International Journal of Botany Studies
ISSN: 2455-541X; Impact Factor: RJIF 5.12
Received: 05-05-2020; Accepted: 16-05-2020: Published: 06-06-2020
www.botanyjournals.com
Volume 5; Issue 3; 2020; Page No. 179-182

Response of growth and yield attributes of maize crop against seed priming with two different sources of zinc

Ali Raza Malik[1*], Mukkaram Ali Tahir[2], Syed Ayyaz Javed[3], Ali Afzal[4], Muhammad Abubakar Siddiq[5], Muhammad Tauseef Jaffar[6]

[1-3] Department of Soil and Environmental science, College of Agriculture, University of Sargodha, Pakistan
[4] Provincial Pesticide Reference laboratory, Institute of Soil Chemistry and Environmental Sciences, Kala Shah Kaku, Sheikhupura, Pakistan
[5] Soil and Water Testing laboratory for Research Sargodha, Government of Punjab, Pakistan
[6] Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Abstract

Maize (*Zea mays* L.) ranks third most important cereal crop after wheat and rice in Pakistan. Pakistani soils are mostly alkaline and calcareous in nature with micronutrient dearth. All micronutrients perform a crucial role in improving growth and yield parameters. Zinc is also limited in Pakistani alkaline soils after nitrogen and phosphorus. In order to estimate the influence of two different sources of zinc in improving maize yield and growth attributes a research was concluded in 2018 in the field of College of Agriculture, University of Sargodha. Seven treatments of zinc nutrient were applied to maize seeds with two different sources and levels of zinc concentration. A required amount of macronutrients (NPK) was applied in all treatments along with zinc seed priming. Each treatment was replicated thrice under design of R.C.B.D in field study. The applied treatments were as T_1as a Control (recommended NPK), $T_{2,}$ T_3 and T_4 treatments were applied as 1%, 2% and 4% solution of zinc sulphate (ZnSO4) Similarly other source of chelated zinc (Zinc EDTA) was applied in T_5, T_6 and T_7 as 0.5%, 1.5% and 3.0% solution respectively. Data of Growth and yield parameters was collected after laboratory analyses and interpreted for statistical analysis using statistics 8.1 software. All mean values of treatments were found to be different from each other comparatively when LSD test was applied at $p \leq 0.05$ level of significance. The results indicated that 4% solution of ZnSO4 (T_4) executes best in improving growth and yield (7.99 t ha^{-1}) attributes. Results revealed that values of all treatments were different from each other significantly.

Keywords: seed priming. zinc. maize. yield

1. Introduction

Maize (Zea mays L) is appraised as third major crop among other cereal crops in Pakistan as the population is growing gradually. Its mean we have to grow more to feed our people to meet the consumption [5]. About 6.4%, grain crops are contributed by maize crop in Pakistan. In Pakistan, 4.62 million tones grain production with a normal production of 4278 kg/ha is cultivated by using about 1.08 million ha area [6]. For this reason, it is the time, to manage and make more reliable strategies to make progress in production development. As we have to improve the yields of our cereals, optimum and balanced doses of fertilizers are needed simultaneously [3].

Verma (2011) describes the high demanding behavior of maize crop about the micro nutrients like zinc (Zn) acts as cofactor in more or less 300 enzymes and in maintaining the protein synthesis, pollen formation, plants integrity [1]. This nutrient also involves in the growth of plant root system, synthesis of proteins and increase in flower setting [12] especially in reduction of kernel absorption [17]. However, micronutrients has major role in improving maize production. Since a wide range soils are deficient in zinc, seed priming technique along with the zinc application has effective impact on zinc deficiency in plants and soils. Experiments showed various results that reflect seed priming with zinc nutrients in different types not only enhanced weed competition ability and also improved the grain yield [8].

Seed priming has successful evidences in improving seed health and vigor for many agronomic and vegetable crops, leading to boost and equal germination and emergence of seedlings. Under adverse conditions like high or low temperatures, low water availability and salinity, seed priming improve seed vigor [11]. Imperfect crop stand formation is one of the main constraints reported in under developing and developing countries. Which have so many reasons include low quality seed, improper seedbed preparation, late in sowing, poor sowing techniques, poor soil properties etc. So, seed priming has solution to eliminate seed related problems efficiently. It is actual modest, low risk and low-cost technique for farmers and has positive impact on their livelihoods by enhancing the rate of seed emergence, development and duration as well as crop productivity. Therefore, we executed a study in the field to examine the influence of $ZnSO_4$ and Zn-EDTA on physiochemical and growth parameters of maize crop.

