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# IMPACT OF DIFFERENT RATES OF PHOSPHATIC FERTILIZER ON THE GROWTH AND YIELD OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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**A B S T R A C T**

The experiment was carried out at the Students Experimental Farm, Department of Agronomy, Sindh Agriculture University Tandojam, during autumn 2022. An experiment was laid out in RCBD to determine the influence of different phosphorus levels on sunflower growth and seed yield. The experiment consists of six treatments of P levels, repeated three times. The variety HO-1 was treated with different P levels: $P_1$ = 00 kg ha$^{-1}$, $P_2$ = 30 kg ha$^{-1}$, $P_3$ = 45 kg ha$^{-1}$, $P_4$ = 60 kg ha$^{-1}$, $P_5$ = 75 kg ha$^{-1}$, and $P_6$ = 100 kg ha$^{-1}$. Experiment analysis of variance (ANOVA) showed a significant difference ($P<0.05$) for all growth and yield characteristics due to treatments. Maximum plant population (9.9 m$^{-2}$), tallest plant (253.0 cm), maximum stem girth (11.7 cm), maximum head diameter (50.0 cm), maximum seeds head$^{-1}$ (2015.0), maximum seed weight head$^{-1}$ (71.2 g), seed index (35.0 g), and maximum seed yield (2760.3 kg ha$^{-1}$) were recorded in treatment 6 where phosphorus was applied 100 kg ha$^{-1}$ P, followed by $P_5$ = (phosphorus 75 kg ha$^{-1}$) with (9.6 m$^{-2}$) plant population, with (247.7 cm) plant height, with (11.6 cm) stem girth, with (48.0 cm) head diameter, with (1971.3) seeds head$^{-1}$, with (69.5 g) seed weight head$^{-1}$, with (34.0 g) seed index, and seed yield (2725.7 kg ha$^{-1}$) however show that the lowest was P1 = control (no fertilizer) minimum plant population (6.2m$^{-2}$), smallest plant (190.0 cm), minimum stem girth (7.4cm), minimum head diameter (22.7 cm), minimum seeds head$^{-1}$ (1363), minimum seed weight head$^{-1}$ (33.2 g), seed index (22.0 g), and minimum seed yield (2070kg ha$^{-1}$). It was also observed that sunflower performance was on par with $T_6$ and $T_5$. From the present study, it is concluded that sunflowers performed equally well at $T_5$ and $T_6$. Hence, for economic yield, $T_5$ is recommended.

**Keywords:** Different Rates; Growth; Phosphorus; Sunflower; Yield

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## INTRODUCTION

Sunflower (*Helianthus annuus* L.) belongs to the composite family. Sunflower, considered one of the top four significant oilseed crops globally alongside soybean, peanut, and rapeseed, is cultivated on a vast scale worldwide. Its cultivation encompasses. With an expansive cultivation area exceeding 23.31 million hectares, the sunflower crop yields a substantial output of 29.90 million tons. In Pakistan, sunflowers are grown on approximately 0.453 million hectares, with two planting seasons occurring annually during spring and autumn. Specifically in the Sindh region of Pakistan, sunflower cultivation takes place during these two seasons (Mustafa et al., 2022). Sunflower is one of the major oilseed plants, with 41–52.8% oil (Balogun et al., 2023). In 2018, the world's area under cultivation for sunflower was 26 million hectares, with a total production of 45 million metric tons. The country is facing an acute deficiency in edible oil production. Pakistan imports 88% of oil for edible purposes, whereas at the country level only 12% is being produced. The import expenses for edible oil during 2016–17 were Rs 320.893 billion (GOP, 2020).

Sunflower is a crop with high phenotypic adaptability that can be cultivated on all continents (Arif et al., 2017). Sunflower seeds are rich in various beneficial compounds, including oleic and linoleic acids. These elements help in the formation of a healthy and effective body of sunflower plants. The medicinal benefits associated with sunflower seeds and oils can be attributed to their high quantities, as well as the fact that mono- and polyunsaturated fats, proteins, and tocopherols are among the nutritional contents. These elements have antibacterial, anti-diabetic, anti-inflammatory, antihypertensive, and antioxidant activities that benefit general health (Piracha et al., 2022). The sunflower oil in Pakistan is 1.3 tons $ha^{-1}$. Sunflower is renowned for its aesthetic appeal and its significant value in the food industry. Sunflower oil is not only considered a healthy option, but its seeds are also highly nutritious and versatile in various culinary applications. These vitamins and minerals, like magnesium, phosphorus, selenium, and iron, are abundant in seeds.

