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EFFECT OF VARIOUS LEVELS OF POTASSIUM ON THE GROWTH AND YIELD OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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A B S T R A C T

Potassium is one of the major plant nutrients which play a key function in sunflower. It increases seed yield and enhances quality production. In (RCBD) Design was kept to determine influence of different potassium levels on the sunflower growth and seed yield. Experiment consists of six treatments of K levels repeated three times. The variety HO^{-1} was treated with different K levels: 00, 20, 40, 60, 80, and 100 kg ha^{-1}. Experiment analysis of variance (ANOVA) shows significant difference ($P<0.05$) for all growth and yield characteristics due to treatments. Maximum plant population (9.9 m^{-2}), tallest plant (255.0 cm), maximum stem girth (12.2 cm), maximum head diameter (49.8 cm), maximum seeds $head^{-1}$ (2059.3 $head^{-1}$), maximum seed weight $head^{-1}$ (74.5 g), seed index (38.0 g) and maximum seed yield (2803.3 kg ha^{-1}) were recorded in K_6 where potassium was applied @ 100 kg ha^{-1}, followed by K_5 where potassium was applied @ 80 kg ha^{-1} with (9.6 m^{-2}) maximum plant population, (253.3cm) tallest plant, (11.6 cm) maximum stem girth, (49.5 cm) maximum head diameter, (2055.0 $head^{-1}$) maximum seeds $head^{-1}$, (74.0 g) maximum seed weight $head^{-1}$, (36.3 g) seed index (2766.7 kg ha^{-1}) and maximum seed yield. However, K_1 00 kg ha^{-1} (control) shows that the lowest plant population (6.1m^{-2}), smallest plant (200 cm), minimum stem girth (6.3 cm), minimum head diameter (23.3 cm), minimum seeds $head^{-1}$ (1192.7 $head^{-1}$), minimum seed weight per head (35.0 g), seed index (23.0 g) and minimum seed yield (1870.0 kg ha^{-1}). It was also observed that sunflower performance was at par with T_6 and T_5. From the present study it is concluded that sunflower performed equally better at T_5 and T_6. Hence, for economic yield T_5 is recommended.

Keywords: Growth; Potassium; Sunflower; Yield

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INTRODUCTION

Sunflowers belong to Composite family (Ullah et al., 2018). It is one of the oilseed crop that is cultivated all over the globe in the greatest quantities (Vital et al., 2017). Sunflowers are the second most significant oil crop after soybeans in terms of production worldwide. Its protein level varies from 20% to 21%, and its edible oil content ranges from 30 to 42%. In addition to being used as animal feed, it has a range of 30 to 42% in edible oil (Hussain et al., 2018). It is possible that the fact that more than 90 percent of its oil is composed of beneficial unsaturated fats such as linoleic (18:2) and oleic may be responsible for the positive affects that it has on both the quality of life and the pocketbook (18:1). Sunflowers provide a huge portion of Pakistan's ability to satisfy its need for oil (Aslam et al., 2013). Although Pakistan's domestic production totaled just 0.606 million tons of edible oil seed during 2013-2014, the country imported 1.72 million tons of edible oil seed at a cost of US$ 1.43 billion (GOP, 2019).

Sunflowers are an extremely important oilseed crop that has evolved to grow in a wide variety of environments and kinds of soil all over the globe. The fourth extensively produced oil harvest in the world after oil palm, soybeans, and rapeseed, which together desire for over 87 percent of the world's total vegetable oil production. It contributes around 12% of edible vegetable oil (Nasreen et al., 2015; Rauf et al., 2017). This crop is crucial to human nutrition because it produces cholesterol-free oils and the essential unsaturated fatty acids that are needed by the body. It is gaining popularity among chefs and farmers alike due to the high quality of the crop and the short growing season required to produce sunflower. It is dependable for frying meals without changing their natural flavor while simultaneously elevating the flavor of the things being fried. It has been claimed that edible oil, which is the most vital items in everyday consume in Pakistan, has been stolen (Khan and Akmal, 2016).

