Research Article

# Effect of Foliar Spray of Zinc on Growth and Yield of Sunflower (*Helianthus annuus* L.)

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**Abstract** | Pakistan fulfils 80% of its edible oil requirements through import from other countries. Import of edible oil is a huge burden on country's economy and therefore, indigenous oil production must be augmented. Sunflower seed contains 40% of good quality oil. Hence, it can play a significant role for fulfilling the Pakistan's oil needs. This study was conducted to identify the optimum foliar zinc (Zn) supplement for sunflower variety HO-1. The experiment was conducted at field of Oil Seeds Section, Agriculture Research Institute (ARI), Tandojam, Sindh using RCBD design with three replications. The maximum plant height (203.33 cm), stem girth (11.67 cm), head diameter (19.71 cm), number of seeds head$^{-1}$ (1300.0), seeds weight head$^{-1}$ (62.74 g), seeds index (60.12 g), seed yield (1927.8 kg ha$^{-1}$) and oil content (41.92%) were observed under 2.00% Zn, while and minimum plant height (143.67 cm), stem girth (6.19 cm), head diameter (12.65 cm), number of seeds head$^{-1}$ (715.3), seeds weight head$^{-1}$ (35.53 g), seed index (43.82 g), seed yield (1062. 7 kg ha$^{-1}$) and oil content (29.28%) was recorded under control (no foliar spray of Zn). Thus, the plant height, stem girth, head diameter, and number of seeds head$^{-1}$ increased by 41.5%, 88.5%, 55.8% and 81.7%, respectively on applying highest concentration of Zn. While, seeds weight head$^{-1}$, seeds index, seed yield, and oil content ascended by 76.6%, 37.2%, 81.4%, and 43.2%, receptively as compared to the control. It was concluded on the basis of these findings that the foliar application of Zn in 2.0% concentration can be employed to increase the sunflower yield and oil content. The study suggests that Zn can be employed for improving sunflower yields and quality, especially in regions where the soils are Zn deficient. Such approaches could contribute to optimizing current fertilization strategies and can help in improving sunflower production.

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## Introduction

Sunflower (*Helianthus annuus* L.) occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world (Rodriguez et al., 2002; Ahmad et al., 2011). It is currently cultivated on approximately 23 million hectares in 40 countries of the world, including some countries in humid tropical Africa because it is quite rustic and can perform well under varying climatic and soil conditions (Seiler et al., 2008; Kaleem et al., 2011b; Konyalt, 2017). The major oilseed crops grown in Pakistan include sunflower,

canola, rapeseed/mustard and cotton. Availability of edible oils in Pakistan remained at 3.623 million tons of which local production contribute 0.431 million tons, while the imports' share was 3.191 million tons. The import bill of Pakistan for edible oil is around Rs. 320.893 billion (GOP, 2018-19).

Sunflower is considered an important oilseed crop as its oil is widely chosen for cooking purposes. It is grown in two seasons in Pakistan, spring and summer (PARC, 2019). Although it is a high yielding, high oil crop which gives promising returns to the farmers, no serious efforts have been made to augment the local production of this crop. Therefore, it is extremely important to introduce new improved genotypes of sunflower, as well as mature its production technology which could play huge role in improving its per unit area yields in the country.

Sunflower is quite responsive to Zn deficiency which is prevalent on a wide range of soils in many countries of the world, including Pakistan (Tiwari et al., 2014). Although Zn deficiency occur in several areas of the world, semi-arid areas having calcareous soil are highly impacted. It is one of the most prevalent micronutrient deficiency issue. As a fertilizer, zinc sulfate plays a major role in regulation of stomata influencing the photosynthesis, and ionic balance in plants which is further involved in drought tolerance (Babaeian et al., 2010; Baybordi, 2006; Kassab, 2005).

Most of the soils in Pakistan are reported to be Zn deficient (Siddiqui et al., 2009). Impaired availability of Zn in the top and subsoil act as a restraint towards sustainable crop production in Pakistan (Torshin et al., 2015). Therefore, use of fertilizers needs to be modulated to ensure balanced supply of nutrients as well as micronutrients, and the application of fertilizers such as zinc sulfate must be given appropriate consideration to compensate for the deficiency in affected areas (Baybordi, 2006; Babaeian et al., 2010).