They contribute to enhancing brain function, supporting digestion, and promoting a healthy cardiovascular system (Shafique et al., 2022). While sunflower oil, which is abundant in linoleic acid, is deemed suitable for consumption, it exhibits inadequate oxidative stability when used as a frying or cooking oil (Chernova et al., 2021).Sunflower increments have been classified into three categories based on their oleic acid content, including standard sunflower types, which typically exhibit an oleic acid content of around 80% (Shah et al., 2023). After nitrogen, phosphorus is considered one of the most crucial components for plant growth. It assumes a crucial role in numerous physiological and biochemical activities within plants, including photosynthesis, the conversion of sugar to starch, and the transportation of genetic traits (Kalaiyarasan et al., 2019). Phosphorus is a pivotal element that holds the key to enhancing the yield of field crops (Singh et al., 2017). Phosphate assumes a critical role in facilitating energy transfer within plants, making it indispensable during phases of rapid growth. During early growth stages, it also promotes the development of roots, which is vital for efficient absorption of other essential nutrients (Naresh et al., 2016).

## MATERIAL AND METHOD

The field experiment was carried out at the student's farm department of Agronomy Sindh Agriculture University, Tando Jam, to determine the impact of soil-applied fertilizers on sunflower growth and yield. The experiment followed a completely randomized block design with a net plot size of 6m x 5m ($30m^2$).The land preparation methods recommended for sunflower plantations were implemented. The study focused on the local variety HO-1 and was replicated three times. The soil-applied fertilizers included Phosphatic fertilizer at the recommended doses of NPK.

### Culture Practices

A good seed bed was prepared by two dry plowings and leveling the land. The recommended dose of NPK was applied to all treatments during the sowing time. Throughout this study, during seeding, Phosphatic fertilizer was applied to different stages of sunflower. The agronomical traits of the plants were observed by selecting five plants in each plot at five-day intervals during the initial 10 days following crop formation.

1. $T_1$ =Phosphorus @ 00 kg $ha^{-1}$(Control)
2. $T_2$ = Phosphorus @ 30 kg $ha^{-1}$
3. $T_3$ = Phosphorus @ 45 kg $ha^{-1}$
4. $T_4$ = Phosphorus @ 60 kg $ha^{-1}$
5. $T_5$ = Phosphorus @ 75 kg $ha^{-1}$
6. $T_6$ = Phosphorus @ 100 kg $ha^{-1}$

During the maturity stage, 15 plants were sampled from each experimental unit to measure their plant height (cm), stem girth (cm), and head diameter (cm). The seed heads were separated from each plant, threshed, and used to calculate the number of seeds $head^{-1}$, seed weight $head^{-1}$ (g), weight of 1000 seeds (seed index), and seed yield, all of which were recorded.

### Statistical analysis

Statistical analysis was performed on the collected data through ANOVA via Statistix-8.1 Computer Software (Statistix, 2006). In cases where it remained deemed necessary, the LSD test was utilized to compare the superiority of different treatments.

## RESULTS

### Plant Population ($m^{-2}$)

The result proved the significant difference ($p<0.05$) in sunflower at various levels of phosphorus.The phosphorus 100 kg $ha^{-1}$ produced better with maximum plant population ($m^{-2}$) of (9.9), followed by phosphorus fertilizer was 75 kg $ha^{-1}$ plant population ($m^{-2}$) of (9.6), whereas plant population ($m^{-2}$) of (8.3) was recorded where fertilizer of phosphorus was utilized 60 kg $ha^{-1}$ , while the population ($m^{-2}$) of (7.7) was observer when phosphorus 45 kg $ha^{-1}$ was applied, whereas plant population ($m^{-2}$) of (6.8) was observed when phosphorus fertilizer 30 kg $ha^{-1}$ was applied and the

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minimum plant population ($m^{-2}$) of (6.2) observed when fertilizer of phosphorus was control (Table 1).

