Effect of Nitrogen and Phosphorus Fertilizer Rates on Growth, Yield and Yield Components of Sunflower Varieties

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Abstract
The experiment was carried out for two successive years (2017 and 2018) at to evaluate the effect of different levels of phosphorus and nitrogen fertilizer application on yield and yield components of sunflower. One released variety Oissa and two pipe lines Adadi-1 and NK ferti; five fertilizer rates (F1= No fertilizer, F2= 11.5 kg N/ha & 11.5 P2O5 kg/ha, F3= 23 kg N/ha & 23 kg P2O5/ha), F4= 34.5 kg N/ha & 34.5 kg P2O5/ha and F5= 46 kg N/ha & 46 kg P2O5/ha) were arranged in RCBD with factorial combination and three replication. The main effect of fertilizer rate significantly affected all yield and yield related traits except seed oil content at both locations. Oissa have almost the same seed yield response both sites with an average seed yield of 1653 kg/ha and 1641 kg/ha respectively. The partial analysis result showed out of the five tasted fertilizer rates application of 34.5 kg N/ha and 34.5 kg P2O5/ha becomes profitable than others and can be recommended for sunflower production. This preferable fertilizer rate record high net benefit for all varieties but it needs a variety preference for locations. Using the same fertilizer rate, Adadi 1 and 'Nk fert' varieties gave high seed yield at Adadi than Holetta sites.

Keywords: sunflower, variety, fertilizer rate, seed yield, seed oil

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INTRODUCTION
Sunflower (Helianthus annuus L.) is a member of the family composite. Sunflower is an important oilseed crop which ranks third after soybean and peanut along with other oil seed crops like (canola, and cotton) which contributes considerably to edible oil in the world (Thavaprakash et al., 2002). Evidences suggested that sunflower was introduced to the North Horn of Africa including Ethiopia by the Italians some 160 years ago. Although the crop is not widely grown in Ethiopia, the country has immense potential for sunflower production. The current demand of sunflower for edible oil both locally and abroad raises the growing interest of private farmers to produce the crop. In oil seed crops, quality criteria are fatty acid composition of the seed oil and the intended use of the oil. Polyunsaturated cooking oils have been the driving force for the sunflower industry. The oleic acid (a monounsaturated fatty acid) content of oil seeds has important implications for product preference and consumer health. High oleic varieties have provided the opportunity for repositioning sunflower products at the premium end of the growing monounsaturated market. Sunflower oil is gaining popularity in European and East Asian countries for salad and cooking oil and margarine production, which are based on oil composition and the absence of cholesterol. Ryland (2003) compared different vegetable oils and found that sunflower oil to be the healthiest due to its high oleic acid content. Sunflower can improve edible oil production due to its high oil contents and wide adaptability to soils and climatic conditions. Abbadi and Gerendas (2009) noted that optimal supply of N fertilizer in sunflower result in grain yield more efficiently than low supply of Nitrogen. Regina (2008) concluded that Nitrogen is the most important element to increase grain protein content. Increasing Nitrogen rates reduced seed oil percentages but increased seed yields and consequently increased oil yield per unit area (Zheljazkov et al., 2009). The importance of supplemental Phosphorus fertilizer in enhancing sunflower yield has been well documented (Muralidharudu et al., 2003). Because further increases in yield (flower diameter) diminish with further increases in the amount of Fertilizer Phosphorus beyond 60kg/ha, the efficiency of nutrient utilization declines as yield increases (Muralidharudu et al., 2003). Therefore, the aim of this study was to evaluate the effect of different levels of phosphorus and nitrogen fertilizer application on yield and yield components of sunflower in order to achieve the optimum use of resources.

