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# INTEGRATED MANAGEMENT OF NP FERTILIZERS CAN BOOST THE GROWTH AND YIELD PERFORMANCE OF SUNFLOWER (*HELIANTHUS ANNUS* L.)

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**ABSTRACT**

Nitrogen and phosphorus (NP) are two most important essential nutrients promoting plant growth and yield traits of all crops. NP fertilizers are easy to use and quick in releasing nutrients. A field experiment was conducted at Oilseed section, Agriculture Research Institute, Tandojam to determine the effects of different doses of NP fertilizers on the time of maturity, vegetative growth and yield and yield related traits of sunflower variety HO-1. The six NP fertilizer levels viz. $T_1$ = 0-0 (control), $T_2$ = 80-40, $T_3$ = 100-50, $T_4$ = 150-50, $T_5$ = 120-50 and $T_6$ = 120-75 NP kg $ha^{-1}$ were set in a randomized complete block design (RCBD). The results revealed that all the parameters of sunflower were significantly affected ($P < 0.05$) by different NP fertilizer doses. It was observed that maximum 184.25 (cm) plant height, 6.66 (cm) stem girth, 28.19 (cm) head diameter, 1161.92 seeds $head^{-1}$, 90.33 (g) seed index and 2172.00 (kg $ha^{-1}$) seed yield was achieved by applying 150-50 NP fertilizer kg $ha^{-1}$. It was also noted that 150-50 NP kg $ha^{-1}$ promoted the sunflower crop to mature early by enhancing vegetate growth. The poor performance for all growth, yield and maturity parameters were observed in the treatment where no NP fertilizer was applied (control). It was concluded that growth and seed yield was increased by increasing the application of NP fertilizers up to 150-50 NP kg $ha^{-1}$ and thus recommended to get better growth and yield performance of sunflower crop in locality.

***Keywords*:** Sunflower, NP fertilizers, Growth, Yield, Performance

## INTRODUCTION

Pakistan has chronic deficiency in edible oilseed production and is the largest importer of edible oil in the world involving huge foreign exchange. Local production of edible oil during 2018-19 (July-Match) recorded at 0.5 million tons (GOP, 2019) which was insufficient to meet the requirement of oil consumption demand in the country. So, for that, Pakistan imported 2.421 million tons edible oil and spent nearly Rs.192.203 (US$ 1.455) billions to meet its edible oil requirements and thus become the largest importer of edible oil in the world (GOP, 2019). Nevertheless, the demand for the edible oil is increasing steadily over the time while production is stagnant. Thus, Pakistan is still facing an acute shortage of edible oil. All this necessitates need more concern to increase domestic oilseed production. Sunflower (*Helianthus annus* L.) is one of the major oilseed crops of Pakistan grown over an area 0.264 million acres (GOP, 2019). Sunflower seed contains 25-48% oil and 21-27% protein. Its oil contains high percentage of poly-unsaturated fatty acids (60%), accepted largely in diet to reduce cholesterol in blood and prevents heart diseases (Rathore, 2001). Sunflower oil is quite palatable and contains soluble vitamins A.D.E and K, it is used in manufacturing of margarine. Sunflower cake is used as cattle feed too (Hussain *et al*., 2000).

The average yield of sunflower is lower than the potential of the hybrids. Among different factors affecting crop yield, productivity and profitability, optimum dose of fertilizers is necessary to get maximum growth, seed and oil yield content of sunflower crop. (Chaudhary *et al*., 1999). However, it is very important for growers and farmers to apply the fertilizers at the appropriate rate in order to get the maximum productivity from the crop plants. N is most important crop supplement which significantly affects almost every area of the crop such as vegetative, reproductive, physiological growth and development as well as metabolic and biochemical processes of the plants (Massignam *et al.,* 2009). N plays a key role in maximizing yield and quality of all crops (Ullah *et al.,* 2010). Increasing N levels significantly increased photosynthetic activity, leaf area production and its duration and net assimilation rate of the crops (Ahmad *et al.,* 2009). Research has shown that the

development of individual leaf area and its total leaf area is directly proportional to the seed yield (Rafiq *et al*., 2010). Optimum use of N ultimately enhanced the growth and development of sunflower (Bange *et al*., 2000) while its deficiency showed a significant decline in vegetative and reproductive growth including premature senescence which ultimately results in poor production (Kusa *et al*., 2010). Vigil *et al*. (2001) recommended 56 kg N ha$^{-1}$ required to get 1120 kg ha$^{-1}$ of seed yield of sunflower. After seven years, he again conducted the same experiment and made an update in his previous recommendation by applying 67-78 kg N ha$^{-1}$ for getting 1120 kg ha$^{-1}$ of seed yield (Vigil *et al*., 2009).

Phosphorus (P) is a major nutrient required for growth, its deficiency has negative effects on growth and promotes purple colour in leaves of sunflower. Although P required in less quantities but it is as important as N and other elements. P has significant effects on flowering, fruit formation and seed yield of crops (Aduayi *et al*., 2002). P is an essential constituent of metabolically active cells. Previous research has showed that the biomass of sunflower crop grown in P sufficient soil was drastically increased (Padmanabhan and Sahi, 2011) by increasing LAI and in results seed yield was maximum (Khan, 2010). Not only had thisbut efficient use of P at the rate of 40-60 kg ha$^{-1}$ facilitated other nutrients in the uptake and accumulation process in sunflower crop (Fagbayide and Adeoye, 1999). Increases in P levels significantly increased seed yield of sunflower as compared to the control (Muralidharudu *et al*., 2003).

