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Foliage applied zinc improves growth, yield and oil contents of sunflower hybrids (*Helianthus annus* L.)

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ABSTRACT

The research was conducted at Research Area of Department of Agronomy, Bahauddin Zakariya University Multan, during the spring season, 2016. The study aimed to evaluate the influence of foliage applied zinc on growth, yield and oil contents of hybrid sunflower. Experimental treatments comprise of two sunflower hybrids *viz*. H_1= Hysun-33 and H_2= S-278 and three zinc levels *viz*. T_1= Control (no application), T_2=1% $ZnSO_4$ and T_3 = 2% $ZnSO_4$. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement and repeated thrice. Data regarding growth, yield and oil contents were collected by using standard procedures. Results revealed that sunflower hybrid Hysun-33 gained maximum plant height (210.67cm), stem diameter (2.427), head diameter (15.533) achene number (852), achene yield (189.19 t ha^{-1}), leaf area (789.56cm^2) and oil contents (40.423%) followed by sunflower hybrid S-278. Zinc application significantly improved the yield and oil contents. In this regard, maximum plant height (194.67 cm), stem diameter (2.718cm), head diameter (14.633 cm), achene number (842.17), achene yield (194.56 t ha^{-1}), leaf area (782.5cm2) and oil contents (40.12%) from 2% foliar application of zinc followed by 1% foliar application of zinc. Whereas, minimum plant height, stem diameter, head diameter, achene number, achene yield, leaf area and oil contents were recorded from control where no zinc was applied. Interaction of sunflower hybrids with zinc was also significant. In this contest, maximum plant height (231.67cm), stem diameter (2.917cm), head diameter (15.7cm), achene number (925.0), achene yield (205.89 t ha^{-1}), leaf area (801.33cm^2) and oil contents (41.65%) were recorded from sunflower hybrid Hysun-33 with 2% application of zinc followed by sunflower hybrid S-278 with 1% zinc foliar application. In Conclusion, sunflower hybrid along with the 2% foliar application of zinc is the most suitable combination to achieve higher yield and oil contents.

INTRODUCTION

The sunflower is the third most essential wellspring of edible oil and records for around 14% of world generation of grain oil. Even though the sunflower is all about adjusted to semi-arid regions, low fertile soil and supplements inadequacies are significant yield-restricting elements for sunflower production. In the year, 2016-17 the total accessibility of edible oil was 3.726 million tons in which local manufacture contributed 0.462 million tons (14 percent of requirement) while brought of edible oil or oilseeds was 3.264 million tons and its bill reached Rs. 2.710 billion in 2015-16 (GOP 2017).

The chief fats in oil were linoleic and oleic acid and others are palmitic and stearic unsaturated fatty acids. It is cultivated in all over Pakistan. It is deep rooted crop,

intermediary in water that can remove water below root zone of normal small grain crop (Berglund, 1999). Sunflower had capability to compensate the hole among requirement and amount of edible oil and it was well amended to ecological conditions of Pakistan .

About 48% of soils in the world are Zinc (Zn) deficient whereas crops showed significant responses to Zn fertilization in nearly 72% field experiments due to widespread hidden hunger. In addition, Zn is the main composition of the ribosome and is essential for their development. Zinc also plays an important role in the production of biomass . stated that lack of zinc is a major problem in the world and shortage of zinc will reduce crop yield severely.

Zinc shortage in plants cause usual signs; conversely, due to Zn deficiency, the crop growth reduces up to 50%. Zinc deficit indications occur in numerous crops usually seem in twenty-eight days, ancient florae on elder and younger foliage. The symptoms are faded patches in between two zones of mature vegetation. The new plants develop less in mass also frequently named as "slight foliage". In much scarcity, the distance between two nodes becomes very short, then all leaves show to derive since similar tip, then it is known such as "rosetting" .

