

Optimizing Biofortification Of Zinc By Application In Barley Under Calcareous Soil Condition

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Abstract

Barley such as *hordeum vulgare vulgare L* is view of the familiar earliest grains which has been developed from the food grain to support and malting grain. Air dried soil was taken and passing it through the sieve of 2mm. To store them pouring the soil into the plastic pot. To check the performance of optimizing biofortification of zinc in calcareous soil by the process of foliar application of zinc sulphate and fertigation in barley, consideration is taken place. Zinc was applied through fertigation and foliar application at a distinct rate (zer0,10,20,30). The potted experiment showed enhanced effect with the Zinc fertigation and foliar application in the plant weight and plant height as highest plant weight of fertilized treatments at the rate of Zn 10 was 2.227 and it is followed by treatment at the rate of Zn 30 was 1.704 and the lowest

value showed at the rate of Zn 30 was 1.197. Moreover, out of fertigation and foliar application process of fertilized treatment of Zn by Zinc use efficiency shows the highest value by the treatment at the rate of Zn 10 was 45.04 and at the rate of Zn 30 was 44.46 which is followed by the treatment at the rate of Zn 30 was 36.61. So, it is cleared from the results that fertigation and foliar application process is more appropriate for optimizing the biofortification of zinc in barley in a calcareous soil by using zinc sulphate.

INTRODUCTION

Only minute quantity of the zinc required by the plant, human, animals for their growth and development in accordance by the (Gondal *et al.*, 2021) point of view. It is a micronutrient and also a heavy metal containing atomic no 30 and is abbreviated by Zn (Filler & Felder, 2014). For the reliability of member of human race fitness, plant growth, the micronutrient is very important part of this stated by (Proietti, Frazzoli, & Mantovani, 2015). It is present in the form of free ions in the plant and may also form complexes with compounds of low molecular mass (Khan *et al.*, 2022). In all six classes of enzymes such as lysases, oxidoreductase, isomerases, ligases, transfarases, hydrolases, the metal zinc is intricated in these.

The insufficiency of the micronutrient in the plant may create many problems. In the plant, zinc is important for their growth in a small amount but their deficiency led to create various problem like stunned growth , interveinal chlorosis ,leaf deformation , rosetting, root development chlorophyll synthesis, reduce yield and overall effect the plant growth and health (Elsheery, Helaly, El-Hoseiny, & Alam-Eldein, 2020) . Zinc insufficiency is a major problem over the world in millions of the areas where the cereals are grown. This shortage affects both yield and grain quality (Cakmak, 2009). (Imtiaz, Rashid, Khan, Memon, & Aslam, 2010) suggested that the soil with insufficient amount of micronutrient like Zinc may affect their crop yield. Out of the mineral's element, zinc is ranked at the third number in the world population next to iron or vitamin (ALKURD *et al.*, 2023). Children and women are facing more problems in the world with the zinc insufficiency. The crop which are tolerating with the weather condition effects the fertile growth of plant with the low amount of the zinc in it. In the case of cultivation, barley is considered as the most advance grain in the world stated by (Soto-Gómez & Pérez-Rodríguez, 2022) . The usage of the barley in making animal food and alcoholic beverages is predominant around the globe. It is studied as the fourth main cereal crop of the world. Cultivated barley which is known as the *hordeum vulgare* derived from the species which is *hordeum spontaneum*. According to (Fahad *et al.*, 2019) the growth of barley occurs where the other cereals cannot grow well because of the elevation, storm, less salinity. The adaptability of the barley represents with the help of its extensive taxonomic range of cultivation that gets diverse from Norway to Chile. It contains 17% of fiber which is a highest level among whole grain cereals. A special type of fiber that is present in the barley known as beta glucan fiber that gives the structural support to barley grain strengthen their cell wall, provide flexibility and rigidity and also maintain the grain shape. This fiber also act as a reserve carbohydrate that store the plant energy and use it whenever they needed it. This fiber also helps in plant water retention and in seed germination (Panahi, Ezatagha, Temelli, Vasanthan, & Vuksan, 2007). To increase the income range of the farmland where barley is a chief food not only by expanding viable crop production but also making better sustenance, lowering work labor and also making the different products which contains huge amount of barley grains. Biofortification also called as biological fortification in which bio means life and fortificare means to make strong. So, the biological fortification or biofortification is a process which is used to increase the food nutritional value of the crop by enrichment of micronutrient in the edible portion of staple crop. It is a strategy which is used to combat the micronutrient deficiencies in the developing areas of the world.