The application of essential plant nutrients in optimum quantity and right proportion is the key to increase and sustain crop production (Cisse and Amar, 2000). Studies on the effects of N and P fertilization on sunflower phenology, growth, yield components, and seed yield have produced some confusions to find out the accurate dose of NP fertilizer to get optimum growth and development of sunflower. Keeping this question in view, we designed the study to find out the suitable NP fertilizer dose for obtaining higher yield and productivity of sunflower crop along with this, we also evaluated the effect of combinations of NP fertilizer doses on growth and yield of sunflower.

## MATERIALS AND METHODS

### Site selection and Plant Material

The study was conducted at Oilseed Section of Agriculture Research Institute (A.R.I) Tandojam, Sindh, Pakistan (Late. 68.33°, long. 25.25°) in the month of February. The seed of sunflower variety HO-1 was obtained from Oilseed Section, A.R.I. Tandojam to assess its growth and yield performance against different NP (Nitrogen, Phosphorus fertilizer doses). The seeds were sown at the rate of 5 kg ha$^{-1}$ using single coulter hand drill. The distance between rows was kept 75 cm while plant to plant distance was set as 45 cm. The net plot size was kept 5 m x 4 m.

### Experimental design and NP treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments consisted six NP fertilizer doses$T_1$ (0-0NP kg ha$^{-1}$) Control, $T_2$ (80-40 NP kg ha$^{-1}$), $T_3$ (100-50 NP kg ha$^{-1}$), $T_4$ (150-50 NP kg ha$^{-1}$), $T_5$ (120-50 NP kg ha$^{-1}$), and $T_6$(120-75NP kg ha$^{-1}$). Urea (N-46%) and Triple Superphosphate ($P_2O_5$-46%) were used as sources of N and P, respectively. The 100% dose of phosphorus and 50% dose of nitrogen was applied as a basal dose and remaining nitrogen was applied at the time of first irrigation.

### Agronomic Management

The land preparation was done by giving two dry ploughings to break the hard pan of the soil and to eradicate the weeds. However, seedbed preparation was done after dry ploughings followed by soft ploughings with clod crushing and land levelling. The purpose was to obtain fine seedbed as well as uniform distribution of seed, fertilizer and water in the field. The crop was kept weed free throughout the growing season. Weeding and Inter culturing was done after 30 days of sowing and after second and fourth irrigations. Total four irrigations were applied from seedling emergence to crop maturity at 26, 41, 66 and 80 days after sowing. The crop was harvested at its full maturity at 110 days after sowing. Harvesting and threshing practices were performed manually. Days to 75% maturity, Days to 90% maturity, Plant height (cm), Stem girth (cm),Head diameter (cm), Seeds head$^{-1}$, Seed index (100 seed weight, g) and Seed yield (kg ha$^{-1}$) were recorded.

### Trait Measurement:

Following traits were measured according to their procedures:

i. **Days to 75% maturity:** When the crop reached at its 75% maturity, the days were counted from sowing to reaching at 75% maturity for each treatment.

ii. **Days to 90% maturity:** Days were counted from 75% maturity till reaching the crop at its 90% maturity.

iii. **Plant height (cm):** Plant height was measured in centimeters from five selected plants of each treatment and mean was worked out. It was measured with the help of measuring tape.

iv. **Stem girth (cm):** The stem girth was measured by means of Vernier Caliper at the time of maturity of the crop in labelled plants in each treatment and mean was worked out.

v. **Head diameter (cm):** Head diameter (cm) were recorded when the heads of the plants were fully developed with mature seeds. Measuring tape was used to record head diameter (cm)and averages were worked out.

vi. **Seed head$^{-1}$:** Mature heads were harvested from randomly selected plants of each treatment and the total number of seeds were counted from them to record seeds head$^{-1}$. The mean was from randomly selected five heads from each treatment.

vii. **Seed index (100 seed weight, g):** One hundred seeds of randomly selected five samples from each plot in each replication were collected and weighed to record the weight of seed index of different treatments.

viii. **Seed yield (kg ha$^{-1}$):** Seed yield kg ha$^{-1}$ was calculated in kilograms on the basis of seed yield plot$^{-1}$ using the following formula:

$$\text{Seed yield}\left(\text{kg per ha}\right)=\frac{\text{Seed yield per plot}\left(\text{kg}\right)}{\text{Plot Size}\left(\text{m}^2\right)}\times 10000$$

**Statistical Analysis**

The data thus collected was subjected to statistical analysis using STATISTIX-8.1. Least significant differences (LSD) were used to test for significant differences among the treatments (P=0.05) and figures were made from Graph Pad Prism software version 6.01.

## RESULTS

**Days to 75% maturity**

The results regarding days to 75 % maturity of sunflower are presented in Table.1 which showed a significant effect ($P$<0.05) of NP fertilizer doses on the days to 75% maturity of the crop. It was found that application of 150-50 kg NP ha$^{-1}$ recorded minimum days to 75% maturity (87.88). However the highest number of days to 75% maturity were recorded in the control treatment where no NP fertilizer was applied. Statistically there was no significant difference in the treatments 80-40 NP kg ha$^{-1}$fordays (89.30) to 75% maturity, 100-50 NP kg ha$^{-1}$ (89.25 days) and 120-50 NP kg ha$^{-1}$ (89.38 days).

