

**Effect of Different Levels of Nitrogen and Phosphorus on the Yield, Yield Components and Quality of Sunflower (*Helianthus Annuus L*) under Agro-Climatic Conditions of Goner Farm Diamer GB**

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**Received:** 16-10-2025

**Revised:** 30-10-2025

**Accepted:** 15-11-2025

**Published:** 01-12-2025

**ABSTRACT**

*Effect of different levels of Nitrogen and Phosphorus on the yield, yield components and quality of sunflower NK. Armony was studied at the field crop Research Station Goner Farm Diamer during spring 2023. The experiment was laid out in Randomized complete block design with 3 replications with a net plot size of 5m x 3m (15sqm). It was observed during this study that plant height head diameter (cm) number of seeds (head<sup>-1</sup>), 100 seed weight (g) seed yield (t/ha<sup>-1</sup>) stalk yield (t/ha<sup>-1</sup>) and seed oil contents were significantly affected by N and P<sub>2</sub>O<sub>5</sub> levels. While number of leaves per plant<sup>l</sup> was not affected significantly. Maximum plant height (cm) head diameter (cm) number of seeds head<sup>-1</sup>, seed yield (t/ha<sup>-1</sup>) stalk yield (t/ha<sup>-1</sup>), and seed oil contents were recorded in plants fertilized at the rate of 130kg N and 130kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, while the maximum 100 seed weight was recorded at the rate of 80kg N and 80kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.*

*Keywords: Quality, yield components, NP, sunflower, spring*

## INTRODUCTION

Sunflower (*Helianthus annuus* L) belongs to the family Compositae. It originated in Peru or Mexico. Plants of this family bear heads in which the fertile flowers are aggregated and are bordered by the rays of the corollas of sterile flowers (ASWINI, 2022). The cultivated sunflower is a stout, erect annual 3-5m in height with a rough, hairy stem, 2.5 - 7.5 cm in diameter, which terminates into a head or disk (principles of field crop production). The disk is brown to nearly black. The flowers are almost entirely cross-pollinated (Goldblatt & Manning, 2019). Sunflower is an important edible oil crop ranking next to soybean. It is a newly introduced oilseed crop in Pakistan, which gives very good performance regarding yield and quality of oil as compared to our conventional oilseed crops. Edible oil is an important component of the human diet (Qaisar et al., 2024). The domestic production of edible oils in the country is meeting only 35% of the total requirements (Khurshid 2022-23). The per capita availability of edible oil in Pakistan is 13.27 kg per annum, which is much less than the recommended fat intake (SUDHIR, 2022). At present, our National requirements of edible oil are about 2.437 million tones with an import bill of over 50 billion rupees in foreign exchange, while the remaining requirements 70% is being met through import (Ahmed 2023-24). A huge amount of foreign exchange is spent every year on the import of edible oil. So there is an imperative need to enhance domestic production of edible oil (Dutta, 2021). New and non-conventional sources of edible oils are sunflower, safflower, and soybean. The seed of these crops is rich in oil content and contributes 15-16% to the local production (Khan et al., 2024). Sunflower is a drought-tolerant and short-duration (90-110 days) crop and has a wider range of adaptability. Sunflowers can be grown twice a year in Pakistan successfully in the spring and autumn, while in Gilgit-Baltistan, they are grown once a year as a spring crop. Its seed contains high oil contents ranging from 40-45% and is rich in protein, 23%. Its oil is also free from toxic elements (ASWINI, 2020).

Among the non-conventional oilseed crops, sunflower is one of the most important crops, which is currently grown on an area of 234000 ha, and its seed production is 404000 tons (Lim, 2013). However, there is great potential to increase the area under this crop. Nitrogen and Phosphorus are the major plant food nutrients responsible for almost all of the plant characteristics, which consequently contribute towards final yield and quality of the product (Sinha & Tendon, 2020). Low doses of these vital elements cannot exploit the inherent potentials of new sunflower cultivars, where imbalanced application of these fertilizers, besides being a waste of resources, increases the cost of their production (S. A. Harris, 2018). So the current study is therefore designed to formulate a balanced dose of N and P for the sunflower NK Armory under agro-climatic conditions of Goner Farm, Gilgit Baltistan, during the year 2023.