METHODOLOGY

Soil Collection and Physiochemical Analyses

Air dried soil was taken to perform this experiment to analyze the different aspects. From 2mm sieve, soil is passing out and pour them in a plastic glass for storage. To check the distinct boundary of the soil such as soil particle size and emergence of sub sample, analysis was done. Soil paste was made to check the pH of the soil. Soil extract was made for calculating the Electrical conductivity, filed capacity of the soil.

Dispersing solution 500mL) was made by adding 25g sodium hexametaphosphate (Na₆(PO₃)₆) in measuring flask and volume was made up to 500mL by addition of distilled water. Zinc is attainable to the plant and other minerals such as nitrogen (Bagur-González, Estepa-Molina, Martín-Peinado, & Morales-Ruano, 2011). According to the (Beretta *et al.*, 2014) the texture of soil was extract by bouyocous hydrometer method. The field capacity that was evaluated from the saturated soil paste extract was 0.017.

Experimental Design and Treatments

In a completely randomized design (CRD), the experiment of the biofortification of zinc was intended with the replicates of three which was 7 treatments in total that was present in 21 glass pot and also comprises of subsequent treatments such as control (zero Zn) (soil application by fertigation) Zn 10 mg ZnSO₄, Zn 20 mg ZnSO₄, Zn 30 mg ZnSO₄, although the others with (soil application by foliar application) are Zn 10 mg ZnSO₄, Zn 20 mg ZnSO₄, Zn 30 mg ZnSO₄. The solution of DAP (Diammonium Phosphate) along with Zinc sulphate and urea was also used in the treatment as a necessary nutrient to eliminate the nutrient deficiencies.

Filling of Glass, Sowing of Seed and Harvesting

Soil which was taken about 500g and was filled in a plastic glass that was organized in a completely randomize design (CRD). Before the sowing of the seeds of barley, water was also flooded in the glass. After the accomplishment of field capacity of soil, 3 seeds of the barley were sown in each plastic glass. The seeds of the barley attained that much growth and were harvested 3 months after the growth. The required doses of the nutrients were applied to each plastic glass during the whole experiment. The concentration of the zinc was estimated in the sample by using meta- vanadate yellow color method that is go along with H₂SO₄ digestion. For the saturation of zinc determination, the research was finished by spectrophotometer. After the harvesting of the plant different parameters were perceive from the experimental journey like biomass of plant (BOP), plant height, zinc uptake zinc use efficiency etc.

Statistical Analysis

By using the Statistics 8.1, the collection of data during the experiment was evaluated and is deal out with the ANOVA (Analysis of Variance) to compare the means of different treatments to see if there is a significant difference among them.

RESULTS AND DISCUSSION

Assessment of weight associated variable

The important parameter of the plant which is measured in cm. By using the electronic weighing balance, the overall weight of the plant was considered. The weight of plant was calculated exactly after the four weeks of sowing. The application of the Zinc was in two ways, first is the fertigation process in which zinc is used in mixture with the soil and the second is the foliar application in which zinc is applied in spray form on plant leaves, flower or stem part. Outcome of unified apply of distinct levels of the zinc fertilizer on plant in plant weight shows that the plant proposed highest plant weight at Zinc 30 in the fertigation process as in comparison to the other rates. Also, in the process of foliar application plant manifest the higher weight at the rate of Zn 30 while the alternatives depict the lower weight.

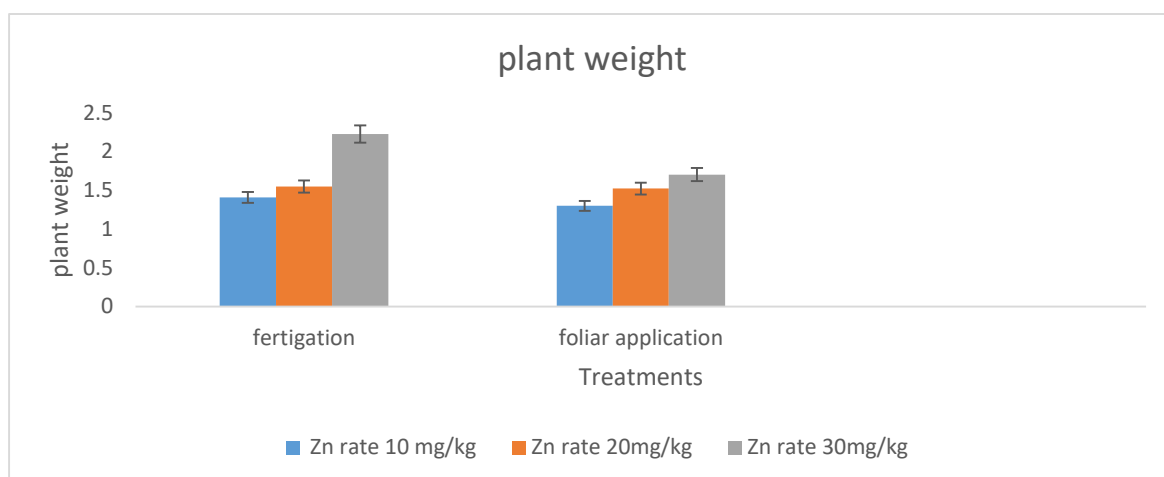


Fig. 1. Effect of integrated use of different levels of Zinc fertilizer on plant in plant weight