**Days to 90% maturity**

The data regarding days to 90% maturity of sunflower crop was recorded between the interval of days to 75% maturity and days to 90% maturity. The data indicated a significant effect ($P$<0.05, Table 1) of NP fertilizer levels on the days to 90% maturity of the sunflower crop. The results obtained from the data showed a decreasing trend of days to 90% maturity as the NP doses were increased up to 150–50 NP kg ha$^{-1}$ and then rose again. The maximum days (16.01) to 90% maturity were recorded where no NP fertilizer were applied and the minimum days (14.62) to 90% maturity were recorded in the treatment 150–50 NP kg ha$^{-1}$. Statistically remaining treatments showed no significant difference among each other.

**Plant height (cm)**

Increasing the levels of NP up to 150-50 NP kg ha$^{-1}$significantly increased ($P$<0.05, Fig. 3) the plant height (cm) of sunflower crop. It was observed that plant height (cm) tends to increase its level as NP fertilizer level was increased from 0-0 NP kg ha$^{-1}$ up to 150-50 NP kg ha$^{-1}$. After this treatment, plant height again started to decrease in the treatments 120-50 NP kg ha$^{-1}$ and 120-75 NP kg ha$^{-1}$. The highest plant height was observed in the treatment where 150-50 NP kg ha$^{-1}$ fertilizer level was applied whereas lowest plant height was noted in control plants where no NP fertilizer was applied.

**Stem girth (cm)**

The results showed that the stem girth (cm) of sunflower crop were significantly ($P$<0.05, Fig. 2) affected with the increasing levels of NP fertilizer doses in comparison to 0-0 NP fertilizer kg ha$^{-1}$ (control). Statistically there was no significant difference among the treatments i.e. 100-50 NP, 150-50 NP, 120-50 NP, 120-75 NP fertilizer kg ha$^{-1}$ for the stem girth (cm). All these treatments showed high values for stem girth (cm) of sunflower crop. However, control plants showed poor performance in regard to stem girth (cm) in comparison of all the treatments.

**Head diameter (cm)**

The results regarding head diameter (cm) of sunflower variety HO-1showed a significant ($P$<0.05, Fig. 3) effect of increasing NP fertilizer levels. The maximum (28.19 cm) values for stem girth (cm) were observed in the plots where crop was fertilized with 150-50 NP kg ha$^{-1}$ which produced wider head size, followed by 120-50 NP kg ha$^{-1}$ (25.96 cm) and 120-75 kg NP ha$^{-1}$ (25.71 cm) which were statistically similar to each other. However the smallest head diameter (16.67 cm) was recorded under 0-0 NP kg ha$^{-1}$ (control treatment) where no application of fertilizers were used.

**Seeds head$^{-1}$**

The results regarding number of seeds head$^{-1}$ are presented in the Fig-4, and their analysis of variance revealed that NP fertilizer levels had significant ($P$<0.05) effect on this trait. It was further found that application of 150-50 kg NP ha$^{-1}$ resulted in maximum number of seeds followed by 120-50 kg NP ha$^{-1}$. Statistical analysis showed no significant difference between 100-50 NP kg ha$^{-1}$ and 120-75 kg NP ha$^{-1}$. Both treatments produced statistically similar number of seeds head$^{-1}$. The lowest performance for producing seeds head$^{-1}$ was observed in the plots which received no fertilizer application (control).

**Seed index (100 seed weight, g)**

The crop fertilized with 150-50 NP kg ha$^{-1}$significantly ($P$<0.05, Fig.5) resulted in the maximum (90.33 g) seed index (100 seed weight), while the minimum seed index (47.67 g) was seemed in the plants grown in control (0-0 NP kg ha$^{-1}$). Statistically, there was no significant difference in seed index (100 seed weight, g) for rest of the treatments i.e. 80-40 NP fertilizer kg ha$^{-1}$.100-50 NP fertilizer kg ha$^{-1}$, 120-50 NP fertilizer kg ha$^{-1}$ and120-75 NP fertilizer kg ha$^{-1}$.

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

The results showed an increasing trend of seed yield (kg ha$^{-1}$) with the increment of NP fertilizer doses up to 150-50 NP kg ha$^{-1}$. The crop provided with nitrogen and phosphorus (NP) fertilizer at the rate of150-50 kg ha$^{-1}$ significantly ($P$<0.05, Fig. 6) produced maximum seed yield (kg ha$^{-1}$) while the minimum seed yield was found in 0-0 NP kg ha$^{-1}$ (control) and 80-40 NP kg ha$^{-1}$ plots which were statistically similar to each other. The treatment 120-50 NP kg ha$^{-1}$ and 120-75 NP kg ha$^{-1}$ were ranked 2$^{nd}$ in producing maximum seed yield and were statistically alike.