## MATERIALS AND METHODS

An experiment on "Effect of different Levels of Nitrogen and Phosphorus under Agro-climatic Conditions of GB" was conducted at the Field Crop Research Station Goner Farm Diamer, during the year 2023 on a clay loam soil having pH 8.1, O.M(%) 0.72, N 0.040%, 6.00 ppm available phosphorus, and 125.0 ppm extractable potassium.

The experiment was laid out in a randomized complete block design with three replications. Keeping a net plot size 5m x 3m (15sqm). The crop was sown on 15 June 2023 on a well-prepared seedbed with the dibbling method. Row to row and plant to plant distances were maintained at 60 cm and 20 cm apart. Sunflower NK-Armony was used as the medium of trial (Koutsoubos et al., 2023).

Urea and phosphorus were used as fertilizer sources for N and P<sub>2</sub>O<sub>5</sub>. The whole of the phosphorus and half of N were applied at the time of sowing, and the remaining half of N at the first irrigation. Recommended

dose of K<sub>2</sub>O (50kg ha<sup>-1</sup>) was applied to all treatments in the form of potassium sulphate at the time of sowing. After 20 days of sowing 1st irrigation was given to the crop, while subsequent irrigation was applied when required. Thinning was done at the 4-5 Leaf stage. Two manual hoeing's were done before earthing up to keep the crop free of weeds. Crop was earthen up after the 2nd irrigation in order to prevent lodging. Crop was harvested when it reached physiological maturity (Adhikary et al., 2024).

Experiment comprised the following N and P<sub>2</sub>O<sub>5</sub> levels as treatments.

Treatments	Nitrogen (kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )
T <sub>1</sub>	0	0
T <sub>2</sub>	80	0
T <sub>3</sub>	0	80
T <sub>4</sub>	80	80
T <sub>5</sub>	130	0
T <sub>6</sub>	0	130
T <sub>7</sub>	130	130

The following observations were noted, plant height (cm). Number of leaves per plant, Head Diameter (cm), Number of seeds per head, 100 seed weight (g), seed yield (t/ha<sup>-1</sup>), stalk yield (t/ha<sup>-1</sup>), seed oil contents (%). The data collected were analyzed statistically by the analysis of variance technique, and treatment means were compared using the LSD test at 5% level of probability (Fernandez, 2021).

## RESULTS AND DISCUSSION

An experiment to evaluate the effect of different levels of nitrogen and phosphorus on the yield, yield components, and quality of sunflower NK-Armory under agro-climatic conditions of Gilgit Baltistan was conducted at the field crop research station, Goner farm, Diamer, during June 2023. Statistically analyzed data along with their interpretation regarding yield, yield components, and quality of the crop are presented and discussed in this chapter.

### Plant height (cm)

Data on plant height at maturity is given in Table I, and analysis of variance is presented in Appendix I. Statistical analysis of the data shows that plant height was significantly affected by different levels of Nitrogen and Phosphorus. Maximum plant height (181.7cm) was recorded in plots treated with 130-130 NP kg ha<sup>-1</sup>. This is statistically different from all other treatments. It was followed by plant height (178.0 cm) obtained at T<sub>4</sub> and T<sub>5</sub> where 80-80 NP kg ha<sup>-1</sup> and 130-0 NP kg ha<sup>-1</sup> were applied, respectively (Xiao et al., 2019). Similarly, there was no significant difference between T<sub>1</sub> and T<sub>3</sub>, which were control and 0-80 NP kg ha<sup>-1</sup>. The minimum plant height (159.40cm) at maturity was recorded at T<sub>6</sub>, where 0-130 NP kg ha<sup>-1</sup> was applied (Chaves et al., 2019). Similar results were also reported by (Mojiri-A & Azrani-A 2023) at the College of Agric Isfahan (Iran) when they applied 0, 75, 150, 225 kg N ha<sup>-1</sup>.

**Table -1: Effect of different Levels of Nitrogen and Phosphorus on plant height (cm) in individual comparison of treatment means.**

Treatments	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Mean
T <sub>1</sub>	0	0	161.0d
T <sub>2</sub>	80	0	171.2c
T <sub>3</sub>	0	80	160.9d
T <sub>4</sub>	80	80	178.0b
T <sub>5</sub>	130	0	178.0b
T <sub>6</sub>	0	130	159.40e
T <sub>7</sub>	130	130	181.7a

LSD value = 1.0545, Means not sharing a common letter are significantly different at 5% level of probability.