Use of Zn along with other fertilizers can be adopted to surmount the Zn deficiency. Zn enhances the growth, plant height, and leaves and dry matter production of sunflower. Such ameliorations in crop parameters can be attributed to improved metabolic role of this micronutrient (Torun, 2013). Foliar fertilization is increasingly popular especially regarding production of high value crops such as sunflower (Fernández and Brown, 2013; Fernández et al., 2013). Foliar application of many of Zn has been reported to produce positive response on seed yield and seed quality of sunflower (Jabeen et al., 2013; Skarpa et al., 2013; Yang et al., 2013; Tahir et al., 2014). Foliar application of Zn is also suggested to alleviate the adverse effects of water stress on plant photosynthesis and photosynthesis-related characteristics and yield contributing traits (Kassab, 2005).

This study was conducted to investigate the influence of various concentrations of Zn on sunflower yield and yield components. Four different levels of Zn were investigated against a check. The study gives an insight into optimizing sunflower fertilization as well role of Zn towards yield and yield-contributing traits of this high value crop. The experiment investigated apposite level of Zn for foliar spray on sunflower. This strategy can play huge role in sunflower production in Pakistan and can help in decreasing country's import bills for this commodity. Hence, the study carries immense importance towards crop science, as well as towards Pakistan's edible oil scenario.

## Materials and Methods

The experiment was conducted at Oil Seed Section, Agriculture Research Institute, Tandojam, Pakistan to evaluate the effect of foliar spray of Zn on growth and yield of sunflower. The experiment was laid out in randomized complete block design (RCBD) replicated three times under five treatments i.e. $T_1$= control (no Zn fertilizer application), $T_2$ = 0.5% Zn, $T_3$= 1.0% Zn, $T_4$= 1.5% Zn, $T_5$= 2% Zn. The net plot size of 5 m x 3 m= (15 $m^2$) was maintained with one feet row to row spacing. 90-45 kg $ha^{-1}$ NP were supplemented in all plots as doses of fertilizer. Foliar applications of Zn were carried out at the time of flowering stage. The observations were recorded for plant height (cm), stem girth (cm), head diameter (cm), seeds $head^{-1}$, seed weight $head^{-1}$ (g), seed index (1000 seed wt. g), seed yield (kg $ha^{-1}$) and oil content (%).

### *Statistical analysis*

The recorded experimental data were subjected to factorial design of analysis of variance (ANOVA) under linear models of statistics to observe statistical differences among different traits of sunflower by using computer program, Student Edition of Statistix (SWX), v. 8.1 (Analytical Software, 2005). Further least significant difference (LSD) test was also applied to test the level of significance among different

combination means (Gomez and Gomez, 1984).

## Results and Discussion

### *Plant height (cm)*

The statistical analysis of variance for plant height (cm) indicated that levels of Zn were highly significant at 5% probability level (Figure 1). The maximum plant height (203.33 cm) was recorded under the Zn level of 2.00%, followed by 0.50% (197.33 cm). While the lowest plant height was recorded to be 143.67 cm under control. The results agreed with Praksh and Halaswamy (2004) who suggested that the superiority of plant height could be attributed to high available of nutrient application.