## DISCUSSION

**Effects of different NP fertilizer doses on the time of maturity of sunflower variety HO-1**

Various studies have proved that N is actively involved in the constituent of proteins, nucleic acids and nucleotides that are essential to the metabolic function of a plant and as a result it stimulates vegetative growth which lead the plant to mature early (Ali *et al*., 2004). In the present research, the minimum days to 75% maturity (87.88) and days to 90% maturity (14.62) were obtained from NP fertilizer dose of 150–50 kg ha$^{-1}$ (Table 1). All other treatments including control showed delay in maturity in comparison of this treatment. This is because research has shown that the application of N above 100 kg ha$^{-1}$ and P at 50 kg ha$^{-1}$ fasten the process of maturity and led the sunflower crop to mature early (Handayati and Sihombing, 2019). If a crop matures early is mean that it also flowers early. Ali *et al*. (2014) reported that the number of days to 50% flowering were shortened by the application of nitrogen and phosphorus.

Similar results were obtained by TOMAR *et al*. (1999) who indicated that flowering of sunflower was hastened by fertilizer application; which explains their responsiveness to fertilizer. Here, we conclude that the integrated application of NP fertilizers at the rate of 150-50 kg $ha^{-1}$ matured sunflower variety HO-1 early and lessen the time to take yield benefits from the crop.

**NP fertilizer doses significantly affected the growth parameters of sunflower**

Inorganic fertilizer components such as N, P and K are essential nutrients for plant growth and the yield. Balanced fertilization of each played a significant role in supplying the nutrients needed, to attain maximum sunflower growth (Patil *et al*., 2009). Of the nutrient elements required by plants, nitrogen (N) is most essential for all life processes of plants and is required in the largest amount from soil (Lewis, 1986; Lægreid *et al*., 1999). Application of N to crops produces abundant vegetative growth and large leaves with deep green color. Nitrogen deficiency is generally the most limiting nutritional disorder affecting growth and production of sunflower. Phosphate compounds act as energy currency within the plant. Plants suffering from P deficiency are retorted in growth. Thus not only low growth and yield but also poor quality of fruit and seed are obtained from P deficiency in crops (Mengel and Kirkby, 1987). Suzer (1998) had reported that appropriate fertilization of essential macronutrients is important for getting vigorous growth. So, it was much important to investigate the appropriate combine dose of NP fertilizers for healthy and vigorous sunflower growth for which the experiment was designed.

In the present study, we found that the application of 150-50 kg NP $ha^{-1}$ recorded maximum (184.25 cm) plant height. The lowest plant height (123.17 cm) was observed under control plots where no NP fertilizers were added (Fig. 1). Previous studies have also shown that the application of nitrogen and phosphorus either alone or in combination enhanced the plant height (Poonia 2000, Malik *et al*., 2004). Ali *et al*. (2014) reported that plant height of sunflower was enhance when the levels of N and P were increased up to 80-100 kg $ha^{-1}$, respectively. Our results for stem girth (cm) showed no significant difference among the treatments where nitrogen was applied at or above the rate of 100 kg $ha^{-1}$. The results showed that stem girth of sunflower crop was similar at the rate of 100-50 NP kg $ha^{-1}$, 150-50 NP kg $ha^{-1}$,120-50 NP kg $ha^{-1}$ and 120-75 NP kg $ha^{-1}$ (Fig. 2). This is because the N is actively involved in promoting the vegetative growth of plants. Similarly, high rate of N up to 100 kg or above enhanced the size of stem girth and thus showed no significant difference. Similar kinds of results were reported by Handayati and Sihombing (2019) where they stated that the stem diameter was affected considerably by NPK levels. The biggest stem was gained from d treatment where 120-75-75 NPK kg $ha^{-1}$ was applied.

**Yield and yield components were significantly enhanced by the increasing application of NP fertilizers**

There is no doubt about the importance of the application of nutrients, particularly nitrogen (N) and phosphorus (P), in the form of artificial fertilizers which play a vital role in boosting up yield and production of sunflower (Ahmed *et al*., 2010). Quantifying the optimum fertilizer rate accurately is essential to maximize the profitability of crop (Chaudhry and Sarwar, 1999). Head diameter (HD) is one of the most important yield components in sunflower plant; nitrogen fertilizer had significant effect on HD. Presently, we observed that wider head diameter was achieved in the treatment where highest combined dose of NP fertilizers (150-50 kg $ha^{-1}$) was applied (Fig. 3). The second wider head diameter was observed in the treatments such as 120-50 NP kg $ha^{-1}$ and 120-75 NP $kg^{-1}$. This showed that when N level was decreased, the head diameter (cm) was also decreased, no matter P fertilizer was increased or remained same in the quantity. This proved that the size of head diameter (cm) was correlated with the amount N fertilizer. Similar results were reported by Nasim *et al*. (2012), who claimed that response of nitrogen fertilizer with different N levels on HD was highest with increasing nitrogen fertilizer. Contradictory, the significant effect of nitrogen and phosphorus application on head diameter has also been reported by various researchers (Malik *et al*., 2004; Ali *et al*. 2012).