**Plant height (cm)**

Plant height (cm) the phosphorus 100 kg $ha^{-1}$produced better with maximum plant height (cm)of (253.0), followed by phosphorus fertilizer was 75 kg $ha^{-1}$ plant height (cm) of (247.7), whereas plant height (cm) of (224.0) was recorded where fertilizer of phosphorus was applied (60 kg $ha^{-1}$) , while the plant height (cm) of (215.0) was experiential when phosphorus 45 kg $ha^{-1}$ was functional, whereas plant height (cm) of (202.7) was practical when phosphorus fertilizer (30 kg $ha^{-1}$)was applied and the minimum plant height (cm) of (190.0) observed when fertilizer of phosphorus was control (Table 1).

Tables 1. Effect of different rates of phosphatic fertilizer on growth parameters of sunflower.

| Treatments | Plant population ($m^{-2}$) | Plant height (cm) | Stem girth (cm) | Head diameter (cm) |
|---|---|---|---|---|
| $T_1$=No Phosphorus 00 kg $ha^{-1}$ | 6.2 e | 190.0 e | 7.4 e | 22.7 e |
| $T_2$=Phosphorus 30 kg $ha^{-1}$ | 6.8 d | 202.7 d | 8.6 d | 33.8 d |
| $T_3$=Phosphorus 45 kg $ha^{-1}$ | 7.7 c | 215.0 c | 9.0 c | 42.3 c |
| $T_4$=Phosphorus 60 kg $ha^{-1}$ | 8.3 b | 224.0 b | 10.2 b | 44.7 b |
| $T_5$=Phosphorus 75 kg $ha^{-1}$ | 9.6 a | 247.7 a | 11.6 a | 48.0 a |
| $T_6$=Phosphorus 100 kg $ha^{-1}$ | 9.9 a | 253.0 a | 11.7 a | 50.0 a |
| S.E | 0.1262 | 2.4252 | 0.2343 | 0.7262 |
| LSD (0.05) | 0.2812 | 5.4036 | 0.5220 | 1.6180 |
| CV% | 1.91 | 1.34 | 2.99 | 2.21 |

**Stem girth (cm)**

Stem girth (cm) the phosphorus 100 kg $ha^{-1}$ produced better with maximum stem girth (cm)of (11.7), followed by phosphorus fertilizer was 75 kg $ha^{-1}$ stem girth (cm) of (11.6), whereas stem girth (cm) of (10.2) was recorded where fertilizer of phosphorus was applied 60 kg $ha^{-1}$ , while the stem girth (cm) of (9.0) was noticed when phosphorus 45 kg $ha^{-1}$ was used, whereas stem girth (cm)of (8.6) was observed when phosphorus fertilizer (30 kg $ha^{-1}$) was used and the lowest stem girth (cm) of (7.4) observed when fertilizer of phosphorus was control (Table 1).

**Head diameter (cm)**

Head diameter (cm) the phosphorus 100 kg $ha^{-1}$ produced better with maximum head diameter (cm) of (50.0), followed by phosphorus fertilizer was 75 kg $ha^{-2}$head diameter (cm)of (48.0), whereas head diameter (cm)of (44.7) was recorded where fertilizer of phosphorus was applied 60 kg $ha^{-1}$, while the head diameter (cm)of (42.3) was detected when phosphorus 45 kg $ha^{-1}$ was reliable, whereas head diameter (cm)of (33.8) was observed when phosphorus fertilizer 30 kg $ha^{-1}$ was applied and the smallest head diameter (cm)of (22.7) observed when fertilizer of phosphorus was control (Table 1).

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

The number of seeds head- of the phosphorus 100 kg $ha^{-1}$ improved with the highest number of seeds head-1 of (2015.0), followed by phosphorus fertilizer at 75 kg $ha^{-1}$ and the number of seeds $head^{-1}$ of (1971.3), whereas the number of seeds $head^{-1}$ of (1789.3) was recorded where fertilizer of phosphorus was applied at 60 kg $ha^{-1}$, though the number of seeds $head^{-1}$ of (1586.0) was pragmatic when phosphorus 45 kg $ha^{-1}$ was functional, whereas the number of seeds $head^{-1}$ of (1448.3) was observed when phosphorus fertilizer 30 kg $ha^{-1}$ was applied and the lowest number of seeds $head^{-1}$ of (1363.0) observed when fertilizer of phosphorus was control.

