J. Plant Environ. 03 (01) 2021. 49-61 DOI: 10.33687/jpe.003.01.3974

Available Online at EScience Press
Journal of Plant and Environment
ISSN: 2710-1665 (Online), 2710-1657 (Print)
https://esciencepress.net/journals/JPE

Influence of Foliage Applied Zinc on Growth and Yield of Hybrids Sunflower (*Helianthus Annus* L.)

[a]Shabir Hussain*, [a]Hakoomat Ali, [a]Muhammad Ehmer, [b]Muhammad Saqib
[a] *Department of Agronomy, Bahauddin Zakariya University, Multan 60000, Pakistan.*
[b] *Department of Agronomy, The Islamia University, Bahawalpur, Pakistan.*

ARTICLE INFO

Article History
Received: March 17, 2021
Revised: May22, 2021
Accepted: June 27, 2021

Keywords
Hybrid sunflower
Oil contents
Achene yield
Foliar application
Zinc

ABSTRACT

The aim of study was 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 H2= 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 was 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 (801.33cm2) 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 most suitable combination to achieve higher yield and oil contents.

Corresponding Author: Hakoomat Ali
Email: hha94@bzu.edu

INTRODUCTION

The sunflower is the third most essential wellspring of consumable oil and records for around 14% of world generation of seed oils. 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 creation.In Pakistan there is less production of vegetable oil. We only get 32% of our basic needs through native sources. The other 62% we can meet through imports. The edible oil budget which we import through outside is building up to billions of dollars and turning into a major deplete for outside trade. Eatable oil and oilseed import charge added up to 1.004 billion US$ amid 2004-5. Palatable oil necessity is remained at 2.764 billion tons in same year. This incorporate is 1.907 million tons from imported sources while nearby generation stayed at 0.857 million

tons. Request of palatable oil is expanding at a rate 5.16% every year. At this, our yearly prerequisite would be 3.555 million tons following 5 years and if neighborhood creation is not increment quickly yearly import bill will raise to 1.291 billion dollars.

In Pakistan, we get edible oil through rapeseed. Cotton, mustard, sesame and ground nut, modified as conventional and sunflower, soybean and safflower now presentation as non-conventional oilseed crops. Cotton is real wellspring of consumable oil. Oil commitment from cotton seed was 62.54% of aggregate household eatable oil creation in the nation (GOP,2006) yet cotton is essentially produce for its fiber oil with eatable oil as by item. It is not reared for oil since its seed oil substance is contrarily corresponded with fiber. Therefore, reproducing cotton for expanding oil substance is counter financial (PODB, 1997). Rapeseed and mustard are main winter, oil seed trim and constituted around 7.47% of local oil generation (GOP, 2006). Rapeseed and mustard oil can't be utilized more than 5% for oil mixing in ghee formation because of presence of high erucic corrosive and glucosinolates (PODB, 1995). Subsequently we should scan for non-ordinary oil seed products, for example, sunflower, soybean and safflower. In spite of the fact that soybean appreciate a considerable measure of generation advantage yet because of preparing at conventional expeller plant, soybean and safflower contribute a little(less than 1%) towards assembling oil deficiency.

Sunflower is a produce that has a significant yield in an extensive variety of conditions and the world need the consumable vegetable oils as a fundamental prerequisite and it is a standout amongst the most vital oil seeds. Additionally, it is considered as the fifth most critical wellspring of eatable oil after soybean, cotton, canola and peanuts. Sunflowers have low cholesterol and a high substance of polyunsaturated unsaturated fats, with the goal that its oil has an excellent. In spite of the huge capacity in the creation of oilseeds, little advance has been accomplished in this field. As of late, because of the nation's requirement for oil, sunflower can be reflected as an imperative modern and oily plant.

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 known such as “rosetting”. Oil producing harvests such as groundnut or soybean display alike indications at primary phases of progress. The overall deficit signs of Zn on several oil forming produces was studied by Murthy (2011). In India’s oil seed crop, the sub terminal 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 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 (Bagci *et al.,* 2007). These abiotic stresses/antagonistic soil conditions prompt obstructed development of plants and moderate root action, bringing about a repressed spatial accessibility of Zn. Main considerations in charge of increment in frequencies of Zn inadequacy incorporate extensive Zn expulsion because of high product yields and escalated trimming framework, lesser use of natural composts, utilization of high examination manures, expanded utilization of phosphatic composts bringing about phosphorus (P)- prompted Zn lack and the utilization of low quality water system without satisfactory seepage (Prasad, 2006).

Often unusual, zinc toxicity can take place when its levels in the tissue surpass 200 ppm. Its signs are seen as reduced leaf size, chlorosis in fresher leaves, necrotic leaf tips, and growth of the entire plant is stopped, and/or less root growth. Further, surplus zinc found in the growing medium can strive with plant consumption of iron, manganese, phosphorous or copper and can affect their insufficiency in plant material.

Zinc is much accessible for plant intake when the pH is less for growing medium; subsequently if harmful of zinc is occurred, check the pH and levels of Zn inside the growing zone. Zinc can be present in top rank in several water bases and can be selected, when the water interacts with new spur metal, surfaces. Previously testing tissue, clean the leaves first as precise fungicides which has zinc as an active ingredient, that is added to the zinc ranks in tissue test results.