We further found that application of 150-50 NP kg $ha^{-1}$ resulted in maximum number of seeds (1161.92) $head^{-1}$ which was followed by 120-50 kg NP $ha^{-1}$ (1059.17). The lowest amount (850.25) of seeds was observed under 0-0 NP kg $ha^{-1}$ (Fig. 4). Ali *et al*. (2014) conducted a study on sunflower to check the effect of varying N and P fertilizer levels. He found that the interactive application of 80-100 NP kg $ha^{-1}$ produced more number of seeds $head^{-1}$. In another study, Nasim *et al*. (2012) conducted a two year study on different cultivars of sunflower to check the impact of various N levels, where he found that the highest number of achenes $head^{-1}$ were achieved when N was applied in highest (180-240 kg $ha^{-1}$) quantities. Seed index (100 seed weight, g) was expressed highest when integrated application of 80-100 NP kg $ha^{-1}$was supplied to sunflower (Ali *et al*. 2014). Khan (2010) reported that maximum (53.30 g) seed index was noted when the sunflower crop was fertilized with 90 kg $P_2O_5$. Many previous researches have proved that the application of N and P either alone, combined or with other essential nutrient element can significantly enhance the weight of seed index in sunflower crop (Nasim *et al*. 2012; Akpojotor *et al*. 2019; Handayati and Sihombing, 2019). Our results are in agreement with above experiments where we found higher (90.33 g) values of seed index where higher NP 150-50 kg $ha^{-1}$ was applied (Fig. 5). Our results further demonstrated that sunflower fertilized with 150-50 kg NP $ha^{-1}$ gave maximum seed yield (2172.00 kg $ha^{-1}$). While lowest (1512.70 kg $ha^{-1}$) seed yield was perceived in the plots where no dose of NP fertilizers was applied (Fig. 6). Killi (2004) obtained high seed yield (4.3 t $ha^{-1}$) by applying different levels of nitrogen application. Baloch *et al*. (2020) reported that an increasing level of N up to 180 kg $ha^{-1}$ can significantly improve the seed yield of the crop. Along with that many studies reported that increasing level of NP fertilizers can enhance the seed yield of the sunflower crop (Akpojotor *et al*. 2019; Handayati and Sihombing, 2019).

## CONCLUSIONS

It is concluded from the study that Nitrogen and Phosphorus (NP) are important nutrients for the growth, development and seed yield of sunflower. Optimum and accurate use of fertilizers containing these two essential nutrients led to achieve good vegetative growth and higher seed yield and ultimately one can get a good amount of edible oil content. It was observed that as the increasing nitrogen and phosphorus fertilizer doses up to 150-50 kg NP $ha^{-1}$significantly enhanced the growth and yield performance

of sunflower variety HO-1, thereby decreasing the number of days to mature. It is recommended that local farmers and growers can use 150-50 NP kg $ha^{-1}$ to get maximum seed yield from sunflower.

**Table 1 :** Effect of NP fertilizer doses on days to 75% flowering and days to 90% of sunflower variety HO-1.

| | Days to 75% maturity | | | | Days to 90% maturity | | | |
|---|---|---|---|---|---|---|---|---|
| **NP Fertilizer Doses** | **R1** | **R2** | **R3** | **Mean** | **R1** | **R2** | **R3** | **Mean** |
| 0-0 NP kg $ha^{-1}$ | 92.35 | 90.75 | 90.41 | 91.17 a | 15.85 | 15.80 | 16.38 | 16.01 a |
| 80-40 NP kg $ha^{-1}$ | 90.41 | 87.50 | 90.00 | 89.30 c | 15.80 | 14.30 | 15.80 | 15.30 ab |
| 100-50 NP kg $ha^{-1}$ | 90.00 | 92.35 | 85.40 | 89.25 c | 15.25 | 14.60 | 15.25 | 15.03 ab |
| 150–50 NP kg $ha^{-1}$ | 90.75 | 85.40 | 87.50 | 87.88 d | 14.30 | 15.25 | 14.30 | 14.62 b |
| 120-50 NP kg $ha^{-1}$ | 85.40 | 90.41 | 92.33 | 89.38 c | 16.38 | 15.00 | 14.60 | 15.33 ab |
| 120-75 NP kg $ha^{-1}$ | 87.50 | 91.33 | 91.35 | 90.06 b | 15.00 | 15.25 | 15.85 | 15.37 ab |

The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

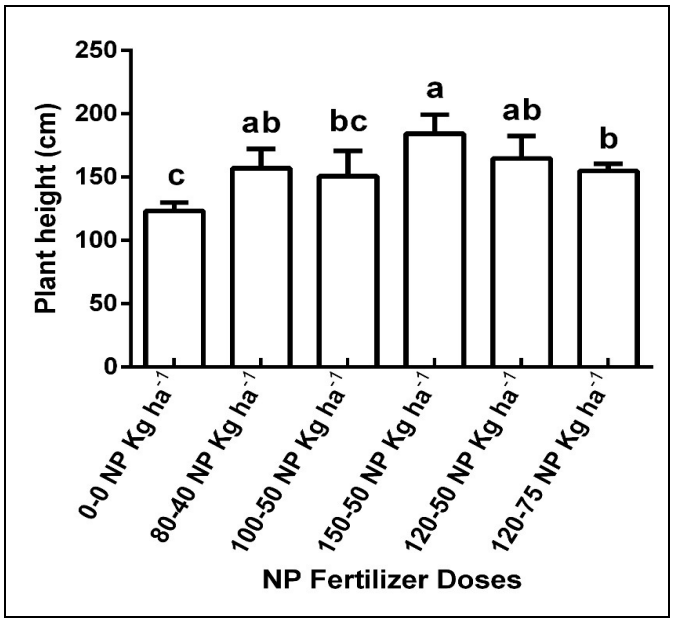


**Fig. 1 :** Effect of different NP fertilizer doses on plant height (cm) of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