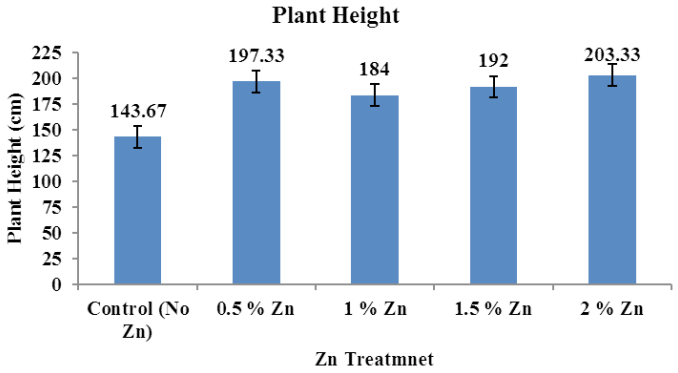


**Figure 1:** *Effects of foliar application of Zn on plant height of sunflower (Helianthus annuus L.).*

### *Stem girth (cm)*

The statistical analysis of variance for stem girth (cm) indicated that Zn levels were highly significant at 5% probability level (Figure 2). The results indicated that maximum stem girth was 11.67 and 11.44 cm under Zn level of 2.00 and 1.50%, respectively. 1.00% Zn treatment produced stem girth of 9.74 cm, while minimum stem girth was observed to be 6.19 cm under control. These results suggested that foliar spray Zn augmented the plant growth ultimately resulting in an increase in stem diameter of the sunflower. Earlier, similar observations have been proposed by Khaliq and Cheema (2005).

### *Head diameter (cm)*

The statistical analysis of variance for head diameter (cm) indicated that different Zn levels produced variations in sunflower's head diameter however, many of the such variations were non-significant at 5% probability level (Figure 3). The maximum head diameter was achieved under Zn level of 2.00% (19.71 cm), followed the treatments of 1.00 and 1.50 % (16.04 and 16.14 cm, respectively). Nevertheless, these variations were statistically at par with each other. The least head diameter (12.65 cm) was recorded under control. These results are in line with the Reddy et al. (2002) who also demonstrated an increase in plant head diameter under such treatment.

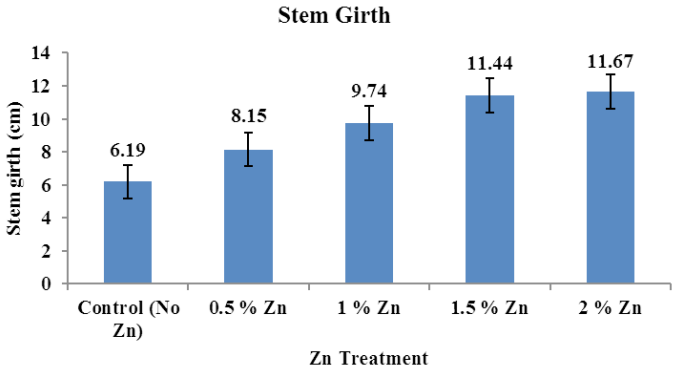


**Figure 2:** *Effects of foliar application of Zn on stem girth of sunflower (Helianthus annuus L.).*

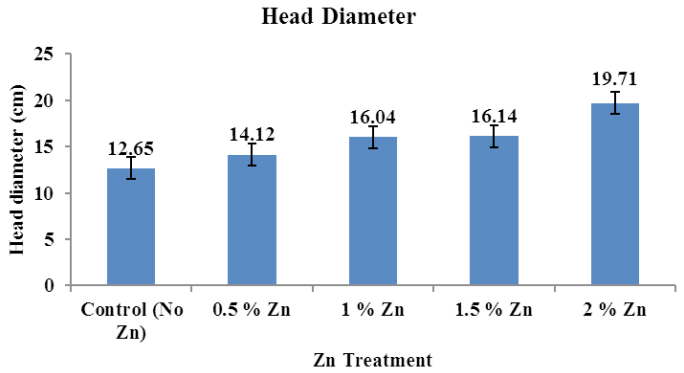


**Figure 3:** *Effects of foliar application of Zn on head diameter of sunflower (Helianthus annuus L.).*

### *Number of seeds head$^{-1}$*

The statistical analysis of variance for number of seeds head$^{-1}$ indicated that Zn levels were highly significant at 5% probability level (Figure 4). The maximum number of seeds head$^{-1}$ (1300.0) were observed under the Zn level of 2.00%, followed by 1.50 and 1.00% (1233.7 and 1118.3). Lowest number of seeds head$^{-1}$ (715.3) were recorded under control. The results were parallel to Babaeian et al. (2011), who also found that the foliar application of Zn at flowering stage produced a higher number of seed head$^{-1}$.