Keeping in view the above discussion it is clear that no significant work has been done on foliage applicant of

zinc on sunflower hybrids. It is hypothesized that foliage application of zinc would enhance the growth, yield and oil quality of sunflower. This study was aim to evaluate the role of foliage applied zinc on growth, yield and oil quality of various sunflower hybrids.

METHODS AND MATERIAL

The seeds of sunflower hybrids (Hysun-33 and S-278) were bought from ICI, Pvt. Ltd and Syngenta Pvt. Ltd. Multan Pakistan respectively. Randomized Complete Block Design (RCBD) with split plot arrangement was employed during the course of study and repeated thrice.

Experimental treatments comprise of two sunflower hybrids viz. Hysun-33 and S-278and three zinc application levels viz. Zn_0= control conditions, Zn_1=1% $ZnSo_4$ and Zn2= 2% $Znso_4$. The experiment was done at 16 March, 2016 to know the foliage application of zinc on growth and yield of sunflower hybrids. Soil was prepared by tractor mounted 2-3 cultivation follow by planking. Furrows were made with the help of ridger and then water was given to the land and seeds were dibbled with hand on the ridges. Irrigation was applied after 3-4 days depending on weather conditions. 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 Luferon was applied. Weeds are also removed manually.

Evaluation of Agronomic Parameters

The height of five plants randomly selected was measured with measuring tape from base of plant to point of oneattachment 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 were taken. Then these heads were threshed individually and their achenes were counted and then average was taken. 1000-achenes were counted and then weight was taken separately from each plot to get 1000-achene weight. Plants from 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 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 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 mill. The grinded seeds were taken oin the already weighed thimbles and weighed to get toal weight. These thimbles were sited in extractors. After this six round bottom flasks of 250ml size were weighed connected to the extractor. Then solvent was added to these flask and placed on heating mantle attach with the condenser. These flask 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, weight of flask and oil was taken together. Oil percentage was calculated with the following formula;

$$\% \text{ Oil} = \text{weight of flask} + \text{oil} - \text{weight of flask/ weight of flask} + \text{seed} - \text{weight of flask}$$

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 AND DISCUSSION

Plant height

Different sunflower hybrid differs highly significantly for plant height. (Table 1) Likewise the influence of Zinc application was also highly significant for plant height. (Table 1). While interaction of Hybrid with Zinc level was also highly significant for plant height. (Table 1) Sunflower hybrid (Hysun-33) had more plant height (210.67 inch) then the hybrid (S-278) which was (146.67 inch). Among different zinc levels, maximum plant height was observed from application of $ZnSO_4$ (2%) followed by no application of $ZnSO_4$ whereas minimum plant height (162.00 inch) was found from application of $ZnSO_4$ (1%). (Table 2). 2% $ZnSO_4$ has maximum achene number (134.67 inch) in Hybrid (Hysun-33) followed by 2% $ZnSO_4$ in hybrid S-278. It was also observed that Hysun 33 (210.67 inch) has high plant height as compare to (146.67 inch) S-278 (Figure 1).

Table 1. Analysis of variance for plant height as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	18432.0	0.0000 **
Zinc(Zn)	2	1602.7	0.0000**
Hybrid*Zinc	2	140.7	0.0011**

**= Highly significant, *=Significant, NS=Non-significant

Table 2. Influence of different levels of foliage applied zinc on plant height of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	189.33 c	211.00 b	231.67 a	210.67 A
S-278(H2)	134.67 f	147.67 e	157.67 d	146.67 B
	162.00 C	179.33 B	194.67 A	
	LSD Value 0.05	Zinc 2.228	Zinc *Hybrid 5.6661	

Letters sharing same letter did not differ significantly at P < 0.05.

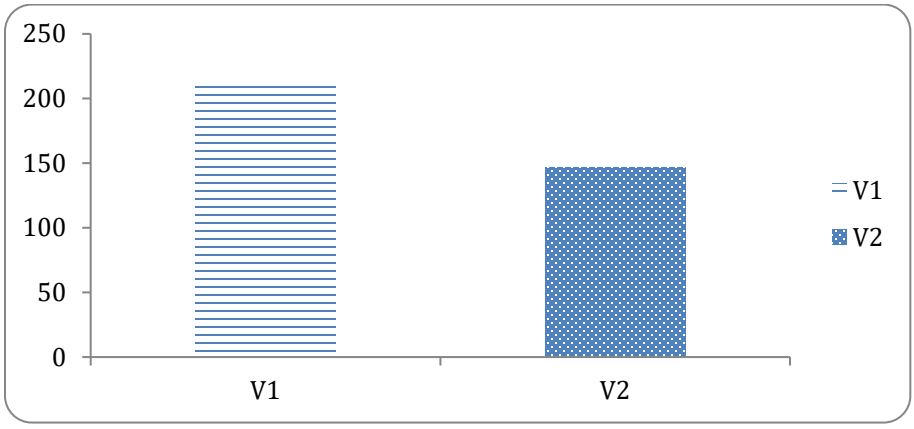

Figure 1. Comparison of plant height of sunflower hybrids as influenced by zinc application.