The hybrid of sunflower give maximum yield by merging organic manure with nitrogen and phosphorous . In India's oilseed crop, the subterminal leaves show light brown necrotic spots while in sesame and sunflower the shortage signs first seem on middle leaves as loss of green shading, trailed by the advancement of darker spots, which develop between the veins. Zinc-insufficient plants are hindered and create little, thin grains. Antagonistic soil conditions, for example, expanding event of dry season spells or saltiness irritate Zn insufficiency issue in edit plants .

From the literature cited and the previous discussion it is hypothesized that exogenous application of zinc can improve the growth, yield and oil contents of sunflower crop. So, this study was aimed to investigate the potential role of foliar application of zinc on growth, yield and oil contents of sunflower hybrids.

MATERIALS AND METHODS

The experiment was conducted at Research Area of Department of Agronomy, Bahauddin Zakariya University Multan. Randomized Complete Block Design (RCBD) with split plot arrangement was employed during the study and repeated thrice. The seeds of sunflower hybrids (Hysun-33 and S-278) were bought from ICI, Pvt. Ltd and Syngenta Pvt. Ltd. Multan Pakistan respectively. Experimental treatments comprise of two sunflower hybrids *viz.* Hysun-33 and S-278 and three zinc application levels *viz.* Zn_0= control conditions, Zn_1=1% $ZnSO_4$ and Zn_2= 2% $ZnSO_4$. The sowing was done on 16 March 2016, to know the foliage application of zinc on growth and yield of sunflower hybrids. The soil was prepared by tractor-mounted 2-3 cultivation followed by planking. Furrows were made with the help of ridge and then water was given to the land and seeds were dibbled with hand on the ridges. Zinc application was done at flowering stage. For plant protection, pest scouting was done after a week. The attack of armyworm was observed for which Lufenuron was applied. Weeds were also removed manually.

Observations

Following observations were recorded during the study.

The height of five plants randomly selected was measured with measuring tape from the base of plant to point of one attachment of stem. Same plants were used to measure stem diameter and head diameter from every plot and their size were taken with help of scale and their average was taken. Then these heads were threshed individually and their achenes were counted and then average was taken. 1000-achenes were counted and then the weight was taken separately from each plot to get 1000-achene weight. Plants from a unit area from each plat were harvested manually. Harvested plants were dried under sunshine and weight was taken along with the heads (achenes) to get biological yield. The heads were separated and threshed to get achene yield from each plot. Harvest index was calculated as a proportion of achene yield to biological yield and expressed in percentage. Leaf area was measured with help of leaf area meter, five plants were taken randomly from each plot and its average is taken.

Oil percentage was measured by using the Soxhlet Fat extraction method. 10 g seeds were oven-dried for 8 hours at 105^0 C to get dry weight. Then 5 g dry seeds were and it was coffee grounded in the mill. The ground seeds were taken in the already weighed thimbles and weighed to get total weight. These thimbles were cited in extractors. After that six round bottom flasks of 250ml size were weighed connected to the extractor. Then the solvent was added to these flasks and placed on heating mantle attach with the condenser. These flasks were heated and its extraction would continue for at least 6

hours. After this, stopped extraction and all the solvent would be taken in Soxhlet extractor. Then cool the apparatus for 1 hour. After cooling, the weight of flask and oil was taken together. Oil percentage was calculated with the following formula;

% Oil=weight of flask + oil-weight of flask/ weight of flask + seed- weight of flask

Statistical analysis

The data collected were analyzed statistically by using Statistix 8.1 software on computer and Least Significant Difference (LSD) test at 5% was employed to compare the treatments means (Steel *et al*., 1997).

RESULTS

Different sunflower hybrids differed significantly for plant height, stem and head diameter, achene number, achene weight, biological yield, achene yield, leaf area, harvest index and oil contents (Table-1). Likewise, Zinc (Zn) application significantly influenced the plant height, stem and head diameter, achene number, achene weight, biological yield, achene yield, leaf area, harvest index and oil contents (Table-1). Interaction of sunflower hybrids with Zinc levels was also highly significant for plant height, stem and head diameter, achene number, achene weight, biological yield, achene yield, leaf area, harvest index and oil contents (Table-1).