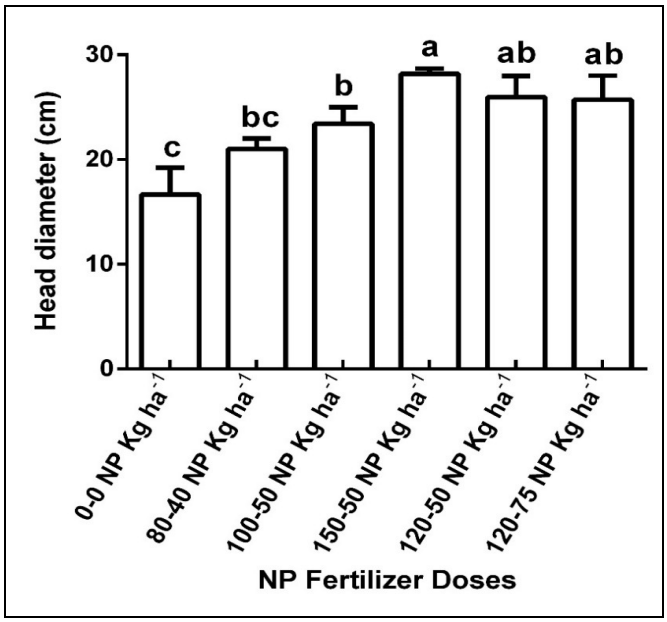


**Fig. 3:** Effect of different NP fertilizer doses on head diameter (cm) of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

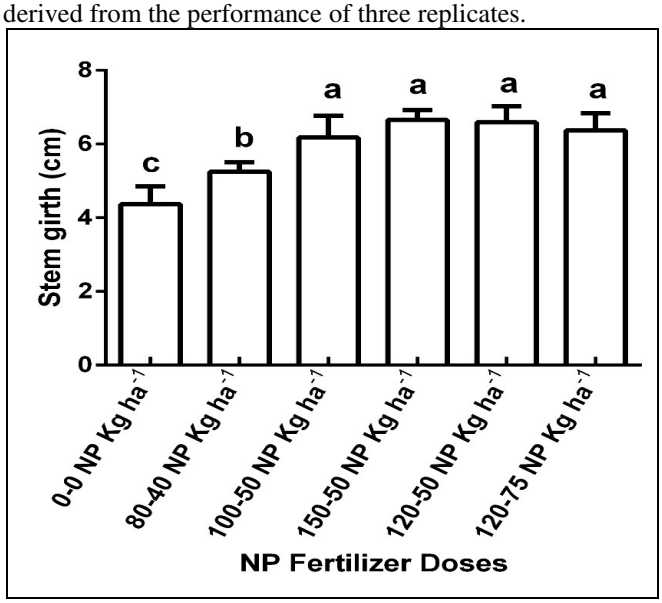


**Fig. 2 :** Effect of different NP fertilizer doses on stem girth (cm) of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

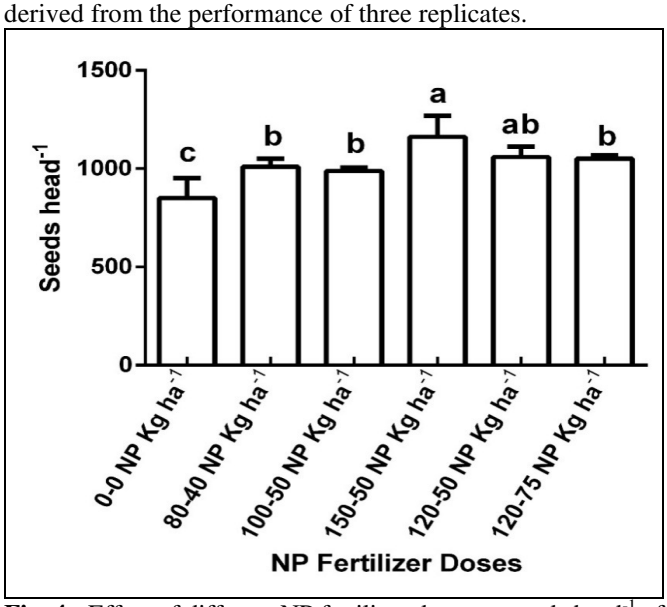


**Fig. 4 :** Effect of different NP fertilizer doses on seeds $head^{-1}$ of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

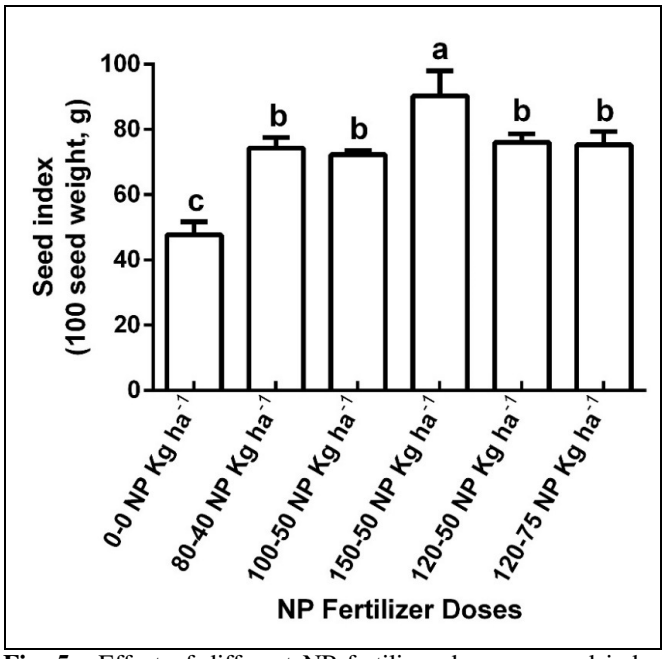


**Fig. 5 :** Effect of different NP fertilizer doses on seed index (100 seed weight, g) of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