Stem Diameter

Different sunflower hybrid differs highly significantly for stem diameter. (Table 3) Likewise the influence of Zinc application was also highly significant for stem diameter. (Table 3) While interaction of Hybrid with Zinc level was non- significant for 1000 achene weight. (Table 3) Sunflower hybrid (S-278) had more (2.8267 cm) then the hybrid (Hysun-33) which was (2.4278 cm). Among different zinc levels, maximum stem diameter was observed from application of $ZnSO_4$ (2%) followed by 1% $ZnSO_4$ whereas minimum stem diameter (2.5417 cm) was found from control where no application was done. (Table 4). 2% $ZnSO_4$ has maximum stem diameter (2.9167 cm) in Hybrid (S-278) followed by 1% $ZnSO_4$ in hybrid S-278. Minimum stem diameter was (2.3367 cm) recorded from control condition in hybrid (Hysun-33). (Table 4.4). From Figure 2 it is concluded that V2 (2.8267 cm) has high stem diameter as compare to V2 (2.4278 cm). So, it is noted that Hysun-33 more diameter than S-278.

Table 3. Analysis of variance for stem diameter as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	0.71601	0.0000 **
Zinc(Zn)	2	0.04696	0.0000**
Hybrid*Zinc	2	0.00016	0.8173NS

**= Highly significant, *=Significant, NS=Non-significant

Table 4. Influence of different levels of foliage applied zinc on stem diameter of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	2.3367 f	2.4267 e	2.5200 c	2.4278 B
S-278(H2)	2.7467 d	2.8167 b	2.9167 a	2.8267 A
	2.5417 C	2.6217 B	2.7183 A	
	LSD Value 0.05	Zinc 2.228	Zinc *Hybrid 0.3337	

Letters sharing same letter did not differ significantly at P < 0.05

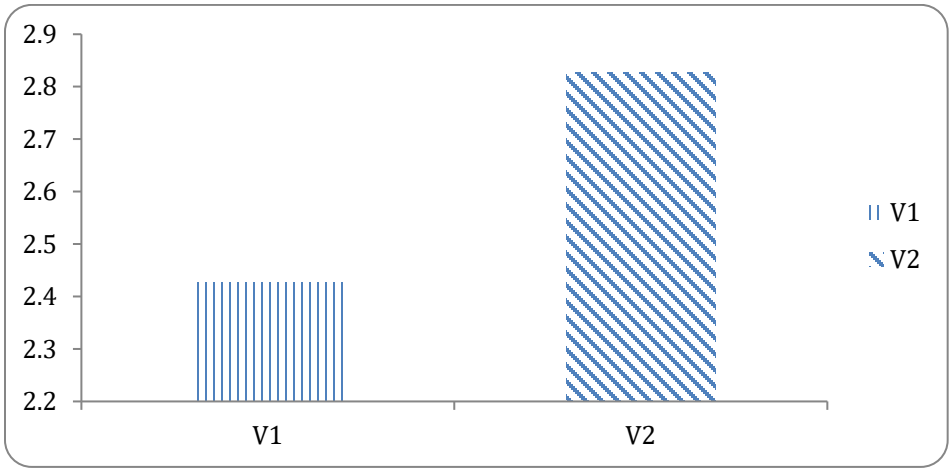

Figure 2. Comparison of stem diameter of sunflower hybrids as influenced by zinc application.

Head diameter

Different sunflower hybrid differs highly significantly for Head diameter. (Table 5) Likewise the influence of Zinc application was also highly significant for Head diameter. (Table 5) While interaction of Hybrid with Zinc level was also highly significant for Head diameter. (Table 5) Sunflower hybrid (Hysun-33) had more Head diameter (15.533cm) then the hybrid (S-278) which was (13.637cm). Among different zinc levels, maximum Head diameter was observed from application of $ZnSO_4$ (2%) followed by 1% $ZnSO_4$ whereas minimum Head diameter (14.512cm) was found from control where no application was done. (Table 6). 2% $ZnSO_4$ has maximum Head diameter (15.700cm) in Hybrid (Hysun-33) followed by 2% $ZnSO_4$ in hybrid S-278. Minimum Head was diameter (13.403cm) recorded from control condition in hybrid S-278 (Table 4.6).

From Figure3 it is concluded that V1 (15.533 cm) has high head diameter as compare to V2 (13.637 cm). So, it is noted that Hysun-33 more head diameter than S-278.

Table 5. Analysis of variance for head diameter as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	16.1881	0.0000**
Zinc(Zn)	2	0.3805	0.0023**
Hybrid*Zinc	2	0.305	0.4206 NS

**= Highly significant, *=Significant, NS=Non-significant

Table 6. Influence of different levels of foliage applied zinc on head diameter of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	15.200 b	15.700 a	15.700 a	15.533 A
S-278(H2)	13.403 d	13.647 cd	13.867 c	13.637 AB
	14.512 A	14.580 A	14.663 A	
	LSD Value 0.05	Zinc 2.22B	Zinc *Hybrid 0.2311	