#### **No of Leaves Plant ha<sup>-1</sup>**

Data presented in Table 2, while its analysis of variance is given in Appendix II, depicts that different levels of N and P<sub>2</sub>O<sub>5</sub> had not affected the number of leaves per plant ha<sup>-1</sup> significantly. The number of leaves plant ha<sup>-1</sup> on average ranged between 26.90 and 28.80 (Connor et al., 2024). Although there were some variations, the difference did not reach the level of significance. The number of leaves plant ha<sup>-1</sup> a varietal character, hence it is little or almost not affected by fertilizer application (Domaratskyi, 2025). Similar results were obtained by Sivakumar-SD and Raju-M (2022) in Karnataka (India)

#### **Head Diameter (cm)**

The production potential of the sunflower plant is characterized by the size of its head, which is an important yield contributing component. It is more or less a genetically controlled character but is also influenced by the environment in which the plant is grown (Mirza be et al., 2022). Data is presented in Table 3, while the analysis of variance in Appendix III shows that different levels of Nitrogen and phosphorus had a significant effect on it. Minimum head diameter (16.47cm) was recorded at Control. It was followed by head diameter (17.80cm) obtained in T<sub>6</sub>, where 0-130 NP kg ha<sup>-1</sup> was applied. Plants in plots fertilized with 130-130 NP kg ha<sup>-1</sup> produced heads of maximum size (20-80cm), which significantly remained superior over the rest of the treatments, but statistically did not differ with head diameter of 20-50cm in plots applied with 80-80 NP kg ha<sup>-1</sup>. Treatments T<sub>2</sub> (80-0), T<sub>3</sub> (0-80), and T<sub>5</sub> (130-0) NP kg ha<sup>-1</sup> showed statistically similar results, producing head diameters of 19.37, 19.30, and 19.23 cm, respectively (Komel & Razzaq, 2023). These results are in agreement with those obtained by Mojiri-A Azrani-A (2022) and (Djokovic et al., 2024).

#### **Number of Seeds Head<sup>-1</sup>**

The number of seeds head<sup>-1</sup> is an important yield component that contributes materially towards the final seed yield of Sunflower (Unger & Thompson, 2019). The data is given in Table 4, and analysis of variance is presented in Appendix-IV, shows that effect of N and P<sub>2</sub>O<sub>5</sub> on this parameter was significant and there

were statistically significant differences among various fertilizer treatments. The maximum number of seed head<sup>-1</sup> (1543) was recorded in plots which were given the fertilizer dose of 130-130 NP kg ha<sup>-1</sup>. It was statistically different from T<sub>4</sub>, T<sub>5</sub> & T<sub>2</sub> where 80-80, 130-0 & 0-80NP kg ha<sup>-1</sup> fertilizer doses were used, which produced 1489, 1488 & 1442 number seeds head<sup>-1</sup>, respectively. Application of 80-80 & 130-0 NP kg ha<sup>-1</sup> also produced closely similar results. Control plots produced the lowest number of seed heads (1135). Table 4 further reflects that the number of seeds head<sup>-1</sup> although a genetically controlled character depends upon the nutrient status and nitrogen alone or with phosphorus produced a higher number of seeds head<sup>-1</sup> but phosphorus alone to a certain extent (0-80NP kg ha<sup>-1</sup>) increased number of seeds head<sup>-1</sup> beyond. This had a detrimental effect on the parameter (Gupta et al., 2022). These results are in line with those documented by Mandal-BK and Mandal-BB (2023).

**Table-2: Effect of different Levels of Nitrogen and Phosphorus on number of Leaves Plant<sup>-1</sup>**

Individual Comparison of Treatment Means.

Treatment	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Mean
T <sub>1</sub>	0	0	27.05
T <sub>2</sub>	80	0	28.00
T <sub>3</sub>	0	80	27.95
T <sub>4</sub>	80	80	26.90
T <sub>5</sub>	130	0	28.80
T <sub>6</sub>	0	130	27.95
T <sub>7</sub>	130	130	28.85

LSD value = 3.1475

**Table-3: Effect of different Levels of Nitrogen and Phosphorus on Head Diameter (cm)**

Individual Comparison of Treatment Means

Treatment	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Mean
T <sub>1</sub>	0	0	16.47d
T <sub>2</sub>	80	0	19.37b
T <sub>3</sub>	0	80	19.23b
T <sub>4</sub>	80	80	20.50a
T <sub>5</sub>	130	0	19.30b

T <sub>6</sub>	0	130	17.80c
T <sub>7</sub>	130	130	20.80a

LSD value = 0.9093, Means not sharing a common letter are significantly different at 5% Level of probability.