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

Seed weight $head^{-1}$ (g) of phosphorus (100 kg $ha^{-1}$) produced better with a maximum seed weight head-1 (g) of 71.2, followed by phosphorus fertilizer at 75 kg $ha^{-1}$ and a seed weight $head^{-1}$ (g) of 69.5, whereas seed weight $head^{-1}$ (g) of 52.6 was recorded where fertilizer of phosphorus was applied at 60 kg $ha^{-1}$, while the seed weight $head^{-1}$ (g) of 44.8 was noticed when phosphorus at 45 kg ha-1 was applied, whereas seed weight $head^{-1}$ (g) of 36.7 was observed when phosphorus fertilizer at 30 kg ha-1 was useful, and the lowest seed weight $head^{-1}$ (g) of 33.2 was experiential when fertilizer of phosphorus was control.

**Seed index (1000-seed weight) (g)**

The phosphorus 100 kg $ha^{-1}$ produced better with a maximum seed index (g) of 35.0, followed by the phosphorus fertilizer 75 kg $ha^{-1}$ with a seed index (g) of 34.0, whereas the seed index (g) of 29.0 was recorded where fertilizer of phosphorus was pragmatic 60 kg $ha^{-1}$, while the seed index (g) of 27.0 was noticed when phosphorus 45 kg ha-1 was used, whereas the seed index (g) of 24.3 was experiential when phosphorus fertilizer (30 kg ha-1) was

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practical, and the minimum seed index (g) of 22.0 was observed when fertilizer of phosphorus was control.

Tables 2. Effect of different rates of phosphatic fertilizer on yield parameters of sunflower.

| Treatments | No. of seeds head$^{-1}$ | Seeds weight head$^{-1}$ (g) | Seed index (1000-seeds wt.)(g) | Seed yield kg ha$^{-1}$ |
|---|---|---|---|---|
| $T_1$=No Phosphorus 00 kg ha$^{-1}$ | 1363.0 e | 33.2 e | 22.0 e | 2070.3 e |
| $T_2$=Phosphorus 30 kg ha$^{-1}$ | 1448.3 d | 36.7 d | 24.3 d | 2206.7 d |
| $T_3$=Phosphorus 45 kg ha$^{-1}$ | 1586.0 c | 44.8 c | 27.0 c | 2316.7 c |
| $T_4$=Phosphorus 60 kg ha$^{-1}$ | 1789.3 b | 52.6 b | 29.0 b | 2556.7 b |
| $T_5$=Phosphorus 75 kg ha$^{-1}$ | 1971.3 a | 69.5 a | 34.0 a | 2725.7 a |
| $T_6$=Phosphorus 100 kg ha$^{-1}$ | 2015.0 a | 71.2 a | 35.0 a | 2760.3 a |
| S.E | 20.649 | 0.8413 | 0.8119 | 31.377 |
| LSD (0.05) | 46.009 | 1.8745 | 1.8091 | 69.912 |
| CV% | 1.49 | 2.01 | 3.48 | 1.58 |

**Seed yield kg ha$^{-1}$**

The phosphorus 100 kg ha$^{-1}$ produced better with a maximum seed yield of 2760.3 kg ha$^{-1}$, followed by phosphorus fertilizer at 75 kg ha$^{-1}$ and a seed yield of 2725.7 kg ha$^{-1}$, whereas a seed yield of 2556.7 kg ha$^{-1}$ was recorded where fertilizer of phosphorus was applied at 60 kg ha$^{-1}$, while a seed yield of 2316.7 kg ha$^{-1}$ was experimental when phosphorus 45 kg ha$^{-1}$ was applied, a seed yield of 2206.7 kg ha$^{-1}$ was experimental when phosphorus fertilizer 30 kg ha$^{-1}$ was applied, and the lowest seed yield of 2070.3 kg ha$^{-1}$ was experimental when fertilizer of phosphorus was control Table 2.