Letters sharing same letter did not differ significantly at P < 0.05

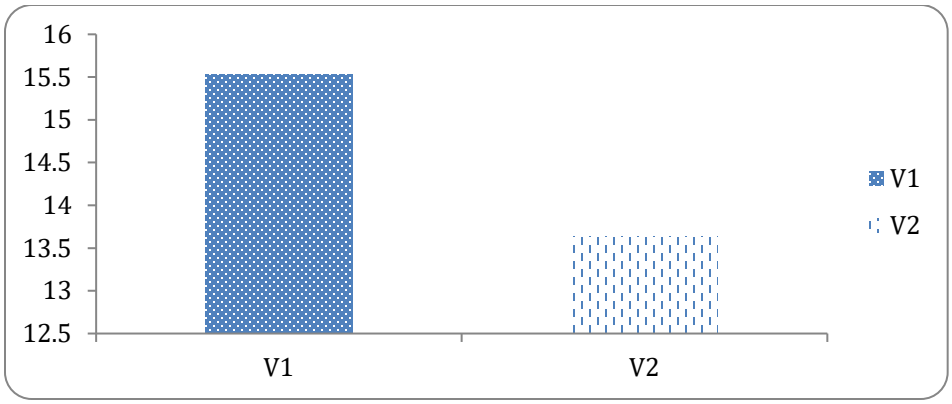

Figure 3. Comparison of head diameter of sunflower hybrids as influenced by zinc application.

Achene Number

Different sunflower hybrid differs highly significantly for achene number. (Table 7) Likewise the influence of Zinc application was also highly significant for achene number. (Table 7) While interaction of Hybrid with Zinc level was also highly significant for achene number. (Table 7). Sunflower hybrid (Hysun-33) had more achene number (852.00 number) then the hybrid (S-278) which was (812.56 number). Among different zinc levels, maximum achene number was observed from application of $ZnSO_4$ (2%) followed by 1% $ZnSO_4$ whereas minimum achene number (825.00 number) was found from control where no application was done. (Table 8).From figure 4 it is concluded that V1 (852.00 numbers) has high number of achene as compare to (812.56 numbers). So, it is noted that Hysun-33 more achene than S-278.

Table 7. Analysis of variance for achene number as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	7001.4	0.0000**
Zinc(Zn)	2	22634.4	0.0000**
Hybrid*Zinc	2	9.49	0.0049**

**= Highly significant, *=Significant, NS=Non-significant

Table 8. Influence of different levels of foliage applied zinc on achene number of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	789.33 e	841.67 c	925.00 a	852.00 A
S-278(H2)	751.67 f	824.33 d	861.67 b	812.56 B
	825.00 B	829.67 B	842.17 A	
	LSD Value 0.05	Zinc 2.22B	Zinc Hybrid 11.78	

Letters sharing same letter did not differ significantly at P < 0.05

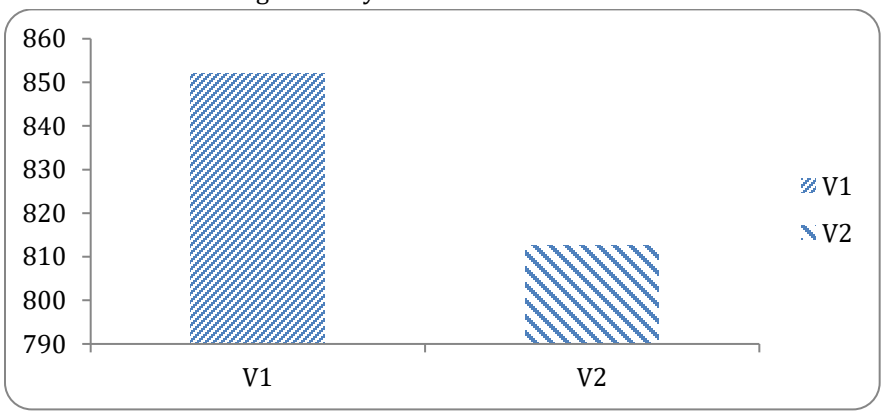

Figure 4. Comparison of achene number of sunflower hybrids as influenced by zinc application.

1000 Achene Weight

Different sunflower hybrid differ highly significantly for 1000 achene weight. (Table 9) Likewise the influence of Zinc application was also highly significant for 1000 achene weight. (Table 9) While interaction of Hybrid with Zinc level was non- significant for 1000 achene weight. (Table 9) Sunflower hybrid (S-278) had more (56.011 g) then the hybrid (Hysun-33) which was (52.711 g). Among different zinc levels, maximum 1000 achene weight was observed from application of $ZnSO_4$ (2%) followed by 1% $ZnSO_4$ whereas minimum 1000 achene weight (50.617 g) was found from control where no application was done. (Table 4.10). 2% $ZnSO_4$ has maximum 1000 achene weight (58.333 g) in Hybrid (S-278) followed by 1% $ZnSO_4$ in hybrid S-278. Minimum 1000 achene weight was (50.617 g) recorded from control condition in hybrid (Hysun-33). (Table 10).

From figure 5 it is concluded that V2 (56.011 g) has high 1000 achene weight as compare to V1(52.711 g). So, it is noted that Hysun-33 more achene weight than S-278.