Weight of barley plant as influenced by various zinc fertilizer treatment in calcareous soil express that throughout the process of fertigation and foliar application of fertilized treatment of zinc by the entire weight of the plant display various distinctions on the treatments. The two level of application was exceptionally diverse from each other's. At the rate of Zn 30 mg kg⁻¹ by the use of Zn nutrient treatment were considered as the highest total plant weight which is 2.2267 in fertilized plant, and at the rate of Zn 20g kg⁻¹ the lowest weight of plant as by the usage of the plant was 1.3000 during the process of fertigation.

Table 1. Weight of the barley plant as affected by different Zinc fertilizer treatment in calcisol

Treatments		Zn application rate mg kg ⁻¹	Plant weight
T ₁	Control	0	1.1967 E
T ₂	Zn (Fertigation)	10	1.4100 D
T ₃		20	1.5500 C
T ₄		30	2.2267 A
T ₅	Zn (Foliar application)	10	1.3000 DE
T ₆		20	1.5233 C
T ₇		30	1.7033 B
HSD			0.0329

Measurement of Zinc application in barley

Fertigation and foliar application demonstrate the different values and effects of zinc in barley. In the fertilized treatment, the value which was highest shows at the rate of Zn 30 was 34.033 that was succeeded by the middle value at the rate of Zn 10 was 25.163. Another value which was lowest value at the rate of control 0 was 20.667. In the fertigation process the highest value shows by the Zn rate 30. But on the other side, the foliar application also displays the more value at the rate of Zn 30.

Table 2. Concentration of Zinc in barley as affected by different zinc fertilizer usage in calcisol

Treatments		Zn application rate mg kg ⁻¹	ZnCn
T ₁	Control	0	20.667 G
T ₂	Zn (Fertigation)	10	23.963 F
T ₃		20	27.367 D
T ₄		30	31.650 B
T ₅	Zn (Foliar application)	10	25.163 E
T ₆		20	28.74 C
T ₇		30	34.003 A
HSD			0.3253

In the foliar application treatment, there was the higher up growth at the 30 Zn rate than the alternative rate which was 20,10. Similarly the same case was also happened in the fertigation process.

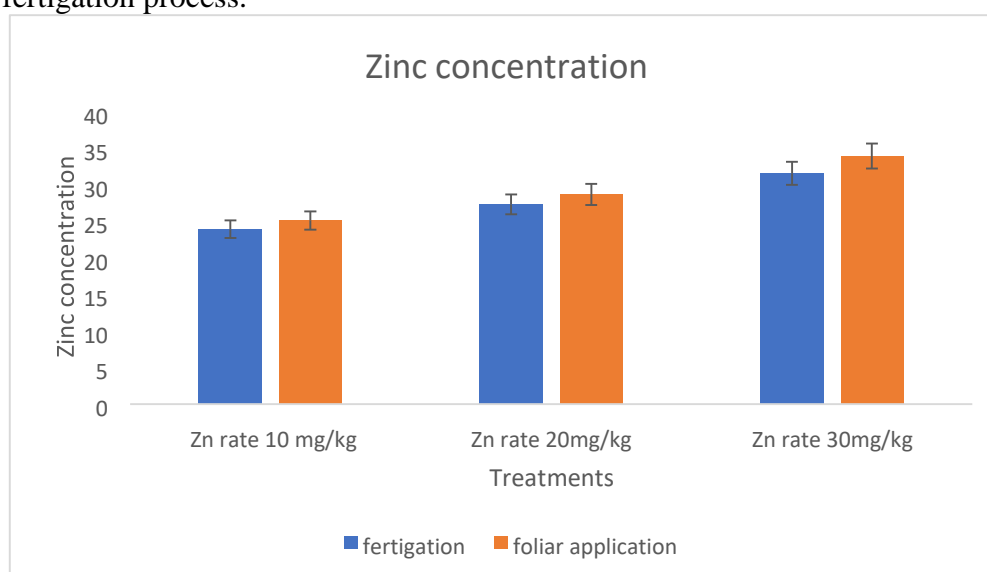


Fig. 2. Effect of integrated use of different levels of Zn fertilizer on plant in plant zinc concentration

Efficiency of Zinc Usage

Amongst the foliar and fertigation procedure of the treatment of fertilizer depict the outstanding variations over the treatments.