**DISCUSSION**

The results demonstrated that the $P_6$ = (phosphorus 100 kg ha$^{-1}$) the highest plant population (m$^{-2}$) (9.9), plant height (cm) (253), stem girth (cm) (11.7), head diameter (cm) (50.0), number of seeds head$^{-1}$ (2015), seed weight head$^{-1}$ (g) (71.2), seed index (35.0 g), and seed yield (2760.3 kg ha$^{-1}$). Similarly, followed by P5=(phosphorus 75 kg ha$^{-1}$) with plant population (m$^{-2}$) (9.6), plant height (cm) (247.7), stem girth (cm) (11.6), head diameter (cm) (48.0), number of seeds head-1 (1971.3), seed weight head$^{-1}$ (69.5), seed index (34.0 g), and seed yield (2725.7 kg ha$^{-1}$). However, the lowest results were observed in P1 = control (no fertilizer) with plant population (m$^{-2}$) (6.2), plant height (cm) (190.0), stem girth (cm) (7.4), head diameter (cm) (22.7), number of seeds head$^{-1}$(1363), seed weight head$^{-1}$ (33.2), seed index (22.0 g), and seed yield (2070kg ha$^{-1}$). Based on the results found in phosphorus applications, the seed yield was markedly higher (2760.3 kg ha$^{-1}$ with $P_6$ @ 100 kg ha$^{-1}$ followed by $P_5$ @ 75 kg ha$^{-1}$ (2725.7kg ha$^{-1}$) whereas the lowest seed yield (2070 kg ha$^{-1}$) was achieved wherever phosphorus remained controlled.

Therefore, it is concluded that a balanced fertilizer is better than the application of treatments alone. It is recommended that characteristics that contribute to the yield of sunflower remain substantially influenced by the use of phosphorus. P @ 100 kg ha$^{-1}$ followed by $P_5$ @ 75 kg ha$^{-1}$ is the most excellent for the development and seed yield of sunflower. Phosphorus (P) fertilizer increased plant growth and production (Zamanian and Yazdandoost, 2021), and phosphorus plays a vital role in the development of plants, and its application increases at the early, active phase of development when it increases the above physiological parameters. However, according to Hammad et al. (2021), the application of phosphorus might also have affected increases in factors of seed yield and parameters of seed yield. Sunflower growth and seed yield were significantly impacted by phosphorus level application as compared to the control (no fertilizer).

According to the previous results, Shahid et al. (2015) also examined that the application of phosphorus significantly improved growth and seed yield if applied at the right time and quantity. Therefore, farmers should apply minerals in the right proportion of at least 75 to 100 kg ha$^{-1}$to their plants for improved yield and growth. However, as the quantity of phosphorus increases, the seed yield increases as well. Similar to this, increasing phosphorus dosages led to an increase in grain production (Jahil and Kamal, 2021). Plant growth and seed yield in sunflowers have strongly responded to the increasing availability of phosphorus (Ghaffari et al., 2019). Phosphate fertilizers contain significant amounts of solvable phosphorus, and when rainwater occurs shortly after their application, it can lead to an increase and a decrease in the absorption of

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phosphorus in the soil (Mahesh et al., 2023). Increasing the external application of phosphorus can lead to not only replacements occurring in soil interactions, but they also occur in plant absorption.

This substitution is observed in the phosphorus concentration within the roots and shoots of sunflower plants, even in the absence of additional phosphorus supplementation (Soomro et al., 2018). However, the plot fertilized with phosphorus at 100 kg $ha^{-1}$ produced the maximum grain yield of sunflower; it is therefore recommended at 75 kg $ha^{-1}$ that for obtaining higher development and grain yield of sunflower, phosphorus should be applied at 75 kg $ha^{-1}$. Moreover, Kousar et al. (2020) also testified that the sunflower recommended dose of phosphorus fertilizer (75 kg $ha^{-1}$) was shown to have a greater seed yield and was highly recommended for local farmers.

## CONCLUSIONS

It is concluded that sunflower growth and seed yield were significantly ($p<0.05$) influenced by phosphorus levels as associated with the control (no fertilizer). The seed yield expanded linearly with increasing phosphorus levels. However, the plot fertilized with fertilizer of phosphorus 100 kg ha-1 produced the maximum (2760.3 kg ha-1) sunflower seed yield, followed by phosphorus 75 kg ha-1 with 2725.7 kg $ha^{-1}$. Hence, the differences between $T_5$ and $T_6$ are statistically almost the same.

## CONFLICT OF INTEREST

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

## AUTHOR’S CONTRIBUTION

All the authors contributed equally in the research and manuscript.

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