Table 9. Analysis of variance for 1000 achene weight as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	49.0050	0.0000**
Zinc(Zn)	2	31.8610	0.0000**
Hybrid*Zinc	2	0.441	0.0805NS

**= Highly significant, *=Significant, NS=Non-significant

Table 10. Influence of different levels of foliage applied zinc on 1000 achene weight of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	50.617 f	52.483 e	55.033 c	52.711 B
S-278(H2)	53.533 d	56.167 b	58.333 a	56.011 A
	52.075 C	54.325 B	56.683 A	
	LSD Value 0.05	Zinc 2.228	Zinc *Hybrid 0.3337	

Letters sharing same letter did not differ significantly at P < 0.05

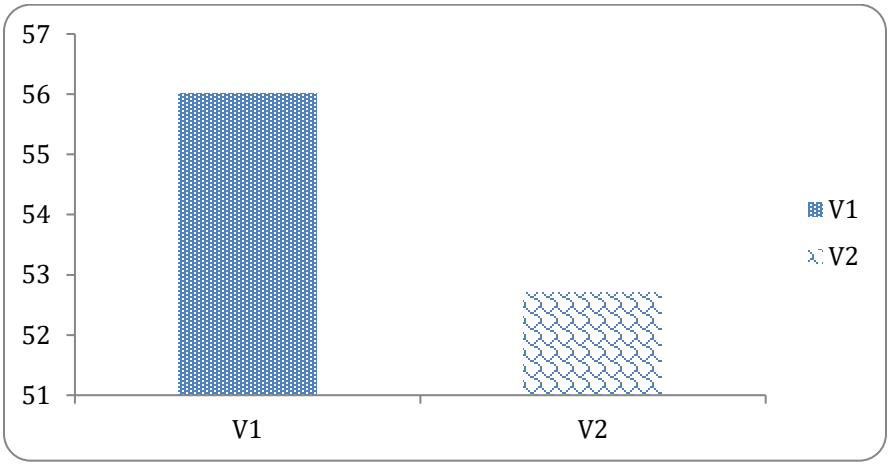

Figure 5.Comparison of 1000 achene weight of sunflower hybrids as influenced by zinc application.

Oil Content

Different sunflower hybrid differ highly significantly for oil content. (Table 11) Likewise the influence of Zinc application was also highly significant for oil content. (Table 11) While interaction of Hybrid with Zinc level was also highly significant for oil content. (Table 11) Sunflower hybrid (Hysun-33) had more oil content (40.423%) then the hybrid (S-278) which was (39.481%). Among different zinc levels, maximum oil content, was observed from application of $ZnSO_4$ (2%) followed by 1% $ZnSO_4$ whereas minimum oil content (39.748%) was found from control where no application was done. (Table 12). 2% $ZnSO_4$ has maximum oil content (41.650%) in Hybrid (Hysun-33) followed by

2% $ZnSO_4$ in hybrid S-278. Minimum oil content was (38.853%) recorded from control condition in hybrid S-278 (Table 4.12).From figure 6 it is concluded that V1(40.423 %) has high oil content as compare to V2 (39.481 %). So, it is noted that Hysun-33 more oil content than S-278.

Table 11. Analysis of variance for oil content as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	3.99502	0.0000**
Zinc(Zn)	2	4.81417	0.0000**
Hybrid*Zinc	2	0.30271	0.0002**

**= Highly significant, *=Significant, NS=Non-significant

Table 12. Influence of different levels of foliage applied zinc on oil content of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	39.463 c	40.157 b	41.650 a	40.423 A
S-278(H2)	38.853 d	39.393 c	40.197 b	39.481 B
	39.748 B	39.992 A	40.117 A	
	LSD Value 0.05	Zinc 2.22B	Zinc *Hybrid 0.1473	

Letters sharing same letter did not differ significantly at P < 0.05

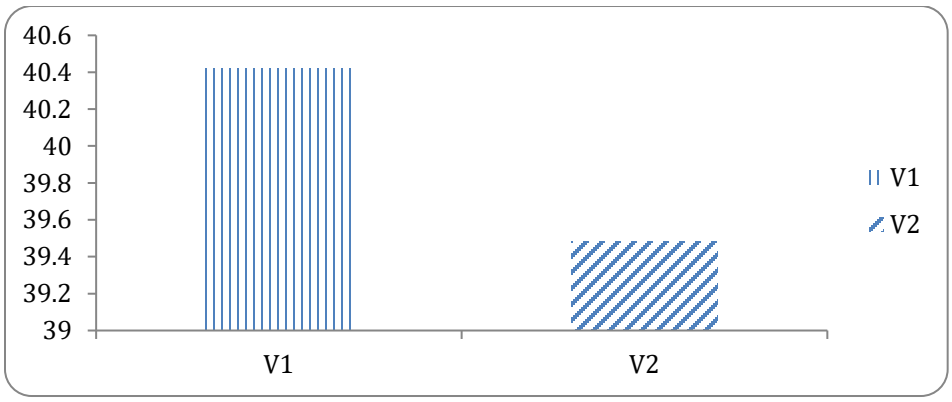

Figure 6. Comparison of oil content of sunflower hybrids as influenced by zinc application.

Biological Yield

Different sunflower hybrid differs significantly for biological yield. Likewise the influence of Zinc application was not significant for biological yield. While interaction of Hybrid with Zinc level was also non-significant for biological yield

(Table 13). Sunflower hybrid (Hysun-33) had more biological yield (566.78 g) then the hybrid (S-278) which was (473.22g). Among different zinc levels, maximum biological yield was observed from no treatment followed by 1% $ZnSO_4$ whereas minimum biological yield (467.00g) was found from control where no application was done. (Table 14). No treatment has maximum biological yield (524.17g) in Hybrid (Hysun-33) followed by 1% $ZnSO_4$ in same hybrid.