The increases number of people living in the world has led to increasing in the demand for items made from sunflowers, such as seeds, oil, and by-products (Taher et al., 2017). The country is facing acute shortage oil, hence imports yearly nearing 88 percent of sunflower were grown for edible oil on 82,186 hectors in 2017-18, yields 40,0000 tons of oil from production of 104,000 tons (GOP, 2018). Every year, around 33,000 metric tons of sunflower oil is produced in Pakistan for use in various industrial applications. In general, oilseed crops provide anything from 11% to 17% of the nation's need for edible oil (GOP, 2021). The application of more potassium dose results in higher seed yield and yield components. One of the vital primary plant nutrients is potassium. Due to intensive farming practices and the occurrence of deficiencies in crop plants, its importance in agriculture has increased. Potassium deficit among plant nutrients restricts crop growth and lowers crop productivity (Dotaniya et al., 2016). Potassium nutrients minimize yield losses brought on by drought by controlling osmotic and turgor pressure and by maintaining a compare between anti-oxidant enzymes, reactive oxygen species. In addition to this, it engages in a significant number of the plant's metabolic activities, where it plays a pivotal function (Abbasi and Butt, 2018). The increase in seed production may be attributed to higher concentrations of nitrogen and phosphorus, as well as closer planting (Shoghi-Kalkhoran et al., 2018). It is also a major Element due to the fact that it participates widely in physiological and biochemical processes that bolster plants' deficiency against biotic as well as abiotic stresses (Wang et al., 2016). A deficiency in potassium may have a number of negative effects, including stunted growth, weakening roots, lodging, and decreased yields (Hasanuzzaman et al., 2018). Potassium gives plants increased resistance to disease and assists grain in reaching its full potential (Dambale et al., 2017). According to some reports, the addition of K to sunflowers resulted in increases both amount of oil produced, and the number of seeds produced (LI et al., 2018). This current study aims to investigate the impact of different potassium levels on the growth and yield of sunflower plants (*Helianthus annuus* L.), contributing valuable insights for optimizing potassium fertilization practices to enhance sunflower crop productivity.

MATERIALS AND METHODS

Experimental design

The field experiment was laid down at student's experimental farm, department of Agronomy, Sindh Agriculture University, Tandojamto explore the Effect of various levels of potassium on the growth and yield of sunflower. The field was designed with Randomized Complete Block Design (RCBD) design with net plot size of ($30m^2$). Mechanical implements were used to adopt a good seedbed with suitable land preparation as per recommended practice for sunflower. Experiment was repeated three times with recommended dose of N, P whereas potassium was applied as per treatments.

Treatments used and parameters studied

Examined six treatments of various Potassium K_2O levels viz., 00, 20, 40, 60, 80, and 100 kg ha^{-1}at the time of maturity. Five plant was selected in each experimental plots and the units to measure, Plant population (m^{-2}) with help of measuring tap, plant height (cm), stem thickness (cm), head diameter (cm), seeds per head, seed weight/head (g), 1000-seed wt. (g), seed yield kg/ha were recorded.

Statistical analysis

In order to do statistical analysis on the information obtained, (ANOVA) Computer Software Statistix-8.1 was used (Statistix, 2006). The LSD test was used in situations in which it was deemed necessary to provide a comparison of the relative effectiveness of several treatments.