2. Material and Methods

This study was conducted in order to elucidate the impact of seed priming with different sources of zinc solutions in improving growth and yield attributes of maize crop. To achieve this objective of study field was converted in to 21 small square parts in which seven treatments were applied including control treatment all with required doses of NPK in all treatments. All treatments were applied randomly in three replications. Hybrid variety of maize seed was sown in departmental research area.

Table 1

Sr. No	Treatments
T1	Control (NPK = 160kg/acre, 96kg/acre, 80 kg/acre respectively)
T2	1% Zinc solution of $ZnSO_4$
T3	2 % Zinc solution of $ZnSO_4$
T4	4 % Zinc solution of $ZnSO_4$
T5	0.5 % Zinc-EDTA solution
T6	1.5 % Zinc-EDTA solution
T7	3.0 % Zinc-EDTA solution

2.1 Preparation of Zinc priming solution

Seed were primed in Zn containing solutions of $ZnSO_4$ @ 1%, 2% and 3% respectively and as the same other solutions of Zn-EDTA (chilled zinc) @ 0.5%, 1.5% and 3.0% accordingly for 12 hours at simple room temperature. Later on seeds were picked up from mentioned solutions and dried them to gain their original weight. Untreated seeds were sowed in control treatment.

2.2 Soil testing before seed sowing

For pre soil analysis soil samples were collected and analyzed to perform physio-chemical analysis using US salinity laboratory staff method (1954).

Table 2: Soil physio-chemical Analysis

Parameter	Value
EC	2.65 dS m^{-1}
pH	7.80
Texture class	Loam
SAR	7.62 $(mmol / L)^{1/2}$
Organic Matter	0.65%
Potassium	280 ppm
Phosphorus	4.00 ppm
Extractable Zn by DTPA	0.19 mg /kg of Soil

2.3 Maize Husbandry

Maize variety (Monsanto CP-77400) was sown in selected place of research center in concerned Department of college of agriculture, university of Sargodha by using 20 kg/acre. Every seedbed contained 2 plant rows having space of 20 cm. The plant to plant distance of 8 inces was kept after thinning at germination. Macronutrients (NPK) at uniform rates (@ 160-96-80 kg/acre) were added by using urea, DAP and SOP respectively. At seed sowing time, half dose of Urea was applied. Remaining dose was used after 25 days to the field. At each required phase, water was applied to field to fulfill the water requirements to maintain water contents in crop. We harvested the crop after its completion, plant specimens were taken from every replication for examination purpose. Also soil samples and plant cobs were collected from each replication in plastic bags and tags likewise. Plant samples were likewise collected, dried and grinded in IKA Werk having sharp blades and steel chamber. Data related to growth and yield parameters were studied during this phase.

2.4 Observation to be studied

Table 3

Growth Parameters	Yield Parameters
Plant Height (cm)	No of grains cob $^{-1}$
Stem Diameter (cm)	1000 grains weight (g)
Plant Biomass (g)	Grain Yield (t.ha^{-1})

2.5 Data collection

On daily basis maize seedlings were counted from each plot and their germination was recorded by using its below mentioned formula:

GP = seeds germination/total seeds x 100

Similarly plant height was recorded using meter rod in centimeters, stem diameter in millimeters by using Vernier Caliper and 1000 grains, weight of cobs, number of grain per cob and plant biomass by using weighing balance**.**

2.6 Zinc determination in Soil Samples

Di-ethylene triaminepenta acetic acid (DTPA) test referred by Lindsay and Norvell, 1978 was performed to find the zinc contents in collected soil samples. Solution of HCl having normality 6N was used to maintain 7.30 pH of DTPA solution. Zinc was determined from final solution of 10-gram soil samples after filtration through wahtman.42 filter paper by driving Atomic Absorption Spectrophotometer. Standard solutions were used to calibrate the instruments for accurate results.