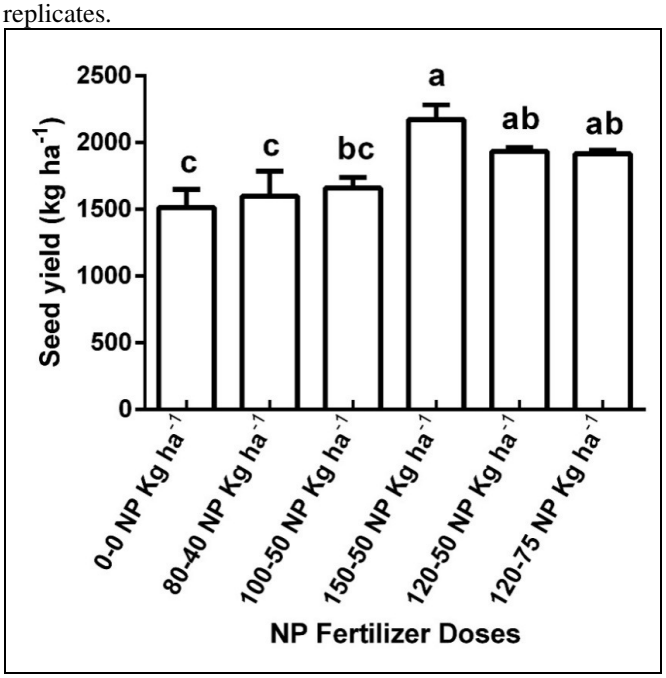


**Fig. 6 :** Effect of different NP fertilizer doses on seed yield (kg $ha^{-1}$) of sunflower variety HO-1. The different letters indicate significant difference among treatments (P< 0.05), and all of the results are presented as mean ± SD. Mean values were derived from the performance of three replicates.

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**Conflict of Interest**

The authors declare no conflict of interest.

## REFERENCES

Aduayi, E.; Chude, V.; Adebusuyi, B. and Olayiwola, S. (2002). Fertilizer use and management practices for crops in Nigeria. Federal Ministry of Agriculture and Rural Development Abuja, Nigeria. P: 63-65.

Ahmad, S.; Ahmad, R.; Ashraf, M.Y.; Ashraf, M. and Waraich, E.A. (2009). Sunflower (*Helianthus annuus* L.) response to drought stress at germination and seedling growth stages.*Pak. J. Bot.,*41(2): 647-654.

Ahmed, A.G.; Orabi, S.A. and Gaballah, M.S. (2010). Effect of bio-NP fertilizer on the growth, yield and some biochemical components of two sunflower cultivars. *Int. J. Acad. Res.,*2: 271-277.

Akpojotor, E.; Olowe, V.; Adejuyigbe, C. and Adigbo, S. (2019). Appropriate Nitrogen and Phosphorus Fertilizer Regime for Sunflower (*Helianthus Annuus* L.) In the Humid Tropics. *Helia,* 42(70): 111-125.

Ali, A.; Ahmad, A.; Khaliq, T. and Akhtar, J. (2012). Planting density and nitrogen rates optimization for growth and yield of sunflower (*Helianthus annuus* L.) hybrids. *The J. Animal Plant Sci.,* 22(4): 1070-1075.

Ali, A.B.; Altayeb, O.A.; Alhadi, M. and Shuang-En, Y. (2014). Effect of different levels nitrogen and phosphorus fertilization on yield and chemical composition hybrid sunflower grown under irrigated condition. *J. Environ. Agric. Sci.,* 1: 7-14.

Ali, H.; Randhawa, S.A. and Yousaf, M. (2004). Quantitative and qualitative traits of sunflower (*Helianthus annus* L.) as influenced by planting dates and nitrogen application. *Int. J. Agric. Biol*., 6: 410-412.

Baloch, N.A.; Kaleri, A.A.; Laghari, G.M.; Kaleri, A.H.; Kaleri, G.S.; Mehmood, A. and Nizamani, M.M. (2020). Effect of nitrogen levels and application scheduling on the growth and yield of maize. *J. Appl. Res. Plant Sci.,*1(2): 42-52.

Bange, M.P.; Hammer, G.L.; Milroy, S.P. and Rickert, K.G. (2000). Improving estimates of individual leaf area of sunflower. *Agron. J.,* 92(4): 761-765.

Chaudhry, A.U. and Sarwar, M. (1999). Optimization of nitrogen fertilization in cotton (*Gossypium hirsutum* L.). *Pak. J. Biol. Sci.,* 2: 242-243.

Cisse, L. and Amar, B. (2000). The importance of phosphatic fertilizer for increased crop production in developing countries. In *Proceedings of the AFA 6th International Annual conference,* World Phosphate Institute Casablanca,, Morocco.

