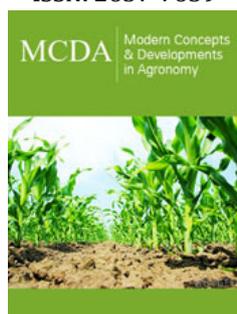


# Performance of Sesame (*Sesamum indicum* L.) Under Different Supplementary Irrigation and Nitrogen Fertilizer Levels in Humera, Northern Ethiopia

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## Abstract

Field experiment was conducted in Humera in 2015 main cropping season in a factorial randomized complete block design (RCBD) to study the performance of sesame under different supplementary irrigation applications and nitrogen fertilizer rates. The study consists of four levels of nitrogen fertilizer rates (0kg N<sub>2</sub>/ha, 23kgN<sub>2</sub>/ha, 37.5kgN<sub>2</sub>/ha and 46kgN<sub>2</sub>/ha) and three levels of supplementary irrigation; rain-fed (I<sub>0</sub>), four irrigations (I<sub>4</sub>), and six irrigations (I<sub>6</sub>). Nitrogen fertilizer was applied in two splits, with the first half at sowing and the remaining half 30 days after emergence. Data on plant height, number of capsules per plant, number of seeds per capsule, thousand seed weight, harvest index, aboveground biomass and grain yield were recorded. The analysis of variance (ANOVA), indicated that application of nitrogen fertilizer significantly ( $p < 0.05$ ) affected sesame grain yield. The highest grain yield 423.4kg/ha, and 455kg/ha was obtained from application of 46kg nitrogen per hectare, and six supplementary irrigation. The results obtained in this experiment showed that, application of supplementary irrigation could be an important climate change adaptation strategy in areas where onset and cessation of rainfall occur.

**Keywords:** Sesame; Nitrogen fertilizer; Supplementary irrigation Grain yield; Humera

## Introduction

Sesame (*Sesamum indicum* L., 2n=26) is the most ancient oilseed crop known and used by man [1]. It is the most important oilseed crop in Ethiopia. Sesame belongs to the *Pedaliaceae* family, which is adapted to hot areas [1] (Thakur, 1975). It is annual plant with broad leaves 2.5-5cm long, white, bell shaped inflorescence, with seeds of white, yellow, brown or black color [2]. It has a nickname 'Queen of oil seeds' due to its high quality polyunsaturated stable fatty acid. The stability of its oil is related to the polyunsaturated fatty acids reducing oxidative rancidity [1] (Balasubramanian & Palaniappal, 2011) and the presence of natural antioxidants sesamol and sesamolinal [3]. Sesame is produced as a cash crop. It can be used for home consumption, but in addition to its oil for food, its byproduct oil cake, is an important animal feed. In Ethiopia, farmers used to burn the stalk after threshing, recently it is becoming an important raw material for different industrial purposes. Sudan is the major sesame producer in Africa followed by Nigeria, Somalia, Uganda and Ethiopia. In Ethiopia, sesame is very expensive, especially, due to its demand as a cash crop, for food and animal feed when compared with other oil crops. Sesame, sunflower, safflower, linseed and Niger seed are the most common oilseed crops in Ethiopia. Sesame is the second most agricultural export commodity in Ethiopia, next to coffee in annual export earning contributing about 14% of the total world export (Monitor Group 2012). Due to the increase in price, production of sesame is increasing in Ethiopia. Ethiopia's export share 1.5% in volume and 1.9% in value to the World market in 1997, had grown to 8.9% and 8.3% in 2004 respectively [4]. The total sesame production cultivated area and productivity in Ethiopia during 2012 was 337,505 ha, 44,783tons and 0.73ton/ha respectively (FAOSTAT, 2013).