### *Seed weight head$^{-1}$ (g)*

The statistical analysis of variance for seed weight head$^{-1}$ (g) indicated that Zn levels were highly significant at 5% probability level (Figure 5). The results of seeds weight head$^{-1}$ indicated that maximum seeds weight head$^{-1}$ (62.74 g) were recorded under the Zn level of 2.00%, followed by the Zn level of 1.00 and 1.50% (56.21 and 56.78 g, respectively). Again, the


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minimum seed weight head$^{-1}$ (35.53 g) was recorded under control. These observations agreed to the report of Baraich et al. (2016) who proposed a production of higher seed weight head$^{-1}$ when foliar application was used.

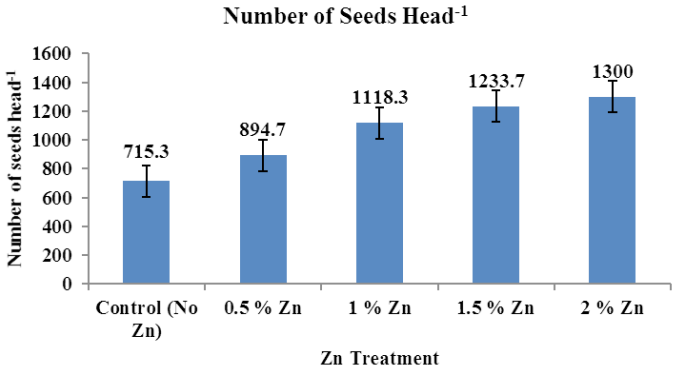


**Figure 4:** *Effects of foliar application of Zn on seeds head$^{-1}$ of sunflower (Helianthus annuus L.).*

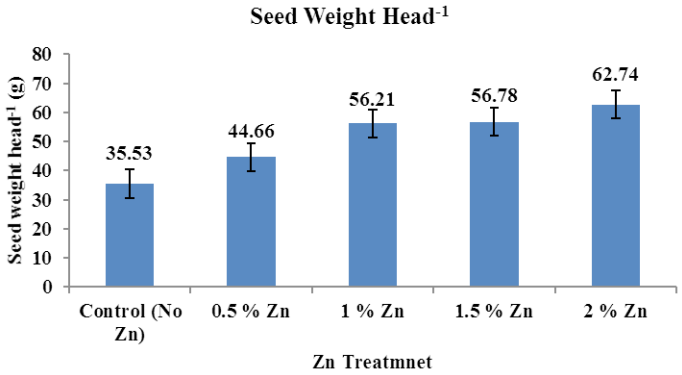


**Figure 5:** *Effects of foliar application of Zn on seed weight head$^{-1}$ of sunflower (Helianthus annuus L.).*

## *Seeds index (1000 seeds weight)*

The statistical analysis of variance for seeds index (1000 seeds weight) indicated that Zn levels were highly significant at 5% probability level (Figure 6). The results of seeds index indicated that highest seeds index was observed under the Zn level of 2.00% (60.12 g), followed by the Zn levels of 1.50 and 1.00% (which yielded seed index of 58.91 and 58.85 g, respectively). The least seed index of 43.82 g was obtained under control. These results were supported by Babaeian et al. (2011) who reported that foliar application of Fe and Zn had improved 1000-seed weight, plant height, and biological yield of sunflower.

## *Seed yield (kg ha$^{-1}$)*

The statistical analysis of variance for seed yield (kg ha$^{-1}$) indicated that Zn levels were highly significant at 5% probability level regarding this trait (Figure 7). The results of seeds index indicated that maximum seed yield at par (1927.8 and 1926.2 kg ha$^{-1}$) were observed under the Zn level of 2.00 and 1.50%, followed by (1805.2 kg ha$^{-1}$) under the Zn level of 1.00% and minimum seed yield (1062. 7 kg ha$^{-1}$) was recorded under control which indicated that foliar application of Zn was involved in yield enhancement. Similar result was reported by Babaeian et al. (2011) reported that foliar application of Fe and Zn had improved seed yield of sunflower. Nevertheless, our study was conducted using one genotype of sunflower, the behavior of sunflower can vary depending upon the genotypes as well which introduces a limitation of the study. In future studies, larger pool of genotypes and higher range of Zn levels should be explored.