2.7 Statistical Study

Interactive and mean effects of Zn priming in maize crop were observed related variables by examine variance (ANOVA) technique. At 5% probability level least significant difference test (LSD) was applied to estimate significantly different treatment means (Steel and Torrie, 1980).

3. Results and discussion

3.1 Growth indices

Data in Table 4 revealed that all growth indices such as plant height, stem diameter and plant biomass were improved due to priming of maize seeds with zinc sulphate in high concentration along with required amount of macronutrients (N.P.K) at significant level ($p \leq 0.05$). Data of growth parameters were analyzed after harvesting of crop. The different interaction was confirmed in different sources of zinc application. In case of plant height peak value (220.31cm) was showed by T_4 than other treatments, where zinc was supplied in the form of 4% zinc sulphate solution through seed priming and minimum value (176 cm) was seen under control treatment (T_1). The non-significant interaction was noted between T_2 and T_3 where maize seeds were treated with 1 % and 2 % solution of zinc sulphate respectively through seed priming mode showing values of 203.30 cm and 208.17 cm correspondingly. Likewise results of treatment T_5, T_6 and T_7 were at par when compared with each other but showed non-significant trend statistically under T_6 and T_7 treatment where zinc was applied using source of EDTA with different concentrations. Albert both sources of zinc (EDTA and zinc sulphate) enhanced plant height relative to control (T_1).The outcomes of Brown

(2003) were also in same line and zinc sulphate through seed priming showed effective results and increase plant height of maize.

In case of stem diameter results also varied significantly from lowest value (2.13cm) to highest value (3.50cm). Plant stem indicated best result (3.50 cm) in case of T_4 when zinc sulphate was applied through seed priming with 4 % solution and lowest result (2.13 cm) was reported in control treatment (T1). After their results of T_3 and T_6 showed non-significant behavior comparatively having values of 3.3 cm and 3.23 cm respectively. Similarly T_2 and T_5 were observed as a non-significant statistically at the rate of 2.87 cm and 2.80 cm values correspondingly. Same outcomes of stem girth were estimated by Harris *et al*., (2007). Both sources showed best results when compared to control value. Zinc sulphate of 4 % solution was proved superior to all treatments.

The same trend of results was observed in case of plant Biomass. The range of analyzed value was 2.29 t.ha^{-1} to 3.64 t.ha^{-1}. First value was noted in case of control treatment (T_1) where no zinc was applied in any form while later maximum value was noted in case of T_4 where zinc was used as ZnSO4 @ 4 % solution. All other treatments findings were also different considerably and T4 was followed by T_3 where 2 % solution of $ZnSO_4$ was used as a seed priming material. However, results of T_2 (1% ZnSO4 as a zinc source) and T_7 (3.0 % EDTA source of zinc) were non-significant comparatively. Among all applied treatments zinc sulphate was proved as a best source of zinc and both sources revealed significant outcomes comparative to control treatment statistically. The findings of Harris, Rashid, Miraj, Arif & Shah (2007) related to stem diameter were also in same line as we found. This may be to the effect of high concentration of ZnSO4 and its availability in Pakistani soils.

Table 4: Effect of seed priming on growth parameters

Treatments	Plant height (cm)	Stem diameter (cm)	weight of plant biomass (t.ha^{-1})
Control	176 c	2.13d	2.29f
$ZnSO_4$ @ 1% solution + NPK	203.30b	2.87c	3.27c
$ZnSO_4$ @ 2% solution + NPK	208.17b	3.30b	3.50b
$ZnSO_4$ @ 4% solution + NPK	220.31a	3.50a	3.64a
Zinc-EDTA @ 0.5% solution + NPK	198.12 ab	2.80cd	2.95e
Zinc-EDTA @ 1.5% solution + NPK	179 bc	3.23b	3.10d
Zinc-EDTA @ 3.0% solution + NPK	180.30 bc	3.13b	3.07d
LSD ($p<0.05$)	0.638	0.573	0.388

3.2 Yield Indices

The results regarding yield parameters (Table 5) also showed that priming of maize seeds with different sources and levels of zinc improved number of grains cob^{-1}, 1000-grains weight and grain yield (t.ha^{-1}) at significant level of $p \leq 0.05$. It is evident from the Information related to number of grains cob^{-1} zinc seed priming had a significant contribution in improving grain numbers per cob ultimately increase in grain yield and thousand grains weight.

