Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences
Volume 1 Number 4: 476-477, 2002

Response of Maize to Applied Soil Zinc

M. Tariq, M. A. Khan and S. Perveen
Department of Soil and Environmental Sciences, NWFP Agricultural University, Peshawar, Pakistan

Abstract: A field experiment was conducted to study the response of maize to varying levels of applied zinc. Zinc was applied @ 0, 5, 10, 15 and 20 kg ha^{-1} along with 120 N, 90 P_2O_5 and 60 K_2O kg ha^{-1}. Results indicated that the yield and yield components were significantly increased with applied zinc over control (with out fertilizer) and NPK alone treated plots. Zinc concentration in soils, in leaves and total uptake by maize also significantly increased with applied zinc, indicated zinc was deficient in the test soil. Therefore, zinc fertilization is necessary for maize crop under prevailing conditions. Moreover, the extraction capacity of AB-DTPA > DTPA for soil zinc and showed close correlation with plant zinc, suggested former method is suitable for extracting available zinc in calcareous soils.

Key words: Yield, yield components, concentration, uptake wet acid digestion, DTPA, AB-DTPA, zinc, maize

Introduction

Maize (*Zea mays* L.) is one of the important kharif crop in Pakistan, which serves three main purposes as a food for human consumption, feed for live stock and poultry, and raw material for agro-based industries. The average yield of maize in Pakistan is low as compared to other maize growing regions of the world. However, lower yield of maize in this region is not due to cultivars response but it seems to inadequate supply of water and nutrients, which are pre-requists for getting higher yield, because the soils of Pakistan are mostly calcareous in nature, alkaline in reaction, low in organic matter and almost deficient/low in major and minor elements specifically zinc (Sillanpaa, 1982 and Khattak, 1991), and the availability of zinc to maize crop is conditioned by these characteristics of soil. Indigenous work indicates that the application of zinc to maize crop have led to a significant increase in yield (Rizvi *et al.*, 1987) and relative yield was closely correlated with extractable soil zinc (Raced and Rafique, 1989). This early work showed response of maize to zinc fertilization, but could not repeated in recent time under different soils and ecological zones, which need further improvement.

Keeping in view the importance of maize crop and nutritional role of zinc in increasing yield, it was planned to conduct a field experiment at Peshawar to find out an optimum level of zinc fertilizer for maize crop and select a suitable extraction technique for soil zinc which correlate to maize yield under prevailing conditions.

Materials and Methods

A field experiment was conducted to study the effect of various levels of zinc on the yield, yield components and uptake by maize (CV. Azam) crop at Peshawar. The experiment was laid out in Randomized Complete Block Design with five replications. The plot size was kept 5x6 m^2 and row to row distance 75 cm apart. A composite soil sample was collected from a depth of 0-20 cm for the determination of various physico-chemical properties and zinc status of soil before sowing (Table 1).

Table 1: Physico-chemical properties of test soil

Properties	Values
clay (%)	4.48
silt (%)	46.0
sand (%)	49.2
Textural class	sandy loam
Organic C (%)	0.89
$CaCO_3$ (%)	11.5
pH (1:5)	8.00
EC_e at 25 °C (dS m^{-1})	0.25
DTPA extractable Zn (mg kg^{-1})	0.25
AB-DTPA extractable Zn (mg kg^{-1})	0.50

Zinc was applied @ 0, 5, 10, & 20 kg ha^{-1} as zinc sulphate (34.16% Zn) along with a basal dose of N, P_2O_5 & K_2O @ 120, 90 & 60 kg ha^{-1} as urea, single superphosphate and potassium sulphate, respectively. Half nitrogen, full phosphorus and potassium and varying zinc levels were thoroughly mixed at the time of sowing, while the remaining half nitrogen was applied at silking stage of the crop. Soil and leaf samples at silking stage and again soil samples at harvesting stage were collected from each treatment plot for the determination of zinc. All the recommended cultural practices were followed uniformly throughout the growing season.

Soil analysis: Representative soil samples were collected from each treatment plot at silking and harvesting stages, air dried, ground, sieved followed by DTPA and AB-DTPA extraction the methods as suggested by Lindsay and Norvell (1978) and Halvin and Soltanpour (1981), respectively and analyzed for zinc using atomic absorption spectrophotometer.