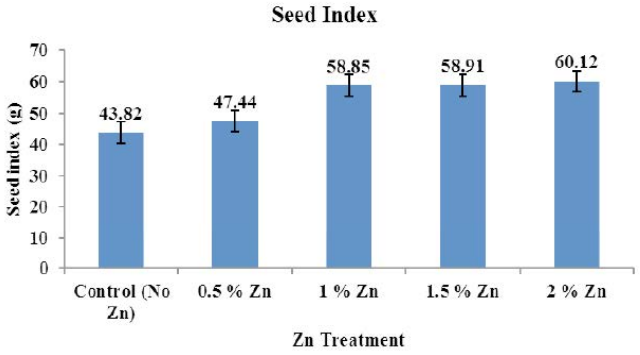


**Figure 6:** *Effects of foliar application of Zn on seed index of sunflower (Helianthus annuus L.).*

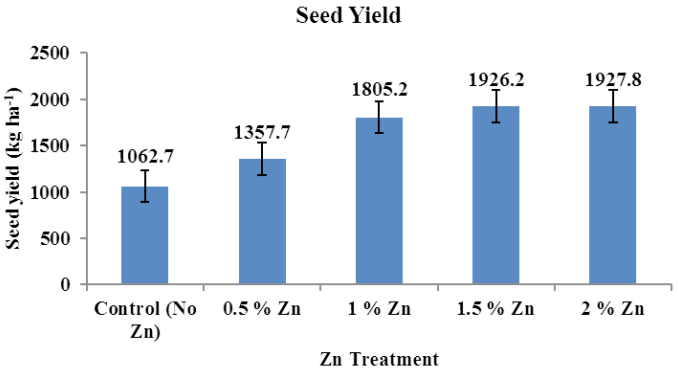


**Figure 7:** *Effects of foliar application of Zn on seed yield of sunflower (Helianthus annuus L.).*

## *Oil content (%)*

The statistical analysis of variance for oil content (%) indicated that Zn levels were highly significant at 5% probability level (Figure 8). The results of oil content indicated that the maximum oil content of 41.92 and 40.36% were produced under the Zn level of 2.00 and 1.50%, followed by 38.05% oil content under the Zn treatment of 1.00%. The minimum oil content of 29.28% was recorded under control. These findings were confirmed by Zheljazkov et al. (2010) who reported significant differences among different sunflower genotypes for seed yield and oil content

under similar treatments.

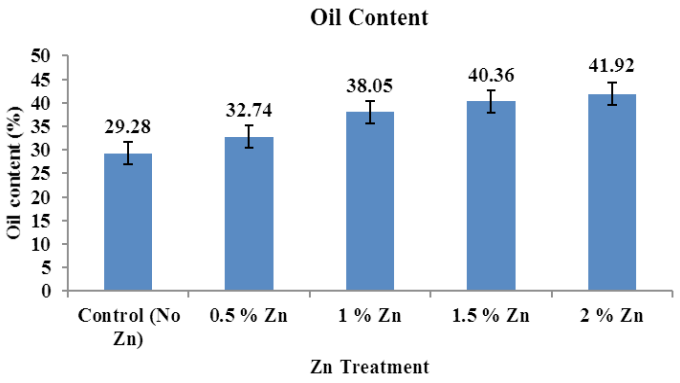


**Figure 8:** *Effects of foliar application of Zn on oil content of sunflower (Helianthus annuus L.).*

## Conclusions and Recommendations

It was concluded that the foliar spray of Zn on sunflower results in significant variations in growth and yield of sunflower (*Helianthus annuus* L.). The maximum yield and yield-contributing traits were observed under the Zn foliar spray of 2.0%. It was concluded this level of Zn foliar spray should be adopted to get maximum harvest and oil content by sunflower variety HO-1.

## Author's Contributions

RAK conducted the study. NSS conceived the idea, and supervised the experiment. AAS helped in collecting the agronomic data of the crop. MAS conducted statistical analysis of the data. MTK supervised the manuscript writing process. GSN provided technical inputs, proofread the work. MNK improved the manuscript through revisions. MS developed graphs of the data. HK provided resources for conducting the work. FDS finalized the references.

*Conflict of interest*

The authors declare that there is no conflict of interests regarding the publication of this article.

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