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EFFECT OF ZINC FERTILIZATION ON THE YIELD AND CHEMICAL COMPOSITION OF MAIZE (CV. CHANGEZ) CROP IN PESHAWAR SOIL SERIES

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A field trial in the Peshawar soil series was conducted to study the effect of zinc on the yield and chemical composition of maize leaf and grain. The effect of zinc on total dry matter, stalk, ear, and cob was nonsignificant but the yield of grain was significantly increased. Extractable zinc (0.1 N HCl) in soil and zinc content of leaf were also significantly increased. The relationship between grain yield and zinc content in leaf showed 14 ppm as the critical level for leaf while the optimum dose was 5 kg Zn/ha for crop. These results could be applied equally to other semi-arid areas, having calcareous, fine-textured soil, and low organic matter content.

Key words: Critical level, maize, optimum yield, zinc.

INTRODUCTION

Maize (*Zea mays* L.) is a crop with high yielding potential and responds to proper fertilization and management. Zinc functions in plants largely as a metal activator of enzymes such as carbonic anhydrase, dehydrogenase, proteinase and peptidase [3,18]. Zinc deficiencies produce changes in leaf morphology and cell histology. Deficiency symptoms in maize include chlorosis and stunted growth. The emerging leaves show yellow to white bleached bands in their lower part and this disorder is called as white bud [10]. With increase in cropping intensity, more nutrients are utilised causing an imbalance in micronutrients, especially zinc on calcareous soils [6,15,19]. Thus the yield is decreased and this may necessitate the inclusion of zinc in regular fertilizer programme for maize production. Rashid *et al.* [14] found an increase in dry matter yield by applying 10.0 ppm Zn in a pot experiment, while Shah *et al.* [16] and Afzal *et al.* [1] reported increased grain yields by the application of zinc and other micronutrients.

Keeping the above in mind, a study on the effect of zinc fertilizer on the yield components and chemical composition of maize in the Peshawar soil series was conducted.

MATERIAL AND METHODS

The project was carried out during 1979-80 at the research farm of the Faculty of Agriculture, University of Peshawar. The experiment was laid out in a complete randomized block design with four replications, having 20 plots, each measuring 5x4 metres. Composite soil samples of 0–25 and 25–50 cm depths were analysed for various physico-chemical properties as described by Black [4], except for the texture which was determined according to the method of Moodie *et al.* [12].

A basal dose of NPK at the rate of 150: 90: 45 kg/ha was applied as urea, superphosphate and potassium sulphate respectively. Zinc in the form of zinc sulphate was applied at the rate of 0, 5, 10, 15 and 20 kg/ha. Half a dose of nitrogen and full doses of potassium and zinc were incorporated in the plots at sowing time. The crop was sown 60 cm apart in rows with a plant to plant distance of 20 cm. Superphosphate was placed 10 cm deep and 10 cm away from seeds in rows. The remaining half of nitrogen was side-dressed at the knee height crop stage. Representative leaf samples opposite to ear along with surface soil samples [9] (0–25 cm) were taken at the silking stage for zinc availability at studies.

After air drying the total dry matter ear and stalk yields were recorded. The grains and cobs were also weighed separately. Leaves were dried overnight at 70^{o}, digested in a nitricperchloric acid mixture and analysed for zinc content by atomic absorption spectrophotometer [7]. Soil extractable zinc by 0.1N HCl was also determined. Crude protein in grains was determined by the semi-microkjeldahl method and ash by dry ashing method as described by Jackson [8].

RESULTS AND DISCUSSION

The test soil series is the Peshawar silty clay (Typic Ustochrepts) and has developed in piedmont material of

Middle Pleistocene. The series has been homogenised deeply, well drained, strongly calcareous with low organic matter and nitrogen but has sufficient phosphorus and potassium content (Table 1). The series occurs in a semi-arid subtropical continental climate and is nearly level with gently sloping.

Total dry matter, stalks, ears and cobs yield and weight of 1000 grains (Table 2) were not affected significantly with zinc fertilizer except for grain yield (P = 0.05). Total dry matter and ear yields increased with zinc fertilization, whereas the stalk yield declined and no consistent effect was noted on cobs yield. All doses of zinc significantly increased the grains yield over control and the maximum yield was obtained with 20 kg Zn/ha. However, this increase was non-significant as compared to the lowest dose which indicated that 5 kg Zn/ha was the optimum dose for maize grains yield. Grain yield increases were in concert with the increases in total dry matter, ears and 1000 grain weight value. Similar effects of zinc fertilization were reported by other workers [1,2,5,14,16]. It can be concluded that contrary to yield of stalks, the significant increase in grains yield indicates that zinc requirement of corn for maximum grains yield is opposite to that for maximum yield of stalks confirming the essentiality of zinc as a metal activator of enzymes in synthesis and the translocation of protein to sink organs [13,18].

Table 1. Physico-chemical properties of the soil.