Plant analysis: Representative leaves were collected from each treatment plot at silking stage, washed with distilled water, oven dried at 70 °C for 48 hours, ground by Willey mill followed by wet acid digestion and the readings were taken on atomic absorption spectrophotometer (Isaac and Kerber, 1971).

Statistical analysis: The data collected during field and laboratory investigations were analyzed statistically on computer using MSTAT-C programme and the means were compared by New Duncan's Multiple Range Test of significance (Steel and Torrie, 1980).

Results and Discussion

Yield and yield components: Results showed that maximum grain yield was obtained with the application of 15 kg Zn ha^{-1} and minimum were recorded in the control (with out fertilizer) and NPK alone treated plots (Fig. 1). It is also evident from the graph that all the zinc treated plots significantly increased the grain yield over control as well as NPK treated alone plots but the differences found among the zinc treated plots were statistically at par. Similar results were reported by Khattak (1980) and Shoukat (1989).

Results of fresh and dry stalk yields showed similar fashion with respect to applied zinc (Table 2). Although zinc treated plots showed non significant differences with each other but there was a consistent increase in fresh and dry stalk yields up to 15 kg Zn ha^{-1}, further increase in the zinc application causes decrease in yields, presumably due to toxic level of applied zinc. These results are in line with the findings of Shah *et al.* (1985).

Table 2: Effect of applied zinc on the yield components of maize

Treatments	Fresh matter	Dry matter	Ears	Stalks
Zn (Kg ha^{-1})	-------- yield kg ha^{-1}----------		--------- No. $plot^{-1}$----------	
0	11704b	7896b	30c	44d
0	12444b	8155b	36b	49cd
5	14963a	9866a	41ab	56abc
10	15555a	10548a	42a	62a
15	16593a	10725a	44a	58ab
20	15407a	9496a	38ab	53bc

Means followed by similar letter (s) do not differ significantly from one another at 5% level of probability

Table 3: Effect of applied zinc on zinc content in soils, in leaf and total uptake by maize

	Silking stage		Harvesting stage			
Treatment	DTPA Zn	AB-DTPA Zn	DTPA Zn	AB-DTPA Zn	Leaf content	Total uptake
Zn (kg ha^{-1})	mg kg^{-1}					g ha^{-1}
0	0.35d	0.57d	0.31c	0.47d	26.42c	208.6c
0	0.42cd	0.59d	0.38c	0.48d	27.84c	227.0c
5	0.62cd	1.46c	0.66b	1.15c	31.27b	308.5b
10	0.83c	1.78c	0.76d	1.41c	32.55ab	343.3ab
15	2.69b	2.69a	1.02a	2.21b	33.58ab	360.1a
20	3.94a	5.85a	1.19a	4.18a	35.20a	334.3ab

Means followed by similar letter (s) do not differ significantly from one another at 5% level of probability

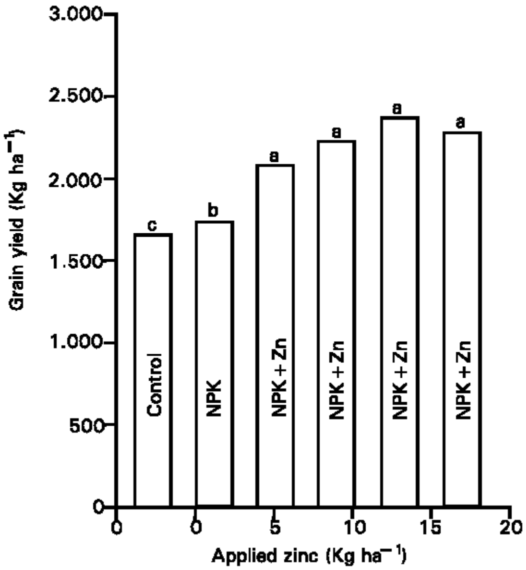

Fig. 1: Effect of applied zinc on the grain yield of maize. Means followed by similar letter do not differ significantly from one another at 5% level of probability