Sunflower hybrid (Hysun-33) had more plant height (210.67cm), head diameter (15.533cm), achene number (852) biological yield (566.78), achene yield (189.19), leaf area (789.56) harvest index (12.019%) and oil contents (40.423%) than the hybrid (S-278). Whereas, sunflower hybrid S-278 exhibited maximum stem diameter (2.8267cm) and 1000-achene weight (56.011 g) than sunflower hybrid Hysun-33 (Table-2).

Among different Zn levels, maximum plant height (194.67cm), stem diameter (2.7183cm), head diameter (14.663cm), achene number (842.17), 1000-achene weight (56.683g), achene yield (194.56), leaf area (782.50), harvest index (11.760%) and oil contents (40.117%) was recorded from the application of $ZnSO_4$ (2%) followed by 1% application of $ZnSO_4$.Whereas, minimum plant height (162.00cm), stem diameter (2.5417cm), head diameter (14.512cm), achene number (825), 1000-achene weight (52.075g), achene yield (168.72), leaf area (763.83), harvest index (10.817%) and oil contents (39.748%) were observed from control where no application of $ZnSO_4$ was done. However, maximum biological yield (524.17) was recorded from control followed by (519.00) 1% $ZnSO_4$application and minimum biological yield was recorded from 2% $ZnSO_4$application (Table-2).

For the interaction of sunflower hybrids with zinc application levels, it was observed that maximum plant height (231.67cm), head diameter (15.70cm), achene number (925), achene yield (205.89), leaf area (801.33), harvest index (12.733%) and oil contents (41.65%) was recorded from sunflower hybrid (Hysun-33) with 2% foliar application of $ZnSO_4$ which was followed by the same hybrid from 1% foliar application of $ZnSO_4$ for plant height (211.0cm), head diameter (15.70cm), achene number (841.67cm), achene yield (188.33), harvest index (11.847%) and leaf area (788.33) from control (Table-2). Whereas, maximum stem diameter (2.9167cm) and 1000-achene weight (58.333g) was recorded from sunflower hybrid S-278 with 2% foliar application followed by the same hybrid with 1% foliar application of Zn SO_4 (Table-2). In contrast, minimum plant height (134.67cm), head diameter (13.403cm), achene number (751.67), biological yield (467.00), achene yield (164.11), leaf area (739.33), harvest index (10.157%) and oil contents (38.853%) were recorded from sunflower hybrid S-278 with no application (Control) of $ZnSO_4$ (Table-2). Whereas, minimum stem diameter (2.336 cm) and 1000-achene weight (50.617g) was recorded from sunflower hybrid Hysun-33 with no application (Control) of $ZnSO_4$ (Table-2).

DISCUSSION

Plant height is a precise vital trait as it affects the constancy of the plant i.e., the opposition to lodging. Sunflower is usually a big plant. Several wild types can reach 4-5m whereas cultivated ones are typically near 150-200 cm tall. The tallness of plants is precise rely on soil and climatic conditions whereas scarcity or deprived nutrition soil severely decrease it. The analysis of variance shown that $ZnSO_4$ had a significant effect ($P < 0.01$) on the height of the plant. The maximum plant height (231.67cm) was observed sunflower hybrid Hysun-33 with 2% $ZnSO_4$application (Table-2). The valuable result of zinc on the height of plant might be due to its vital for the production of auxin and proteins in plants and it stimulate many enzymes like peptidases and proteinase. In this concern, enhancing fertilizer levels of zinc enhance plant height as seen by . Maximum plant height (131.07cm) was attained by Hysun-33 whereas, S-278 attain (124.66cm) plant height. These

outcomes show that variance in plant height may be because of hereditary makeup. Hysun-33 was a variety of average height while S-278 was a semi dwarf variety which is in accordance as observed by who check that semi dwarf varieties achieved less height as related to usual height.