**Table-4: Effect of different Levels of Nitrogen and Phosphorus on number of seeds head<sup>-1</sup>.**

Individual Comparison of Treatment Means

Treatment	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Mean
T <sub>1</sub>	0	0	1135f
T <sub>2</sub>	80	0	1442c
T <sub>3</sub>	0	80	1292d
T <sub>4</sub>	80	80	1489b
T <sub>5</sub>	130	0	1488b
T <sub>6</sub>	0	130	1221e
T <sub>7</sub>	130	130	1543a

LSD value = 12.2848, Means not sharing a common letter are significantly different at 5% Level of probability.

**Table-5: Effect of different Levels of Nitrogen and Phosphorus on 100 seeds weight.**

Treatment	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Means
T <sub>1</sub>	0	0	37.63b
T <sub>2</sub>	80	0	41.2a
T <sub>3</sub>	0	80	42.23a
T <sub>4</sub>	80	80	42.67a
T <sub>5</sub>	130	0	41.66a
T <sub>6</sub>	0	130	39.33ab
T <sub>7</sub>	130	130	41.87a

LSD value = 3.0545, Means not sharing a common letter are significantly different at 5% Level of probability.

### Seed Yield (t/ha<sup>-1</sup>)

Final seed yield t/ha<sup>-1</sup> is a cumulative effect of different yield components like head-1 diameter, number of seeds head<sup>-1</sup>, 100-seed weight under the influence of a particular specific set of environmental conditions (Hladni et al., 2022). The data regarding final seed yield (t/ha<sup>-1</sup>) is given in Table 6, and its analysis of variance is presented in Appendix VI. The table shows that different levels of Nitrogen and Phosphorus produced significant results. Maximum seed yield of 3.20 t/ha<sup>-1</sup> was recorded in Treatment T6, where 130 kg N t/ha<sup>-1</sup> and 130 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> were applied. But it was at par with 2.96 t/ha<sup>-1</sup> treatment T4, where Nitrogen and phosphorus were given at the rate of 80-80 kg ha<sup>-1</sup>. These results were followed by T5 and T2 giving seed yields of 2.65 and 2.62 t/ha<sup>-1</sup>, where N and P<sub>2</sub>O<sub>5</sub> were applied at the rate of 130-0 and 80-0 kg t/ha<sup>-1</sup>, respectively. Minimum seed yield of 2.05 t/ha<sup>-1</sup> was obtained at the control, which is statistically different from all other treatments. Statistically analyzed data reveal that both nitrogen and phosphorus are responsible for the maximum seed yield. Neither nitrogen nor phosphorus alone could exploit the inherent capacity of sunflower NK Armony to produce higher seed yield (Hossain et al., 2022). It also indicates that fertilizer level 80-80 NP kg t/ha<sup>-1</sup> is suitable for obtaining the maximum seed yield of sunflower. These results are in line with those narrated by Thavaprakash-N et al (2022), Ayyappan-S, and (Karam et al., 2021).

**Table-6: Effect of different Levels of Nitrogen and phosphorus on seed yield t/ha<sup>-1</sup>**

Individual Comparison of Treatments Mean

Treatments	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Means
T <sub>1</sub>	0	0	2.05 c
T <sub>2</sub>	80	0	2.62 b
T <sub>3</sub>	0	80	2.37 b
T <sub>4</sub>	80	80	2.96 a
T <sub>5</sub>	130	0	2.65 b
T <sub>6</sub>	0	130	2.38 b
T <sub>7</sub>	130	130	3.20 a

LSD value = 0.3031, Means not sharing a common letter are significantly different at 5% level of probability.