In figure 7 it is concluded that V1(566.78 g) has high yield as compare to V2(473.22 g). It is said that Hysun-33 has good yield than S-278.

Table 13. Analysis of variance for biological yield as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	39386.9	0.0001**
Zinc(Zn)	2	85.2	0.9132 NS
Hybrid*Zinc	2	525.7	0.5852 NS

**= Highly significant, *=Significant, NS=Non-significant

Table 14. Influence of different levels of foliage applied zinc on biological yield of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	581.33 a	558.00 a	561.00 a	566.78 A
S-278(H2)	467.00 b	480.00 b	472.67 b	473.22 B
	524.17 A	519.00 A	516.83 A	
	LSD Value 0.05	Zinc 2.228	Zinc Hybrid 39.218	

Letters sharing same letter did not differ significantly at P < 0.05

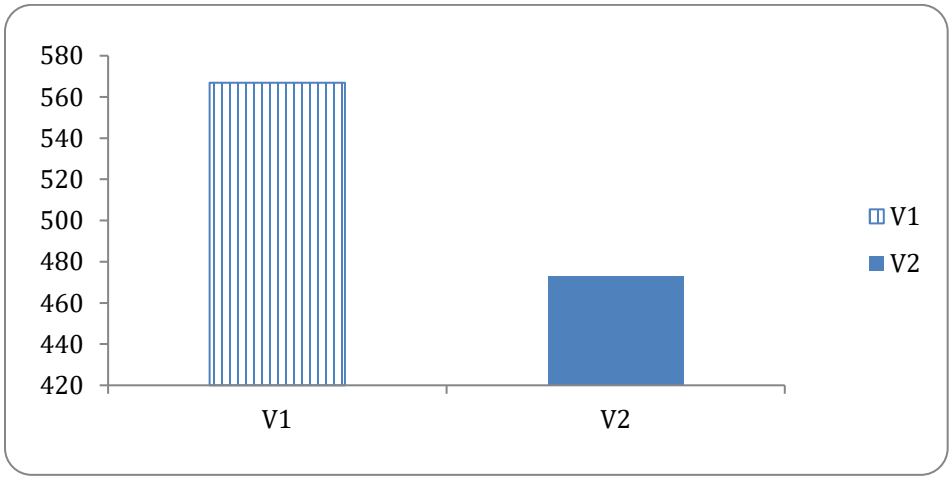

Figure 7. Comparison of biological yield of sunflower hybrids as influenced by zinc application.

Achene Yield

Different sunflower hybrid differs highly significantly for achene yield. (Table 15) Likewise the influence of Zinc application was also highly significant for achene number. (Table 15) While interaction of Hybrid with Zinc level was also highly significant for achene yield. (Table 15) Sunflower hybrid (Hysun-33) had more achene yield. (189.19g) then the hybrid (S-278) which was (174.33g). Among different zinc levels, maximum achene yield, was observed from application of $ZnSO_4$ (2%) followed by 1 % $ZnSO_4$ whereas minimum achene number (168.72 g) was found from control where no application was done. (Table 16). 2 % $ZnSO_4$ has maximum achene yield (205.89 g) in Hybrid (Hysun-33) followed by 2% $ZnSO_4$ in hybrid S-278. Minimum achene yield was (168.72 g) recorded from control condition in hybrid S-278 (Table 16).

From figure 8 it is concluded that V1 (189.19) has high achene yield as compare to V2 (174.33 g). So, it is noted that Hysun-33 more achene yield than S-278.

Table 15. Analysis of variance for achene yield as influenced by different levels of Zinc on sunflower hybrids.

SOV	DF	MS	P-VALUE
Hybrid(H)	1	2568.06	0.0000**
Zinc(Zn)	2	1981.06	0.0000**
Hybrid*Zinc	2	115.06	0.0015**

**= Highly significant, *=Significant, NS=Non-significant

Table 16. Influence of different levels of foliage applied zinc on achene yield of various sunflower hybrids.

	To- Non	T1-1% $ZnSO_4$	T2-2%$ZnSO_4$	
Hysun- 33(H1)	173.33 d	188.33 b	205.89 a	189.19 A
S-278(H2)	164.11 e	175.67 d	183.22 c	174.33 B
	168.72 C	182.00 B	194.56 A	
	LSD Value 0.05	Zinc 2.22B	Zinc *Hybrid 2.5024	

Letters sharing same letter did not differ significantly at P < 0.05

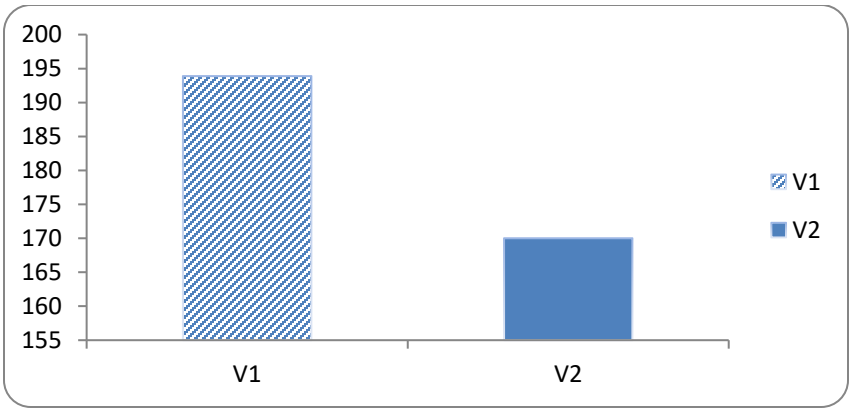

Figure 8. Comparison of achene yield of sunflower hybrids as influenced by zinc application.