MATERIALS AND METHODS
The experiment was conducted for two years (2017 - 2018 in main cropping seasons) at Holeta main research station and Adadi sub center. Holeta is located between 09° 03’ N latitude and 38° 3 0’ E longitude, 29 km west of Addis Ababa, at an altitude of about 2400 m above sea level. The long- term average annual rainfall is 1144 mm, about 85% of which is received from June to September with the remainder from January to May. The average minimum and maximum air temperatures are 6.2°C and 22.1°C respectively. Adadi site is 67 km away from Addis Ababa on the road to Butajira. It is located at 08° 038’ N and 38° 3 0’ E with an altitude 2050 meters above sea levels and with an average annual rain fall of 900 mm. Soil of Adadi area is characterized as Eutric Luvisol with organic carbon (1.16%), Total nitrogen (0.15%), phosphorus (8.7ppm), and pH (6.32) (Gemechu, 2007). Simple
The experiment was laid in a randomized complete block design with three replications. The treatments were a factorial combination of three varieties: one released variety Oissa and two pipeline varieties (Adadi-1 and NK ferti) and five fertilizer rates (F1 = no fertilizer, F2 = 11.5 kg N/ha & 11.5 kg P<sub>2</sub>O<sub>5</sub>/ha, F3 = 23 kg N/ha & 23 kg P<sub>2</sub>O<sub>5</sub>/ha, F4 = 34.5 kg N/ha & 34.5 kg P<sub>2</sub>O<sub>5</sub>/ha and F5 = 46 kg N/ha & 46 kg P<sub>2</sub>O<sub>5</sub>/ha). A gross plot size of 2m width and 3m long was used. The seedbed was plowed well before planting. Spacing used for the sunflower varieties was 75cm between rows and 25cm between plants. Urea and NPS were used as sources of N and P.

Partial budget analysis was done to identify the profitable treatment. The main effect of fertilizer rates significantly affected all yield and yield-related parameters except seed oil content at both locations. Interaction effect of sunflower varieties and fertilizer rates affected grain yield only but any of other parameters tasted were significantly affected interaction effect at both locations (Table 2 and Table 3). As fertilizer rates increase plant height and head diameter shows an increment. Hiray et al. (1992) also reported

### RESULTS AND DISCUSSION

The soil of the experimental area at Holeta site was characterized as slightly acidic pH (5.06) with low total nitrogen content (0.115%) and available P (8.287 ppm) and with organic matter content of (2.41%). But the Adadi site soil has pH = 7.76, a total nitrogen content of 0.11%, available P of (9.7 ppm) and organic matter content of 2.1%. The current research result was indicated that year effect was significant to alter most of the parameters tasted as there was a rain shortage occurred in the second year of the experiment. The two-year data analysis of variance indicated that all parameters tasted (plant height, head diameter, grain yield and seed oil content) were significantly different for different varieties tasted (Table 1).

### Table 1. Main Effects of fertilizer rates and varieties on yield and yield parameters of sunflower (2017-2018)

| Factors                  | Parameters tasted | Holeta           | Adadi            |
|--------------------------|-------------------|------------------|------------------|
|                          | Plant height(cm)  | Head diameter (cm) | Oil content (%) | Plant height(cm) | Head diameter (cm) | Oil content (%) |
| Year                     |                   |                  |                  |                  |                  |                |
| 2017                     | 213.84a           | 18.87a           | 30.26a           | 230.37a          | 18.12a           | 32.08b          |
| 2018                     | 177.17b           | 15.99b           | 24.4b            | 194.92b          | 17b              | 35.9a           |
| LSD(0.05)                | 9.53              | 0.66             | 1.945            | 10.26            | 0.509            | 1.55            |
| Varieties                |                   |                  |                  |                  |                  |                |
| Oissa                    | 218.1a            | 18.5a            | 32.64a           | 237.1a           | 19.12a           | 37.5a           |
| Adadi 1                  | 204.7b            | 18.3a            | 29.72b           | 225.4a           | 18.77a           | 36.6a           |
| NK ferti                 | 163.6c            | 15.39b           | 19.7c            | 175.4b           | 14.8b            | 27.7b           |
| LSD(0.05)                | 11.67             | 0.81             | 2.38             | 12.56            | 0.623            | 1.9             |
| Fertilizer Rate(kg N/ha & kgP<sub>2</sub>O<sub>5</sub>/ha) |                   |                  |                  |                  |                  |                |
| F1 = No fertilizer       | 177.8e            | 15.2c            | 27.57g           | 197.8c           | 15.5d            | 34.57a          |
| F2 = 11.5 kg N/ha & 11.5 kgP<sub>2</sub>O<sub>5</sub>/ha | 184.9bc           | 16.52b           | 29.21a           | 197.8c           | 17.07c           | 34.32a          |
| F3 = 23 kg N/ha & 23 kgP<sub>2</sub>O<sub>5</sub>/ha | 196.9ab           | 18.13a           | 26.6a            | 216.7b           | 17.72bc          | 34.03a          |
| F4 = 34.5 kg N/ha & 34.5 kgP<sub>2</sub>O<sub>5</sub>/ha | 209.04a           | 18.62a           | 26.35a           | 217.8ab          | 18.22b           | 33.08a          |
| F5 = 46 kg N/ha & 46 kgP<sub>2</sub>O<sub>5</sub>/ha | 208.7a            | 18.7a            | 27.0a            | 233.5a           | 19.3a            | 33.0a           |
| LSD(0.05)                | 15.07             | 1.048            | 3.07             | 16.22            | 0.805            | 2.45            |
| CV(%)                    | 11.55             | 9                | 16.85            | 11.43            | 6.86             | 10.82           |