### SEED QUALITY OF SUNFLOWER

#### Seed Oil Contents (%)

The quality of sunflower seed is generally determined by its oil content, which was also the ultimate objective of our study (Nel, 2020). Different levels of nitrogen and phosphorus have a significant effect on the parameter under discussion. Minimum oil content (39.31%) was obtained in 0-0 NP control plots and was at par with T2 producing 39.42% oil content which was given 80-0 kg NP ha<sup>-1</sup>. Maximum oil in seed (44.51%) was produced in the plot treated with 130 kg N + 130 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. It was closely followed by

43.45%, where both nitrogen and phosphorus were applied at the rate of 80 kg ha<sup>-1</sup>. Again it did not differ statistically from the treatment T6 where T3 producing similar results where 0-130 and 0-80 kg NP ha<sup>-1</sup> applied. It was followed by treatment T5 showing 40.62% oil content, where 130-0 kg NP ha<sup>-1</sup> was applied. Data about the seed oil content points out that the parameter in question responds extremely to the phosphorus fertilizer with nitrogen (Ebrahimian et al., 2019). Phosphorus is involved in the synthesis of fatty acids (Gopal, 2014). Table 7 also explains that phosphorus, in combination with nitrogen or alone, increases the oil contents of the seed, but nitrogen alone decreases them. Results obtained were supported by those of Mojiri-A Azrani-A (2019), Bikas-Mandal, and H. C. Harris et al., 2021)

**Table-7: Effect of different Levels of Nitrogen and phosphorus on seed oil contents (%)**

Individual comparison of treatments means

Treatments	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	Means
T <sub>1</sub>	0	0	39.31d
T <sub>2</sub>	80	0	39.42d
T <sub>3</sub>	0	80	43.25b
T <sub>4</sub>	80	80	43.45b
T <sub>5</sub>	130	0	40.62c
T <sub>6</sub>	0	130	43.38b
T <sub>7</sub>	130	130	44.51a

LSD value = 1.0178, Means not sharing a common letter are significantly different at 5% level of probability.

## CONCLUSIONS

It is concluded from the above results that 80 kg N + 80 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> is the optimum dose for obtaining maximum seed yield ha<sup>-1</sup> of sunflower NK-Armony. Under the agroclimatic conditions of GB. (District Diامر Goner farm). 130 kg N + 130 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> is a suitable dose for having maximum oil contents from sunflower NK-Armony.

## RECOMMENDATIONS

Sunflower NK-Armony can be successfully grown in GB (District Diامر Goner farm) due to its best adaptation to local conditions as compared to other varieties. Further experimentation, including more details on fertilization, is required.

**APPENDICES**

**APPENDIX-1**

**Plant Height (cm)**

Analysis of Variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	1.030	0.515	1.4656	0.2695
Treatments	6	1623.753	270.625	770.3164	0.000
Error	12	4.216	0.351		
Total	20	1628.999			

Coefficient of variation = 0.35%

**APPENDIX-2**

**Number of Leaves plant<sup>-1</sup>**

Analysis of Variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	22.397	11.199	3.5814	0.0603
Treatments	6	11.516	1.919	0.6138	
Error	12	37.523	3.127		
Total	20	71.436			

Coefficient of variation = 6.31%

**APPENDIX-3**

**Head diameter (cm)**

Analysis of Variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	1.032	0.516	1.9805	0.1806
Treatments	6	40.787	6.798	26.0816	0.0000

Error	12	3.128	0.261		
Total	20	44.947			

Coefficient of variation = 2.68%

#### **APPENDIX-4**

##### **Number of seeds Head<sup>-1</sup>**

Analysis of variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	57.505	28.753	0.6036	
Treatments	6	439453.441	73242.240	1537.6024	0.000
Error	12	571.609	47.634		
Total	20	4400082.555			

Coefficient of variation = 0.50%

#### **APPENDIX-5**

##### **100-seed weight (g)**

Analysis of variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	14.903	7.412	2.5298	0.1211
Treatments	6	60.025	10.004	3.3965	0.0339
Error	12	35.346	2.945		
Total	20	110.274			

Coefficient of variation = 4.19%

#### **APPENDIX-6**

##### **Seed yield (tha<sup>-1</sup>)**

Analysis of variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
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Replication	2	0.010	0.005	0.1798	
Treatments	6	2.689	0.448	15.3667	0.0001
Error	12	0.350	0.029		
Total	20	3.049			

Coefficient of variation = 6.56%

#### APPENDIX - 7

##### Seed Oil Contents (%)

Analysis of Variance

S.O.V.	D.F	S.S	M.S	F-value	Prob
Replication	2	0.538	0.269	0.8210	
Treatments	6	82.998	13.833	42.2469	0.000
Error	12	3.929	0.327		
Total	20	87.464			

Coefficient of variation = 1.36%

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