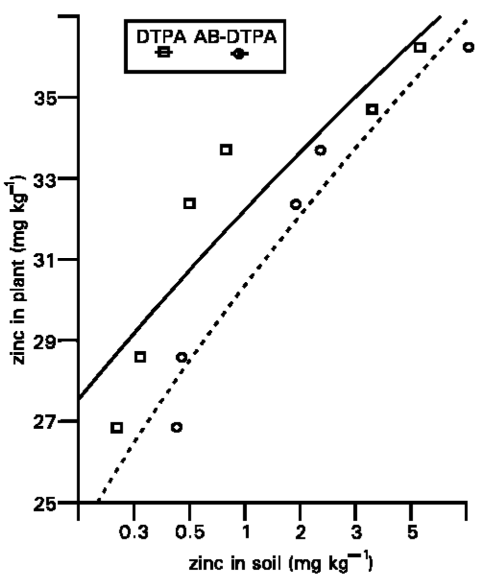

Fig. 2: Relationship between soil and plant zinc

Rest of the yield components such as number of ears and stalks plot^{-1} (Table 2) showed that with increasing the levels of zinc the number of ears and stalks increased over control and NPK alone treated plots indicating the test soil was deficient in available zinc and application of zinc up to 15 kg Zn ha^{-1} was enough to produce maximum number of ears and stalks plot^{-1}, but further increase in zinc application showed reduction in number of ears and stalks of maize crop. Similar observations were recorded by Shah *et al.* (1985).

Zinc content in soils: DTPA and AB-DTPA extracted zinc from soils at silking and harvesting stages are given in (Table 3). Results showed that with increasing levels of applied zinc the contents of extracted zinc in soil at both stages progressively increased over control and NPK alone treated plots, indicating response of zinc in terms of its availability to maize crop. These findings are in agreement with an early work of Rizvi *et al.* (1987). Results also indicate that in those plots where zinc was not applied were found below the reported deficiency levels of zinc in soil (Lindsay and Norvell 1978; Halvin and Soltanpour, 1981).

Zinc content in leaves: Results regarding zinc content in leaves and total uptake (Table 3) revealed that with increasing levels of applied zinc in soil the content in leaves and total uptake of zinc by maize crop significantly increased and both were positively correlated with soil zinc either extracted with DTPA (r^2 = 0.84) or AB-DTPA (r^2 = 0.95) solution (Fig. 2). These results are in agreement with the findings of Raced and Rafique (1989), who found that the plant zinc content and total uptake increased with zinc rate and were highly correlated with soil zinc. Present results also suggests that AB-DTPA is more effective than DTPA for extracting the available zinc under the conditions of the experiment, which showed high correlation between soil and plant zinc.

It can be concluded from the overall results that the test soil was deficient in available zinc therefore, maximum yield of maize can be obtained with the application of zinc @ 15 kg ha^{-1} along with 120 N, 90 P_2O_5 and 60 K_2O. Moreover, AB-DTPA method was more efficient than DTPA method for extracting available zinc under the conditions of the experiment.

References

Halvin, J.L. and P.N. Soltanpour, 1981. Evaluation of NH_4CO_3-DTPA soil test for Fe and Zn. Soil Sci. Soc. Am. J., 45: 70-75.

Isaac, R.A. and J.D. Kerber, 1971. Atomic absorption and flame photometry: Techniques and uses in soil, plant and water analysis. In Instrumental methods for analysis of soils and plant tissue. (ed) Walsh, L.M. Soil Sci. Soc. Am. Madison, WI, USA.

Khattak, J.K., 1980. Effect of zinc fertilization on the yield of maize in Peshawar soil series. Annual Report Co-operative Research Project on Micronutrients. Dept. Soil Sci. NWFP Agric. Univ. Peshawar, Pakistan.

Khattak, J.K. 1991. Micronutrients in NWFP Agriculture. BARD ,PARC, Islamabad, Pakistan.

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

Raced, A. and E. Rafique, 1989. Zinc requirements of corn grown on two calcareous soils of Pakistan. Land Resources Section, NARC, Islamabad, Pakistan.

Rizvi, S.A., J.K. Khattak, A. Raced and S. Ullah, 1987. Effect of zinc fertilization on the yield and chemical composition of maize crop in Peshawar soil series. Pak. J. Sci. Ind. Res., 30: 828-837.

Shah, M., J.K. Khattak and S.A. Rizvi, 1985. Effect of boron and zinc fertilization on the yield of maize. Sarhad J. Agric., 1: 205-209.

Shoukat, U.K., 1981. Effect of zinc fertilization on the yield and chemical composition of maize crop. M.Sc. (Hons), Thesis submitted to NWFP Agric. Univ. Peshawar, Pakistan.

Sillanpaa, M., 1982. Micronutrients and nutrient status of soils: a global study, FAO Soil Bull. No. 48, Rome.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics. A biometrical approach. 2nd. (Ed). McGraw Hill, New York, USA.