RESULT AND DISCUSSION

The result proved the significantly changes ($p<0.05$) in sunflower by various levels of potassium. The experiment was consists of six potassium levels i.e. (T_1 control 00 kg ha^{-1}, T_2 20 kg ha^{-1}, T_3 40 kg ha^{-1}, $T_4$60 kg ha^{-1}, T_5 80 kg ha^{-1}, T_6 100 kg ha^{-1}. The potassium 100 kg ha^{-1} produced better with maximum plant population (9.8 m^{-2}), plant height (255 cm), stem girth (12.2 cm), head diameter (49.8 cm) (Table 1), Number of seeds $head^{-1}$ 2059.3, seed weight $head^{-1}$ (74.5

g), seed index (1000-seed weight, 38 g), seed yield kg ha^{-1} 2803.3 (Table 2). Followed by T_5 80 kg ha^{-1} potassium fertilizer was applied to obtained best results with plant population (9.5 m^{-2}), plant height (253 cm), stem girth (11.6 cm), head diameter (49.5 cm), number of seeds $head^{-1}$ 2055, seed weight $head^{-1}$ (74.0 g), seed index (1000-seed weight, 36.3 g),seed yield kg ha^{-1} 2766.7. While in T_1 control (no fertilizer 00 kg ha^{-1} produced lowest plant population (6.1 m^{-2}), plant height (200 cm), stem girth (6.3 cm), head diameter (23.3 cm), number of seeds $head^{-1}$ 1192.7, seed weight $head^{-1}$ (35.0 g), seed index (1000-seed weight, 23.0 g), seed yield kg ha^{-1} 1870.

Table 1. Effect of various levels of potassium on the growth of sunflower.

Treatments	Plant population (m^{-2})	Plant height (cm)	Stem girth (cm)	Head diameter (cm)
T_1= Control	6.1 e	200.0 e	6.3 e	23.3 e
T_2=Potassium 20 kg ha^{-1}	6.8 d	212.3 d	7.9 d	29.9 d
T_3=Potassium 40kg/ha	7.5c	228.3c	8.9 c	36.3 c
T_4=Potassium 60 kg ha^{-1}	8.2 b	238.6 b	10.1 b	42.5 b
T_5=Potassium 80 kg ha^{-1}	9.5 a	253. a	11.6 a	49.5 a
T_6=Potassium 100 kg ha^{-1}	9.8 a	255. a	12.2 a	49.8 a
S.E. ±	0.1244	4.5793	0.2723	2.0569
P value	0.0000	0.0000	0.0000	0.0000
LSD	0.2772	10.203	0.6067	4.5832

Table 2. Effect of various levels of potassium on the yield of sunflower.

Treatments	Seeds per head	Seed weight /head (g)	Seed index (1000-seeds wt.) (g)	Seed yield kg/ha
T_1= Control	1192.7 e	35.0 e	23.0 e	1870.0 e
T_2=Potassium 20 kg ha^{-1}	1438.7 d	38.3 d	26.6 d	2091.7 d
T_3=Potassium 40kg/ha	1640.7 c	43.9 c	28.6 c	2235.0 c
T_4=Potassium 60 kg ha^{-1}	1733.3 b	56.7 b	32.3 b	2370.0 b
T_5=Potassium 80 kg ha^{-1}	2055.0 a	74.0 a	36.3 a	2766.7 a
T_6=Potassium 100 kg ha^{-1}	2059.3 a	74.5 a	38.0 a	2803.3 a
S.E. ±	17.076	0.5909	0.8300	23.210
P value	0.0000	0.0000	0.0000	0.0000
LSD	38.048	1.3165	1.8493	51.715

There was a noticeable positive trend in plant population, height, stem girth, and head diameter. The statistical analysis, supported by low p-values, indicated a significant impact of potassium treatments on these growth attributes. Specifically, as the potassium dosage rises, there is a significant increase in plant population, height, stem girth, and head diameter. The standard error (S.E. ±) and LSD values provide insights into the precision of the measurements and the significant differences between treatment means.