Fagbayide, J. and Adeoye, G. (1999). Sunflower growth and mineral uptake as influenced by fertilizer phosphorus. *Trop. oilseeds J.,* 4: 21-28.

GOP (2019). Agricultural Statistics of Pakistan (2018-19). Govt. of Pakistan, MINFAL, Economic Wing. Islamabad, Pakistan.

Handayati, W. and Sihombing, D. (2019). Study of NPK fertilizer effect on sunflower growth and yield. In AIP *Conference Proceedings*, AIP Publishing LLC. 2120(1): P. 030031.

Hussain, M.; Rasul, E. and Ali, S.K. (2000). Growth analysis of sunflower (*Helianthus annuus* L.) under drought conditions. *Int. J. Agri. Biol.,* 2(1-2): 136-140.

Khan, M. (2010). Interactive effects of potassium and phosphorus on phenology and grain yield of sunflower in Northwest Pakistan. *Pedosphere*, 20(5): 674-680.

Killi, F. (2004). Influence of different nitrogen levels on productivity of oilseed and confection sunflowers (*Helianthus annuus* L.) under varying plant populations. *Int. J. Agric. Biol.,* 6(4): 594-598.

Kusa, K.; Sawamoto, T.; Hu, R. and Hatano, R. (2010). Comparison of $N_2O$ and $CO_2$ concentrations and fluxes in the soil profile between a Gray Lowland soil and an Andosol. *Soil Sci. Plant Nutr.,* 56(1): 186-199.

Lægreid, M.; Bockman, O.C. and Kaarstad, O. (1999). Agriculture, fertilizers and the environment. CABI Publishers, U.K., pp. 1-320.

Lewis, O.A.M. (1986). Plants and Nitrogen studies in Biology. Serial No.166. Edward Arnold, London.

Malik, M.; Saleem, M.; Sana, M. and Rehman, A. (2004). Suitable level of N, P and K for harvesting the maximum economic returns of sunflower (*Helianthus annuus* L.). *Int. J. Agric. Biol.,* 6(2): 240-242.

Massignam, A.; Chapman, S.; Hammer, G. and Fukai, S. (2009). Physiological determinants of maize and sunflower grain yield as affected by nitrogen supply. *Field Crops Res.,*113(3): 256-267.

Mengel, K. and Kirkby, E. (1987). Principles of plant nutrition. 4th Edition, International Potash Institute Bern, Switzerland. 687-695.

Muralidharudu, Y.; Murthy, I.Y.L.N.; Reddy, K.P.C.; Reddy, B.N. and Chandranath, H.T. (2003). Response of sunflower to phosphorus application in vertisols. *Helia*, 26: 147-154.

Nasim, W.; Ahmad, A.; Hammad, H.M.; Chaudhary, H.J. and Munis, M.F.H. (2012). Effect of nitrogen on growth and yield of sunflower under semi-arid conditions of Pakistan. *Pak. J. Bot.,*44(2): 639-648.

Padmanabhan, P. and Sahi, S.V. (2011). Suppression subtractive hybridization reveals differential gene expression in sunflower grown in high P. *Plant Physiol. Biochem.,*49(6): 584-591.

Patil, V.; Bavalgave, V.; Waghmare, M.; Kagne, S. and Kesare, B. (2009). Effect of fertilizer doses on yield and quality of sunflower hybrids. *Int. J. Agric. Sci.,*5(1): 40-42.

Poonia, K. (2000). Effect of planting geometry, nitrogen and sulfur on growth and yield of sunflower (*Helianthus annuus* L.). *J. Eco-Physiol.,* 3(1/2): 59-71.

Rafiq, M.A.; Ali, A.; Malik, M.A. and Hussain, M. (2010). Effect of fertilizer levels and plant densities on yield and protein contents of autumn planted maize. *Pak. J. Agri. Sci*., 47(3): 201-208.

Rathore, P. (2001). Techniques and management of field crop production. *Agrobis,* India. Pp. 215-220.

Suzer, S. (1998). Effects of different phosphorus rate and application time on sunflower seed yield and yield components. *Helia,* 21(28): 117-124.

TOMAR, H.S.; Dadhwal, K. and Singh, H. (1999). Effect of irrigation, N, and P on yield and yield attributes of spring sunflower (*Helianthus annuus* L.). *Trop. Agric.,* 76(4): 228-231.

Ullah, M.A.; Anwar, M. and Rana, A.S. (2010). Effect of nitrogen fertilization and harvesting intervals on the yield and forage quality of elephant grass (*Pennisetum purpureum*) under mesic climate of Pothowar plateau. *Pak. J. Agric. Sci.,*47(3): 231-234.

Vigil, M.; Benjamin, J. and Schepers, J. (2001). Fertilizer nitrogen recovery and yield response to nitrogen by dryland sunflowers in a no-till dryland rotation. *Proceedings of the National Sunflower Association Research Forum,* Fargo, ND.17 January. National Sunflower Association, Mandan, ND.

Vigil, M.; Lamond, R. and Meyer, R. (2009). Nutrient management. High Plains sunflower production handbook: Kansas St. Univ. Ag. Exp. Stn. and Coop. Ext. Service Publ. MF-2384. Kansas St. Univ. Ag. Exp. Stn., Manhattan. p. 4-7.