The maximum value (661.67) of number grains cob^{-1} was monitored in T_4 treatment where zinc sulphate was used as a zinc source for priming of seeds at the rate of its 4 % solution adjacent to required amount of NPK in soil and least value (380.67) was examined in control T_1 treatment where only NPK was applied with recommended ratio. After T_4 treatment, T_3 was most effective treatment showing value of 605 grains per cob. Result of T_2 was also at par. Two sources of zinc in this trial zinc sulphate and zinc-EDTA showed different results statistically but ZnSO4 showed better results than chelated Zinc-EDTA. Consequences of Basara, Ehsanullah, Cheema & Afzal (2003) were also in same direction of our results.

In the same way if we compare results of all treatments for thousand grains weight, it is confirmed from data that the entire treatments mean has a significant difference comparatively. The values are ranging from 121 g to 203.33 g statistically. The peak value was noted in T_4 (4 % solution of zinc sulphate) and least value was indicated by control (T_1) treatment. After T_4 treatment T_3 was proved better obtaining significant value of 170.23 g. The results of two chelated zinc-EDTA sources in T_7 (3.0 % solution) and T_6 showed non- significant statistical behavior comparatively. Results of T_5 (148 g) were also at par where chelated zinc was applied with 0.5 % solution of zinc-EDTA. Above all it was seen that thousand grains weight was significantly enhanced by high concentration of Zn solution in the form of 4 % solution of zinc sulphate. The results of Rashid & Ryan, (2004) were also similar to our study results. They also observed $ZnSO_4$ as a best source than EDTA for yield parameters and grain weight.

The results associated with grain yield also exposed that use of 4 % zinc sulphate treatment (T_4) is superior to all other treatments significantly showing highest value (7.99 t.ha^{-1}) of grain yield. Least grain yield (4.01 t.ha^{-1}) was noted in control treatment (T_1) where there is no use of zinc source except required amount of NPK in the form of urea, DAP and SOP respectively. Results of all other treatments (T_3, T_4, T_5, T_6 and T_7) were also at par and different significantly. Treatment (T_4) was followed by T3 (2 % zinc sulphate solution) having grain yield of 7.26 t.ha^{-1} and T_7 (3.0 % chelated zinc EDTA) 6.61 t.ha^{-1}. This research proved that high concentration of zinc sulphate shows better results than all other results. However both zinc sources (ZnSO4 and Zn-EDTA) showed statistically better and significantly different results when compared with control but overall best results were indicated by 4 % solution of zinc sulphate. Graham *et al.*, 1992 and Kanwal *et al.*, 2009 also showed similar findings that of our investigation. This may be due to the effect of high concentration of zinc sulphate application under alkaline and calcareous soil. Due to high concentration of zinc under alkaline soil availability of zinc may be increased and causes positive effects on yield indicators of crop.

Table 5: Effect of seed priming on yield parameters

Treatments	Number of Grains Cob^{-1}	1000-grains weight (g)	Grain yield (t ha^{-1})
Control	380.67f	121f	4.01d
$ZnSO_4$ @ 1% solution + NPK	568.67c	162.33e	6.02cd
$ZnSO_4$ @ 2% solution + NPK	605.67 b	170.23de	7.26b
$ZnSO_4$ @ 4% solution + NPK	661.67a	203.33a	7.99a
Zinc-EDTA @ 0.5% solution + NPK	598 bc	178.00cd	5.26d
Zinc-EDTA @ 1.5% solution + NPK	545.33d	185.67bc	6.25c
Zinc-EDTA @ 3.0% solution + NPK	420 e	190.33b	6.61b
LSD ($p<0.05$)	1.017	2.89	1.01

Conclusion

It is concluded from results that nutrient seed priming with 4 % zinc sulphate solution (T_4) along with recommended doses of NPK was found to be most suitable and economical under prevailing conditions of soils in Sargodha. Because most of the soils in Pakistan are alkaline and calcareous in nature due to arid to semi-arid climate of Pakistan. Under these conditions concentration and availability of micronutrients becomes low. So, after application of zinc in high concentration in theses soils, it shows better results.

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