Plant height is 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 type 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 $ZnSO_4$ has significant effect ($P < 0.01$) on height of plant. The maximum plant height was by use of 2% $ZnSO_4$ consumption. The valuable result of zinc on height of plant might be due to its vital for 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 Gitte et al.,jadia and Fulekar, Marie and Howarth. Maximum plant height (131.07cm) was attained by Hysun-33 whereas, S-278 attain 124.66 cm plant height. These outcomes show that variance in plant height may be because of hereditary makeup. Hysun-33 was variety of average height while, S-278 was a semi dwarf variety. These match with results of Iqbal *et al*. (12) who saw 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 sulfate, hybrids and their interaction Maximum stem girth (3.18 cm) was obtained from S-278 while, Hysun-33 exhibited 2.43 cm stem diameter. These results indicate that S-278 attained more stem diameter which might be due to the reason that short stature hybrids have genetically small height but more stem diameter. These results are contradictory to Khaliq and Cheema who reported non-significant differences for stem girth among various sunflower hybrids. As far as zinc sulfate levels are concerned, stem girth was more with 45 kg $ZnSO_4$ per hectare which was at par with 30 and 60 kg $ZnSO_4$ per hectare, whereas minimum stem diameter was in control treatment. The interaction between hybrids and zinc levels showed that S-278 produced more stem girth (3.46 cm) at 45 kg $ZnSO_4$ per hectare followed by 30 and 60 kg $ZnSO_4$ per hectare, respectively. The less stem diameter (1.74 cm) was obtained in control by Hysun-33.

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 by S-278 (15.77 cm). Large size head produced by Hysun-33 might be due to genetic character of hybrid for head diameter. These results are in accordance with results found by Iqbal *et al*. As far as zinc levels are concerned, 45 kg $ZnSO_4$ per hectare gave heads with maximum diameter (18.35 cm) as compared to minimum (14.65cm) in control. The zinc levels 60 and 75 kg per hectare produced head diameter which was at par with each other and significantly higher from 15 and 30 kg $ZnSO_4$ per hectare, respectively but lesser from 45 kg $ZnSO_4$ per hectare. Similar results were reported by Khurana and Chatterjee, they found that zinc application enhanced the capitulum's diameter of sunflower. Contrary to these results Mirzapour and Khoshgoftar reported that head diameter of sunflower did not increase with increasing zinc levels. For hybrids and zinc interaction the maximum head diameter (19.57 cm) was produced by Hysun-33 with 45 kg $ZnSO_4$ per hectare which was at par with 60 kg $ZnSO_4$ per hectare. In case

of S-278, minimum head diameter was obtained in control treatment.

The achene number is a vital and effective element in yield. The analysis of variance indicated significant differences ($P < 0.01$) among $ZnSO_4$ levels in relations of seed number in head. The maximum seed number in head was the use of 2% zinc sulfate. The outcome revealed that 2% $ZnSO_4$ improved the seed number in head. My findings are similar with Praksh&Halaswamy (2004) said that spray plant leaves with 0.3 $ZnSO_4$ 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). Results concerning the number of seeds per head revealed significant differences between numerous levels of zinc, hybrids and in their interactions. Maximum achenes number (940) per head was attained from Hysun-33 trailed by S-278 (860 achenes). This is because of large head size of Hysun-33 and it has dense and short size achenes in head. Significant variances between numerous sunflower hybrids were also described by Saleem and Malik. Zinc increased seeds 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 a main element of sunflower yield. The analysis of variance shown that $ZnSO_4$ has significant effect ($P < 0.05$) on 1000 seed weight. The most 1000 achene weight was in consumption of 20 and 40 kg/ha zinc sulfate but absence of zinc sulfate had the lowest 1000 achene weight. The result showed that apply $ZnSO_4$ increased the 1000 achene weight. Shakoori (2003) said that foliar use of zinc, had significant effect on 1000 achene weight. 1000 achene weight is a variety distinctive and is caused by hereditary aspects however its quantity is effected by conditions of maturing time. Weight of 1000-achenes is major yield element in sunflower which adds significantly to its last yield. Significant variances in 1000 achene weight of sunflower was seen in hybrids dissimilar levels of zinc and interaction among zinc levels and hybrids. In this case, greatest value for 1000-achene weight (56.011 g) was attained by S-278 trailed by Hysun-33 (52.711 g). Because the big size achenes of S-278 as compared to short size achenes of Hysun-33. These results are same by results of Ahmad *et al*. Khaliq and Cheema, Saleem and Malik. These outcomes are same with results of Mirzapour and Khoshgoftar who seen that weight of 1000-achenes was extremely affecting yield constituent by insemination of zinc. Correspondingly Khan *et al*. and Abbas *et al*., said that significant enhance in 1000-grains weight with zinc use.