The potential growth of sunflower is determined from its vigorously growing stem. Significant differences were noted among different levels of zinc sulphate, hybrids and their interaction Maximum stem girth (3.18 cm) was obtained from S-278 while, Hysun-33 exhibited 2.43 cm stem diameter (Table-2). As sunflower hybrid S-278 attained more stem diameter which might be due to those short stature hybrids have genetically small height but more stem diameter. However, these results are contradictory to who reported non-significant differences for stem girth among various sunflower hybrids. Head diameter is an important yield contributing component of sunflower. It is more or less genetically controlled character but also influenced by the environment. Significant differences were noted among different levels of zinc, hybrids and their interactions. Maximum head diameter (17.48 cm) was produced by Hysun-33 and minimum (15.77 cm) from S-278 (Table-2). Large size head produced by Hysun-33 might be due to the genetic character of hybrid for head diameter. These results are in line with that observed by . Zinc application improved the head diameter. Maximum head diameter (14.663 cm) was recorded from 2% application of $ZnSO_4$and minimum (14.512cm) from control (Table-2). Similar results were reported by Khurana and Chatterjee (2001). They found that zinc application enhanced the capitulum's diameter of sunflower. The achene number is the most important and effective element in yield. The analysis of variance indicated significant differences ($P < 0.05$) among $ZnSO_4$ levels in relations of achene number in the head (Table-1). The maximum achene number (925) was noted from 2% $ZnSO_4$. The outcome revealed that 2% $ZnSO_4$ improved the achene number in the head. These findings are similar with who found that spray plant leaves with $ZnSO_4$ give more values of head diameter (20 cm), number of seeds per head, 1000 seed weight (62.2 g) and seed yield (1600 kg/ha). This is because of the large head size of Hysun-33 and it has dense and short size achenes in the head. Significant variances between numerous sunflower hybrids were also described by . Zinc increased achene number per head which may be because of either improved number of fertilized flowers or better progress of anthers and pollen forming capacity.

1000-achene weight is usually the main element of sunflower yield. The analysis of variance shown that $ZnSO_4$ has a significant effect ($P < 0.05$) on 1000 seed weight. The most 1000 achene weight was in consumption of 20 and 40 kg/ha zinc sulphate but the absence of zinc sulphate had the lowest 1000 achene weight. The result showed that apply $ZnSO_4$ increased the 1000 achene weight. said that foliar use of zinc had a significant effect on 1000 achene weight. 1000 achene weight is a variety distinctive and is caused by hereditary aspects however its quantity is affected by conditions of the maturing time. 1000-achenes weight is a major yield element in sunflower which adds significantly to its last yield. Significant variances in 1000 achene weight of sunflower were seen in hybrids dissimilar levels of zinc and interaction among zinc levels and hybrids. In this case, the greatest value for the 1000-achene weight (56.011 g) was attained by S-278 trailed by Hysun-33 (52.711 g). Because of the big size achenes of S-278 as compared to short size achenes of Hysun-33. These results are the same by results of Ahmad *et al*., (2010), , . These outcomes are the same with results of Mirzapour who saw that weight of 1000-achenes was extremely affecting yield constituent by insemination of zinc. Correspondingly and said that significantly enhance in 1000-grains weight with zinc use.

Biological yield is a significant constraint to know the photosynthetic efficacy of a crop. The sunflower hybrid Hysun-33 revealed the highest biological yield (566.78) while S-278 produced biological yield (473.22g) as it remained semi-dwarf and formed less biomass as compared to Hysun-33 (Table-2). Similar results were observed by Ahmad *et al* (2010) who found that zinc application improved the sunflower yield? Similarly, achene yield is the ultimate and economic part of the crop. In this regard, maximum achenes yield (205.89) was recorded from Hysun-33 with 2% application of $ZnSO_4$ then sunflower hybrid S-278 (Table-2). Higher achene yield in Hysun-33 might be due to larger head diameter and greater achenes no. per head than S-278, which may be due to its good adaptableness in current climatic circumstances and advanced hereditary ability. These outcomes were the same as with those of . Harvest index is the proportion of biological yield to the achene

yield. Maximum harvest index (12.733) was calculated from sunflower hybrid Hysun-33 with 2% application of ZnSO4 (Table-2). These observations are in line with that of found by and Khaliq (2004).