Properties	Unit	Surface (0-25 cm)	Subsurface (25-50 cm)
Total nitrogen	%	0.08	0.05
Organic matter	%	0.84	0.49
Available phosphorus (P) ($NaHCO_3$ extractable)	ppm	11.5	11.0
Available potassium (K) (NH_4) AC extractable)	"	195	209.0
Total zinc	"	171	161.0
Acid extractable zinc (0. N HCl)	"	0.8	0.6
pH of saturated paste	–	8.4	8.3
Electrical conductivity of saturation extract	mmhos/cm	2.7	2.1
Lime equivalent	%	13.3	14.2
Clay	"	40.	43.
Silt	"	49.	44.
Sand	"	11.	13.
Textural class (USDA)	–	Siltry Clay	Silty clay
Classification	–	Typic Ustochrepts	

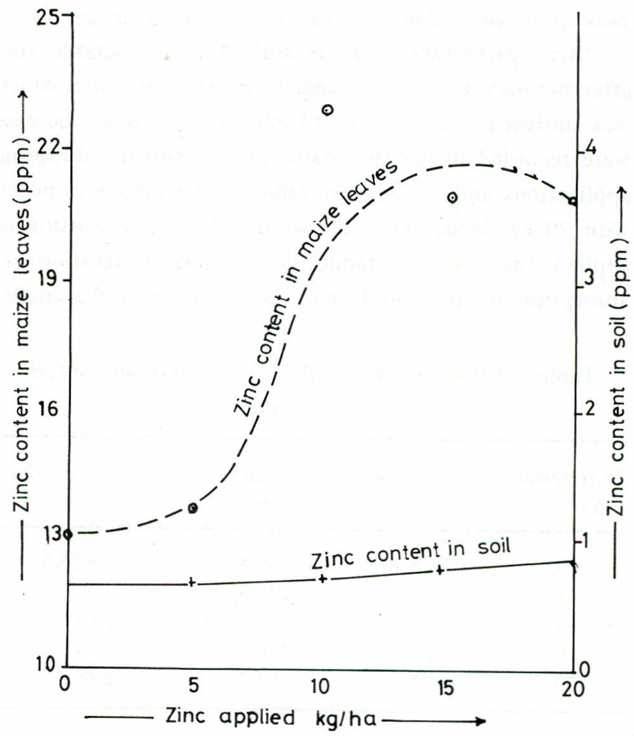

Fig. 1. Effect of Zinc fertilization on zinc content in soil and zinc content in maize leaves.

Table 2. Effect of zinc on the yield components of maize crop.

Zn fertilizer (kg/ha)	Dry matter	grain	Ears (q/h)	Stalks	Cobs	Wt. of 1000 grains g
0	114.06 NS	19.95 a	47.85 NS	66.20 NS	27.90 NS	200.9 NS
5	118.85 "	34.52 b	56.74 "	62.10 "	22.23 "	207.0 "
10	117.75 "	30.79 b	57.22 "	60.53 "	26.42 "	202.0 "
15	123.90 "	33.10 b	67.78 "	59.11 "	31.68 "	201.9 "
20	129.55 "	37.27 b	64.69 "	64.85 "	27.42 "	208.0 "

NS = Non-significant.

Values followed by the same letter(s) are non-significant from each other at 5 % level of probability.

Protein and ash contents of grain. The application of zinc showed a significant effect on the protein content of grain (Table 3) at 5 % level of probability. The protein percentage of grain was significantly increased with zinc application over control. These findings are in conformity with Melsted *et al.* [11], who reported similar results. Total protein in grains per hectare was also statistically significant and in conformity with the protein percentage and grains yield. On the other hand the ash content (Table 3) of maize grains decreased inconsistently with zinc application. However, the results were statistically non-significant. The decline in total minerals absorption might be associated with dilution effect of yield increase [15].

Acid extractable zinc in soil. Acid extractable zinc after the harvest of maize range from 0.6 to 0.9 ppm which was statistically significant (Table 4). Progressive increase were recorded in the zinc status of soil with its additional applications and the highest value of 0.9 ppm was noted with 20 kg Zn/ha. This shows that the major portion of applied zinc has undergone the process of fixation i.e, absorption and precipitation in calcareous soil and a smaller fraction remained to contribute to the increase of available zinc in the soil. Similar results were reported by other authors [15,19,20]. It was also observed that no zinc deficiency symptoms occur in maize if acid extractable soil zinc ranged from 0.6 to 0.9 ppm. The low acid extractable zinc values might be due to the calcareous nature, fine texture and low organic matter content of the soil.

Zinc content of leaves. The total zinc content of leaves at silking stage ranged from 13 to 23 ppm (Table 4) and was statistically significant. It is evident that zinc concentration in the leaves increased by applying 10, 15 and 20 kg Zn/ha doses. A maximum of 23.0 ppm value was found with 10 kg of Zinc/ha and higher doses did not increase it further. Azad [1] also reported similar results on the same soil under greenhouse conditions.

From the relationship of yield data and leaf zinc content, it can be concluded tentatively that the critical level of leaf zinc is about 14 ppm in this particular study. Other workers [5,7,10,17] also reported that the level of zinc in maize tissue above which no further increase in yield occurred ranged between 12 to 15 ppm.

Table 3. Effect of zinc on the protein and ash content of maize grain.

Zn fertilizer (kg/ha)	Protein (%)	Total protein (kg/ha)	Ash content (%)
0	7.78 ab	155.30 a	1.92 NS
5	7.93 a	273.91 bc	1.90 "
10	7.43 b	222.10 ab	1.64 "
15	7.75 ab	256.81 bc	1.74 "
20	8.75 c	319.33 c	1.85 "

NS = Non-significant.

Values followed by the same letter(s) are non-significant from each other at 5 % level of probability.

Table 4. Effect of zinc on the zinc content of leaves and soils.

Zn fertilizer kg/ha	Zn content in leaves ppm	0.1N HCl extractable Zn in soil ppm
0	13 a	0.61 a
5	15 a	0.65 a
10	23 b	0.76 ab
15	21 b	0.77 ab
20	21 b	0.91 b

Values followed by the same letter(s) are nonsignificant from each other at 5 % level of probability.

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