Means followed by the same letter within a table are not significantly different at 5% level of significance.

The main effect of fertilizer rate significantly affects all yield and yield-related parameters tasted except seed oil content at both locations. Interaction effect of sunflower varieties and fertilizer rates affect grain yield only but any of other parameters tasted were significantly affected interaction effect at both locations (Table 2 and Table 3). As fertilizer rates increase plant height and head diameter shows an increment. Hiray et al. (1992) also reported
significant increase in all yield contributing characters with increase in dose of nitrogen to sunflower up to 80 kg N ha\(^{-1}\). The importance of Phosphorus fertilizer in enhancing sunflower yield has been also well documented by Muralidharudu et al., 2003. Similarly Akhtar et al. (1992) reported that N application increased plant height, head diameter, number of seeds per head and seed yield and this could be due to the positive effect of N in stimulating vegetative growth, root growth and better absorption of other nutrients (Ali et al., 2004).

**Table 2.** Interaction effect of fertilizer rates and variety on seed yield (kg/ha) of sunflower at Holeta site (2017-2018)

| Variety | F1(0) | F2(11.5) | F3 (23) | F4(34.5) | F5(46) | Mean |
|---------|-------|----------|---------|----------|--------|------|
| Oissa   | 968f  | 1518d    | 1793bc  | 2036a    | 1951ab | 1653 |
| Adadi 1 | 818fg | 1234e    | 1542d   | 1593cd   | 1608cd | 1359 |
| NK fert | 383h  | 611g     | 744g    | 732g     | 713g   | 637  |

| Mean    | 1216  |
| LSD(0.05) | 210.9 |
| CV(%)   | 15    |

**Table 3.** Interaction effect of fertilizer rates and variety on seed yield (kg/ha) of sunflower at Adadi site (2017-2018)

| Variety | F1(0) | F2(11.5) | F3 (23) | F4(34.5) | F5(46) | Mean |
|---------|-------|----------|---------|----------|--------|------|
| Oissa   | 829cd | 1495b    | 1870.6a | 2008a    | 2004a  | 1641 |
| Adadi 1 | 752cde| 1537b    | 2007a   | 2179a    | 1908a  | 1677 |
| NK fert | 470e  | 714de    | 944cd   | 1030c    | 989cd  | 829  |

| Mean    | 1382  |
| LSD(0.05) | 276.6 |
| CV(%)   | 17.3  |

All varieties tasted have different average yield response at different locations except the variety named 'Oissa'. Oissa have almost the same performance and seed yield response both at Holeta and Adadi sites with an average seed yield of 1653kg/ha and 1641kg/ha respectively. But the rest two pipe line varieties: 'Adadi 1' and 'NK fert' recorded high average seed yield at Adadi site than Holeta site based on the tables above (Table 2 and Table 3). The analysis of variance indicated that statistically there is a significant seed yield difference observed due to the interaction effect of varieties and fertilizer rates tasted. Partial economic analysis was also done for the profitability test of the fertilizer rates to be recommended is indicated below.

