.60	65
Cu	0.06-1.50	0.39	0.20	18
Fe	1.89-14.50	5.61	4.50	22
Mn	1.03-11.50	5.74	3.50	12

Based on the deficiency critical levels used in the state (Nayyar *et al* 1990) 65, 22, 18 and 12 per cent of the fields were found to have deficiency of Zn, Fe, Cu and Mn (Table 1).

The concentration of P and K in maize plants varied between 0.08 and 0.73 per cent and 0.28 and 2.25 per cent, respectively, with corresponding mean values of 0.4 and 1.2 per cent. Averaging at 0.51 and 0.23 per cent, Ca and Mg respectively ranged from 0.17 to 0.99% and 0.07 to 0.43%. The concentration of S in maize leaves varied from 0.06-0.37 per cent with a mean value of 0.13 per cent. Based on the critical deficiency levels given by Reuter and Robinson (1977) 13.00, 74.20, 1.20, 2.40 and 70 per cent maize plants were found to be deficient in P, K, Ca, Mg and S, respectively. The average concentration of Zn, Cu, Fe and Mn in maize plants was 23.10, 19.06, 378 and 44.18 mg kg^{-1} respectively. While 34 per cent plant samples had Mo below the threshold value (Table 2), only 4 per cent plant samples were found to have deficient content of Zn considering 15 mg kg^{-1} Zn as the deficiency level.

These data, thus, revealed that deficiency of S was the major constraint as confirmed by both the soil and maize leaf analysis. Nevertheless, the leaf analysis divulged the problem of K, Mo and P hunger to the tune of 74, 34 and 13 per cent respectively. Obviously, the maize crop in the investigated

*Author for correspondence; e.mail:<dsbenipal@yahoo.com>

Table 2
Nutrient status of maize plants

Nutrient	Range	Mean	Critical level	Percent deficient sample
P%	0.08-0.73	0.40	0.25	13.00
K%	0.28-2.25	1.20	1.80	74.20
Ca%	0.17-0.99	0.51	0.20	1.20
Mg%	0.07-0.43	0.23	0.12	2.40
S(%)	0.06-0.37	0.13	0.15	70.00
Zn (mg kg^{-1})	8.80-49.30	23.10	15.00	4.00
Cu (mg kg^{-1})	5.00-23.30	19.06	5.00	2.00
Fe (mg kg^{-1})	137.00-730.00	378.00	15.00	0.00
Mn (mg kg^{-1})	12.00-95.00	44.18	25.00	0.00
B (mg kg^{-1})	3.60-30.90	15.41	4.00	-
Mo (mg kg^{-1})	Traces-28.20	6.71	0.20	34.00

area needs to be well supplied with K, S, Mo and P in order to sustain the maize yield. The disagreement between the soil and plant analysis in respect of micronutrients indicated a need to refine the critical levels of these nutrients under the investigated conditions.

References

Brar B S, Pasricha N S 1998 Long term studies on integrated use of organic inorganic fertilizers in maize-wheat-cowpea cropping system on alluvial soils of Punjab. *Proc. National Workshop held at Indian Inst Soil Sci,* Bhopal, April 2-4 1998, pp 54-168.

Chandi K S, Takkar P N 1982 Effect of agricultural cropping systems on micronutrient transformations. I. Zinc. *Pl Soil* **69** 23-430.

Chesnin L, Yien C H 1950 Turbidimetric determination of available sulphur. *Soil Sci Soc Am Proc* **15** 149-151.

Jackson M L 1973 *Soil chemical analysis.* Prentice Hall of Indian Pvt Ltd, New Delhi.

Kanwar J S 1963 Investigations on sulphur in soils. Sulphur deficiency in groundnut soils of Samrala (Ludhiana). *Indian J Agric Sci* **33** (1) 196-198.

Lindsay W L, Norvell W A 1978 Development of DTPA soil test for Zn, Fe, Mn and Cu. *Soil Sci Soc Am J* **42** 421-428.

Nayyar V K, Takkar P N, Bansal R L, Singh, S P, Kaur N P, Sadana US 1990 *Micronutrients in soils and crops of Punjab*. Res Bull Department of Soils, PAU, Ludhiana, pp 146-XIV.

Pasricha N S, Randhawa N S, Bahl G. S, Dev G 1977 Change in the uptake of native and applied S in maize as affected by dry matter accumulation with age and response to applied Sulphur. *Indian J Agric Sci* **47** 336-340.

Reuter D J, Robinson J B 1997 *Plant analysis and interpretation manual,* 2nd ed, pp 110-125.

Singh D, Chhibba I M 1991 Efficiency of Sulphur carriers of maize and wheat in Typic Ustipsamments. *Proc Nat Symp on Macronutrients in Soil and Crops*, Ludhiana, pp 29-34.

Takkar P N, Mann M S, Bansal R L, Randhawa N S, Singh H 1976 Yield and uptake responses of corn to zinc as influenced by fertilization. *Agron J* **68** 942-946.

Williams CH, Steinbergs A 1959 Soil sulphur fractions as chemical indicators of available sulphur in some Australian soil. *Aust J Agric Res* **10** 340-352.