The major challenges in sesame production are susceptibility to biotic and abiotic stresses, likes insect pests and diseases; drought and soil fertility respectively [5]. Likewise, sesame productivity is very low in Ethiopia due to traditional production technology such as

broadcasting, poor soil fertility management, recurrent droughts, erratic rainfall, and water logging, and harvesting and postharvest losses. However, there are efforts by several stakeholders, farmers, investors and government bodies to improve its productivity and marketability. Sesame Business Network (SBN), a non-governmental organization for sesame initiative, developed 20 productivity enhancing packages [6]. Among the several the several factors affecting sesame productivity, fertilizer application has been causing a considerable impact on the growth and productivity of the crop. Field experiments have shown that sesame growth and productivity has improved with proper application of nitrogen fertilizer [7,8] in Ethiopia.

In this regard, sesame production has been doubled in the past five years, with potential interest to improve production and productivity, and expanding production and commercialization through modern sesame farming. However, it is important to study the crop improvement and yield enhancement strategies under the existing climatic conditions, improved management practices in the area for improved sesame production and productivity. In arid and semi-arid areas, soil moisture and poor soil nutrient affect crop growth and productivity. Water has been always the most limiting factor [9]. The irregular rainfall pattern, where onset and cessation of rain are not predictable, crop growth and productivity are affected, especially, when soil moisture stress occur at crop critical growth stages. Rainfall variability; late onset and early cessation of rainfall is a recurrent phenomenon in the Humera. Therefore, field experiment was conducted to the performance of sesame under supplementary irrigation and different nitrogen fertilizer rates.

## Materials and Research Methodology

### Description of the Study Area

This experiment was conducted in Western Tigray, in Kafta-Humara Woreda which is located 14.263146N latitude and 36.627184E longitude; with altitude ranging from 560 to 1849 meter above sea level and land comprising of flat, undulating mountains, hills and valleys (Haile, 2007). The study site is classified as hot-warm semi-arid climate with temperature rising up to 42 °C from April to June and declines 25-35 °C from late June to February. The average maximum and minimum temperature of the area is 37 and 20 °C respectively; and the annual average precipitation is 400-650mm (NMA 2014). The textural class of the experimental site was clay type soil. The soil pH of the soil ranges from 8.77 to 9.11 from top to the bottom of the top 60cm of the soil.

**Table 1:** Growth parameters of sesame.

Treatment	PH	No. Capsules Per Plant	No. Branches Per Plant
0kg/ha	69.31a	20.38a	1.43a
23kg/ha	71.44a	22.43a	1.58a
37.5kg/ha	69.53a	22.13a	1.60a
46kg/ha	74.49a	22.31a	1.60a
Cv (%)	6.43		

## Experimental design and procedures

Field experiment was conducted in 2015 main cropping seasons. The experiment was laid out in Randomized Complete Block Design (RCBD). Each treatment was replicated three times. The spacing between blocks was 1.5m and 1m between treatments. There were four nitrogen fertilizer rates; 0kg/ha, 23kg/ha, 37.5kg/ha and 46kg N<sub>2</sub>/ha). Setit-1 was used as a test crop in with spacing 40cm between rows and 10cm between plants. There were three levels of supplementary irrigation; rain-fed (I<sub>0</sub>), four irrigation (I<sub>4</sub>) and six irrigation (I<sub>6</sub>) applications.

## Fertilizer and irrigation application

Nitrogen fertilizer was applied in the form of Urea (46-0-0) at two splits, first half was applied during sowing, and the second half was applied 30 DAE. After preparing the field for sowing, seeds were sowing by drilling on rows 40cm apart. Thinning out was carried out after sesame seedlings grow two to three true leaves to keep spacing between plants 10cm. Irrigation scheduling and crop water requirement were calculated using the FAO CROPWAT8. Irrigation time was adjusted to be at critical depletion with irrigation application as 'refill to Field Capacity'.