The leaf area was shown significant for the application of zinc and non-significant for hybrid while maximum leaf area (789.56) was shown by Hysun-33. Whereas, from zinc application, maximum leaf area was recorded with 2% $ZnS0_4$ application in Hysun-33. Similar results were given by . Oil contents are extracted from the achene and are the most economic part of the crop. Zinc application significantly improved the oil contents. In this regard, maximum oil contents (41.65%) were recorded from sunflower hybrid Hysun-33 with the 2% application of zinc (Table-2). It might be due to its good adaptableness in current climatic circumstances and advanced hereditary ability. Also, zinc application increased all the growth and yield-related traits and ultimately the good oil contents. also found that zinc application enhanced the oil contents.

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Table 1. Analysis of variance for plant height, stem diameter, head diameter, achene number, 1000-achene weight, biological yield, achene yield, leaf area, harvest index, and oil contents of different sunflower hybrids as influenced by zinc foliage application.

SOV	df	Plant height	Stem diameter	Head diameter	Achene number	1000-Achene weight	Biological yield	Achene yield	Leaf area	Harvest index	Oil contents
Hybrid(H)	1	18432.0	0.71601	16.881	7001.4	49.0050	39386.9	2568.06	3.99502	10.5647	3.99502
Zinc (Zn)	2	1602.7	0.04696	0.3805	22634.4	31.8610	85.2	1981.06	4.81417	1.3576	4.81417
H×Zn	2	140.7	0.00016	0.305	9.49	0.441	525.7	115.06	0.30271	0.1933	0.30271

SOV=source of variance, df= degree of freedom.

Table 2. Effect of Foliage application of Zinc on plant height, stem diameter, head diameter, Achene number, 1000-achene weight, biological yield, achene yield, leaf area, harvest index and oil contents of different sunflower hybrids.

Treatment	Plant height	Stem diameter	Head diameter	Achene number	1000-Achene weight	Biological yield	Achene yield	Leaf area	Harvest index	Oil contents
Hybrid										
H_1	210.67A	2.4278B	15.533A	852.00A	52.711B	566.78A	189.19A	789.56A	12.019A	40.423A
H_2	146.67B	2.8267A	13.637AB	812.56B	56.011A	473.22B	174.33B	751.33B	10.487B	39.481B
Zinc level										
Zn_o	162.00C	2.5417C	14.512A	825.00B	52.075C	524.17A	168.72C	763.83B	10.817C	39.748B
Zn_1	179.33B	2.6217B	14.580A	829.67B	54.325B	519.00A	182.00B	765.00A	11.182B	39.992A
Zn_2	194.67A	2.7183A	14.663A	842.17A	56.683A	516.83A	194.56A	782.50A	11.760A	40.117A
Interaction										
H_1Zn_o	189.33c	2.3367f	15.200b	789.33e	50.617f	581.33a	173.33d	788.33ab	11.477c	39.463c
H_1Tn_1	211.00b	2.4267e	15.700a	841.67c	52.483e	558.00a	188.33b	779.00abc	11.847b	40.157b
H_1Zn_2	231.67a	2.5200c	15.700a	925.00a	55.033c	561.00a	205.89a	801.33a	12.733a	41.650a
H_2Zn_o	134.67f	2.7467d	13.403d	751.67f	53.533d	467.00b	164.11e	739.33c	10.157f	38.853d
H_2Zn_1	147.67e	2.8167b	13.647cd	824.33d	56.167b	480.00b	175.67d	751.00bc	10.517e	39.393c
H_2Zn_2	157.67d	2.9167a	13.867c	842.17a	58.333a	472.67b	183.22c	763.67abc	10.787d	40.197d

Figures sharing similar letter did not differ significantly at 5% probability level.