Biological yield is a significant constraint to know the photosynthetic efficacy of a crop. Results about the biological yield display significant differences for biological yield per hectare of sunflower amongst numerous zinc levels and hybrids. The relations between zinc levels and hybrids were significant. The sunflower hybrid Hysun-33 revealed the greater biological yield (566.78 g) while, S-278 made less biological yield (473.22g) as it remained semi dwarf height and formed less biomass as related to standard height Hysun-33. These results are similar with Ahmad *et al*. (Yield improved by zinc use).

The last achenes yield per hectare is expressed by gathered effects of separate yield constituents.

Significant differences for achenes yield of sunflower were seen between hybrids, several zinc levels and interaction among zinc and hybrid. Maximum achenes yield (193.08 g) was got by Hysun-33 whereas, S-278 created 170g. Greater yield in Hysun-33 was because of larger head diameter and greater achenes no. per head than S-278, which may be because of its good adaptableness in current climatic circumstances and advanced hereditary ability.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

All authors have equal contribution.

REFERENCES

Abbas, G., M.Q. Khan, M. Jamil, M. Tahir and F. Hussain. 2009. Nutrient uptake, growth and yield of wheat (*Triticumaestivum*. L) as affected by zinc application rates. International Journal of Agriculture and Biology, 11:389-96.

Agrawal, M.M. and B.S. Verma, 1998. Effect of phosphorus and sulfur on yield, n, p and s content and uptake by sunflower crop in udic ustochrepts." Journal of Agriculture Research, 19: 375-37.

Ahmed, N., M. Abid, and A. Rashid. 2010. Zinc fertilization impact on irrigated cotton grown in an arid soil: growth, productivity, fiber quality,

and oil quality. Communications in Soil Science and Plant Analysis, 41:627-43.

Akhtar, N. 2004. Agro-physiological response of spring sown sunflower (*Helianthus Annus* L.) to various management practices. Unpublished M.Sc. Agronomy Thesis, University of Agriculture, Faisalabad, Pakistan.

Ali, E.A. and A.M. Mahmoud. 2013. Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mung bean in sandy soil. Asian Journal of Crop Science, 5: 33-40.

Bashir, H.J. Ahmad, R. Bagheri, M. Nauman, M.R. Qureshi. 2012. Limited sulfur resource forces Arabidopsis thaliana to shift towards non-sulfur tolerance under cadmium stress. Environmental and Experimental Botany, 94:19-32.

Berglund, D.R. 1999. Sunflower Production. Rev. Ed. N.
Dak. Stat. Uni. Ext. Bull. 25.

Cakmak, I. 2008. Enrichment of Cereal Grains With Zinc: Agronomic or Genetic Bio fortification. Plant and Soil, 302(1-2): pp.1-17.

Gitte, A.N., S.R. Patil and M.A. Tike. 2005. Influence of zinc and boron application on biochemical and yield characteristics of sunflower. Journal of Plant Physiology, 10: 431-438.

Govt. of Pakistan, 2017. Year Book 2015-16. Ministry of Food, Agriculture and Livestock. Finance Division, Economic Advisor's Wing, Islamabad Pakistan. Pp. 71-72.

Iqbal, J., B. Hussain, M.F. Saleem, M.A. Munir and M. Aslam. 2008. Bio economics of autumn planted sunflower (*Helianthus annus* L.) hybrids under different NPK applications. Pakistan Journal of Agricultural Sciences, 45:19-24.

Khaliq, A. and Z.A. Cheema. 2005. Effect of irrigation regimes on some agronomic traits and yield of different sunflower (*Helianthus annus* L.) hybrids. International Journal of Agriculture and Biology, 7: 920-24.

Khan, M.A., J. Din, S.Nasreen, M.Y. Khan, S.U. Khan and A.R. Gurmani. 2009. Response of sunflower to different levels of zinc and iron under irrigated conditions. Sarhad Journal of Agriculture, 25:159-163.

Khurana, N. and C. Chatterjee. 2001. Influence of variable zinc on yield, oil content, and physiology of sunflower. Communications in Soil Science and Plant Analysis, 32: 3023-3030.

Mirzapour, M.H. and A.H. Khoshgoftar. 2006. Zinc application effects on yield and seed oil contents of sunflower grown on a saline calcareous soil. Journal of Plant Nutrition, 29: 1719-1727.

Praksh, B.G. and K.M. Halaswamy. 2004. Effect of seed hardening through chemical treatments in indication of drought tolerance in sunflower (*Helianthus annus* L.). Madras Agricultural Journal, 91: 330-332.

Saleem, M.F. and M.A. Malik. 2004. Agro-economic assessment of different phosphorus levels for diverse sunflower hybrids (*Helianthus annus* L.).Journal of Agricultural Research, 42: 261-70.

Shakoori, A. 2003. Studying effects of different tillage systems and foliar application of zinc, boron and manganese on quantitative and qualitative yield of sunflower. Master's thesis, University of Oromie, P. 128.

Steel, R.G.D., J.H. Torrie and D.A. Dicky. 1997. Principles and Procedures of Statistics, A Biological Approach, (3rd Ed.) McGraw Hill, Book Int. Co. New York. USA. p. 400-28.

Vahedi, A., 2011. The effects of micronutrient application on soybean seed yield and on seed oil and protein content. Journal of American Science, 7: 672-677.