According to the findings, a potassium application rate of K6 = (potassium 100 kg/ha) was necessary to achieve the highest plant population (9.9 m-2), plant height (255.0 cm), stem girth (12.2 cm), head diameter (49.8 cm), seeds per head (2.059.3/head), seed weight per head (74.5.g), 1000-seeds wt. (38. g), and seed yield (2803.3 kg/ha). Furthermore, the listing of the seed yield (9.6 m-2), plant height (253.3 cm), stem girth (11.6 cm), head diameter (49.5 cm), number of seeds per head (2055.0), seed weight per head (74.0 g), seed index (1000-seed weight, g) (36.3 g), and potassium fertilizer application rate (K5 = (potassium 80 kg/ha) All of these numbers can be found in the following table (2766.7 kg/ha). While treatment K1 = control had the lowest plant population (6.1 m-2), plant height (200 cm), stem girth (6.3 cm), head diameter (23.3 cm), number of seeds head-1 (1192.7 head-1), seed weight head-1 (35.0 g), seed index (1000-seeds weight, g (23.0 g), and seed yield (1870.0 kg/ha), treatment K2 = experimental had the highest plant population (6.1 m-2), plant height (200 cm), stem girth ((no fertilizer). It was established that seed production was greatest (2803.3 kg/ha) when potassium was administered at 100 kg/ha, then it greatest when potassium was applied at a rate of K5 at 80 kg/ha

(2766.7 kg/ha), and it was greatest when potassium was controlled at 1870.0 kg/ha.

As a result, we have arrived at the conclusion that a well-balanced fertilizer is better than individual remedies. It has been demonstrated that applying potassium at a rate of 100 kg /ha (ha-1) has the greatest impact on sunflower growth and seed output, with potassium at a rate of 80 kg /ha (ha-1) serving as an effective second choice. Both of these potassium application rates are effective. The use of K helped offset the impacts of the drought and protect plants, enabling them to continue growing and producing fruit even though they were already in the middle of harvest. Because potassium functions as a compatible solute to boost water uplift and plant's ability to put that water to beneficial use through stomatal control, an increase in the potassium content of the sunflower's stem, leaves, and achenes is predictive of improved growth and yield when the plant is subjected to drought stress.

As a direct consequence of this, the stomata of the plant may have partially closed, root penetration may have been increased, and plant tissues may have retained some of the water that was provided exogenously (Hussain et al., 2018). Several drought-affected crops benefit from an increase in photosynthesis, growth, and production when potassium is added to the soil (Aslam et al., 2013). Harvest index, head diameter, total seeds, and wt. per 1000 seeds have all risen, which may be responsible for the rise in overall output (Ranukadevi et al., 2001; Torshin et al., 1997; Wang et al., 2013). Similarly, results on sunflower growth and seed yield were significantly affected by potassium levels application as compared to control (no fertilizer). From pervious outcomes of Shahid et al. (2020) also examined that the use of potassium significantly improved growth and seed yield if applied in the right time and quantity. Therefore, farmer should apply to the mineral in the right proportion of at least 80 to 100 kg $ha^{-1}$to their plants for improved yield and growth. However, as the quantities of potassium dose, the seed yield dose as well. Similar to this, increasing the potassium dosages led to an increase in achene production (Jahil and Kamal, 2021). However, the plot fertilized with potassium 100 kg/ha1 produced maximum sunflower seed yield, it this therefore recommended 80 kg/ha1 that for obtaining higher development and seed yield of sunflower, potassium should be applied 80 kg/ha1. Moreover, Kousar et al. (2020) said better growth and superior seed yield of sunflower suggested dose potassium fertilizer 80 kg ha^{-1} was shown given greater seed yield and highly recommended for local farmers.

CONCLUSIONS

It is concluded that the sunflower growth and seed yield were influenced significantly ($p<0.05$) with potassium levels than compared to control (no fertilizer). The achene yield increased linearly with increasing Kdoses. However, plot fertilized with potassium fertilizer 100 kg per ha maximum (2803.3 kg ha^{-1}) sunflower achene yield followed by potassium 80 kg /ha with (2766.7 kg ha^{-1}). Hence the difference between T_5 and T_6 are statistically almost same.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

All authors contributed and supported in this manuscript.

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