Table 3. Zinc use efficiency of barley as affected by different zinc management in calciso

Treatments		Zn application rate mg kg ⁻¹	ZnUE
T ₁	Control	0	0.0000 D
T ₂	Zn (Fertigation)	10	33.033 C
T ₃		20	33.533 C
T ₄		30	36.600 BC
T ₅	Zn (Foliar application)	10	45.033 A
T ₆		20	40.400 AB
T ₇		30	44.467 A
HSD			1.7753

Elevated value of zinc use efficiency shows at the rate of Zn 10 was 45.033 by the treatment and at the rate of Zn 30 was 44.467. The value that was come after this at the rate of Zn 30 was 36.600. The least value showed by the treatment at the rate of Zn 0 was 0.000. In the method of fertigation, the high up value was 36.600 at the rate of Zn 30 and the lowest value of the treatment was at the rate of Zn 10 was 33.033. In the context of foliar application, the highest value indicated by the Zn use efficiency at the rate of Zn 30 was 44.467 and the smallest estimate by the Zn at the rate of Zn 10 was 45.033.

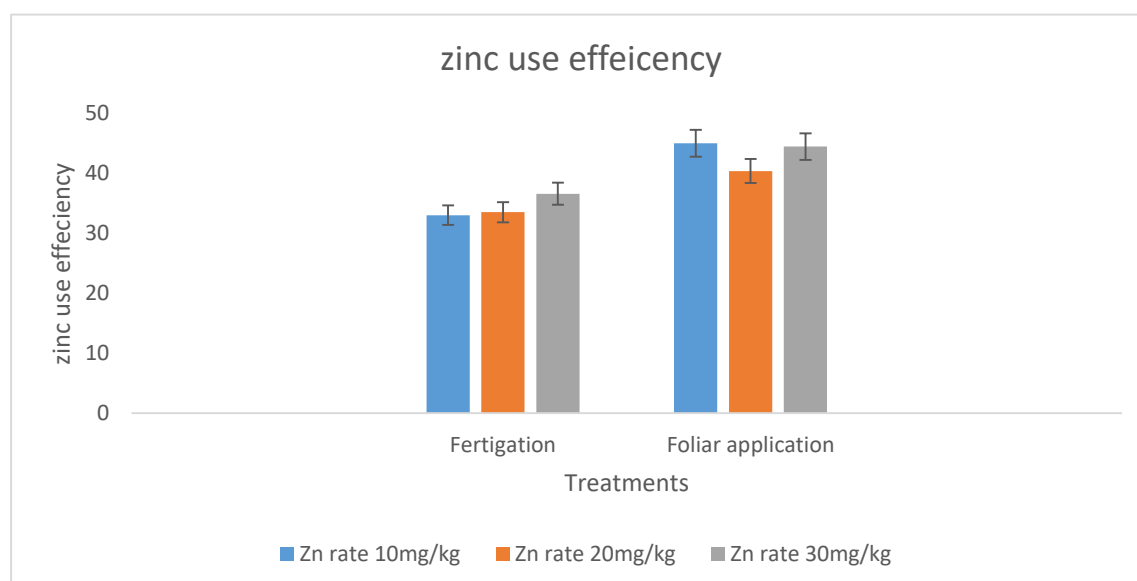


Fig. 3. Effect of integrated use of different levels of Zn fertilizer on plant in plant zinc use efficiency.

Efficiency of the zinc usage in which the most high-rise value of the fertigation process was at the Zn rate 30 apart from the other rates which was 10,20. In the other scenario of the foliar application technique, the highest increase was at the rate of Zn 10 other than rates that was 20,30.

CONCLUSION

The height and the weight of the barley plant raised when the zinc was put in by the process of fertigation and foliar application in the calcisol condition. The zinc intake rate was high-rise not only by using the zinc only but also along with the usage of zinc sulphate fertilizer. The results of the two processes of the application which was foliar and fertigation shows that there was an outstanding increase by the fertigation process on the growth parameters like plant height, weight and also increases the yield of plant by using the different concentration of zinc because fertilizer is applied directly in this process whereas, foliar process reveal less growth rate. In the end it was concluded that zinc sulphate enlarges the plant height and weight in the calcareous soil condition.

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