**Table 4.** Partial budget Analysis for fertilizer application

| Treatments | Location | Holeta | Adadi |
|------------|----------|--------|-------|
|            | Fertilizer rate (kg N/ha) | TVC (Birr/ha) | Gross profit (Birr/ha) | Net benefit (Birr/ha) | Adjusted GY (kg/ha) | TVC (Birr/ha) | Gross profit (Birr/ha) | Net benefit (Birr/ha) |
|            | kg N/ha=kg P\(_2\)O\(_5\)/ha |            |                    |                  |                   |            |                    |                  |
| 1 Oissa    | 0 + 0 | 967.6 | 0 | 19352 | 19352 | 828.5 | 0 | 16570 | 16570 |
| 2 Oissa    | 11.5 + 1.5 | 1518.5 | 242 | 30370 | 30128 | 1494.9 | 242 | 29898 | 29656 |
| 3 Oissa    | 23 + 23 | 1792.6 | 1084 | 35852 | 34768 | 1870.5 | 1084 | 37410 | 36326 |
| 4 Oissa    | 34.5 + 34.5 | 2036.5 | 1611 | 40730 | 39119 | 2007.6 | 1611 | 40152 | 38541 |
| 5 Oissa    | 69 + 69 | 1951.4 | 2148 | 39028 | 36880 | 2004.1 | 2148 | 40082 | 37934 |
| 6 Adadi 1  | 11.5 + 1.5 | 1234.2 | 242 | 24684 | 24442 | 1537.07 | 242 | 30741.4 | 30499.4 |
| 7 Adadi 1  | 23 + 23 | 1542.1 | 1084 | 30842 | 29758 | 2007.3 | 1084 | 40146 | 39062 |
| 8 Adadi 1  | 34.5 + 34.5 | 1593.02 | 1611 | 31860.4 | 30249.4 | 2179.2 | 1611 | 43584 | 41973 |
| 9 Adadi 1  | 69 + 69 | 1607.7 | 2148 | 32154 | 30006 | 1907.5 | 2148 | 38150 | 36002 |
| 10 NK fert | 0 + 0 | 383.19 | 0 | 7663.8 | 7663.8 | 470.1 | 0 | 9402 | 9402 |
| 11 NK fert | 11.5 + 11.5 | 610.6 | 242 | 12212 | 11970 | 713.6 | 242 | 14272 | 14030 |
| 12 NK fert | 23 + 23 | 743.28 | 1084 | 14876 | 13792 | 944.4 | 1084 | 15888 | 17804 |
| 13 NK fert | 34.5 + 34.5 | 731.8 | 1611 | 14636 | 13025 | 1029.73 | 1611 | 20041.4 | 18938.6 |
| 14 NK fert | 69 + 69 | 713.15 | 2148 | 14263 | 12115 | 989.09 | 2148 | 19781.8 | 17633.8 |

Where, price of sunflower grain per 100 kg=2000 birr, the price of 100 kg Urea=1193Birr and the price of 100 kg NPS=1322 Birr was considered.

According to the partial budget analysis, out of the five tasted fertilizer rates application of 34.5 kg N/ha and 34.5 kg P\(_2\)O\(_5\)/ha (F4) becomes profitable than others and can be recommended for sun flower production at the study area due to the fact that it gave the highest net benefit (Table 4). This preferable fertilizer rate record high net benefit for all varieties but it needs a variety preference for locations. Using the same fertilizer rate, Adadi 1 and 'NK fert' varieties gave high seed yield at Adadi than Holeta (Table 4).
CONCLUSION
This field experiment was carried out for two years to study the fertilizer requirements of three sunflower varieties. Based on the statistical analysis, all parameters tasted (plant height, Head diameter, grain yield and seed oil content) were significantly different for different varieties tasted. The main effect of fertilizer rate significantly affect all yield and yield related parameters tasted except seed oil content at both sites. According to the statistical analysis and partial budget analysis, out of the five tasted fertilizer rates application of 34.5 kg N/ha and 34.5 kg P_{2}O_{5}/ha becomes profitable than others and can be recommended for sun flower production at the study area due to the fact that it gave the highest net benefit. Besides, it is recommended that this experiment would be further confirmed in other areas and soil types for sunflower production in general.

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