## Data collection and analysis

Soil samples were collected. soil physical and chemical properties were analyzed before sowing. Plant height, number capsules per plant, harvest index (%), aboveground biomass (kg/ha) and grain yield (kg/ha) were recorded. Five plants were taken randomly to record plant height, number of primary branches, number of capsules per plant. Data collected from different treatments were subjected to analysis of variance (ANOVA). Mean comparison ( $p < 0.05$ ) of each parameter was carried out using SAS 9.0 software. Harvest index was computed as the ratio of grain yield to aboveground biomass.

## Result and Discussion

Mean comparisons for plant height, fruit bearing zone, number of capsules per plant, number of seeds per capsule, thousand grain weight, aboveground biomass, harvest index and grain yield of sesame are presented in Table 1 and Table 2. The ANOVA revealed that there was no interaction effect between supplementary irrigation and nitrogen fertilizer rate. Therefore, results on different crop parameters are presented separately as main effects.

I0	68.87a	22.85a	1.38a
I4	71.93a	21.85a	1.6a
I6	72.80a	20.74a	1.67a
Cv (%)	6.43		

PH, plant height; Cv, coefficient of variation; means with same letter are not significantly different.

**Table 2:** Yield and yield components of sesame under different SI and nitrogen fertilizer levels.

Trt	Grain Yield (Kg/ha)	No. Grains Per Capsule	Aboveground Biomass (kg/ha)	Harvest Index (%)
0kg/ha	309b	42.94a	629.8a	0.55a
23kg/ha	285.2b	48.13a	697.6ab	0.44a
37.5kg/ha	388.7a	46.64a	724.2ab	0.57a
46kg/ha	423.4a	46.16a	920.7b	0.47a
Cv (%)	21.02	9.85	26.37	
I0	272.8a	44.62a	587.2a	0.53a
I4	329.6a	46.29a	797ab	0.45a
I6	455.4b	44.25a	845.1b	0.55a
Cv (%)	21.02	9.85	26.37	

Means connected with same letter are not significantly different ( $p < 0.05$ ).

### Plant height

Application of nitrogen fertilizer and supplementary irrigation did not significantly affected sesame plant height. The highest plant height 74.49cm and 72.8cm was obtained from application of 46kg N<sub>2</sub>/ha and six supplementary irrigation respectively. Whereas, the smallest plant height 68.8cm was recorded from the control (rain-fed treatment). Results obtained in this experiment are similar to the findings reported by Malik et al. [10], showed that sesame plant height increased from 127.48cm to 136.37cm with increasing nitrogen fertilizer levels 0kg N/ha to 80kg N/ha respectively. Similarly, Haruna [11] reported that sesame plant height increased from 85.48cm to 116.73cm with increasing nitrogen fertilizer rates from 0kg to 100kg N/ha respectively. Sesame plant height increased 72.09, 91.5 and 112.2cm, with increasing nitrogen fertilizer rates 0kg, 40kg and 60kg N/ha respectively, while decreasing at 100kg N/ha [12]; which enriches the evidence observed in this experiment.

### Number of capsules per plant

The highest number of capsules per plant 31.56 recorded from Humera-1 was significantly different ( $p < 0.05$ ) from the smallest number of capsules per plant 24.25 recorded from Setit-1; however, number of capsules 27.62 recorded from Setit-2 was not significantly different ( $p < 0.05$ ) from the number of capsules obtained from Setit-1. Shehu et al. [13], stated that number of capsules per plant was affected by application of nitrogen fertilizer rates, which number of capsules increased from 19.78 to 29.37 with increasing nitrogen fertilizer rates from 0kg to 75kg/ha. Number of capsules per plant reported by Malik et al. [10], 88.55, 92.5 and 97.88 capsules per plant obtained from application of 0kg, 40kg

and 80kg N/ha; which are higher than the results presented in this experiment, probably due to agro-ecological and genetic factors. Haruna [11] reported that highest number of capsules per plant 83.80 was recorded from application of 50kg N/ha, which higher than the results obtained in this experiment [14-16].

### Grain yield

However, there was no significant difference ( $p < 0.05$ ) on grain yield obtained from 23 and 46kg N/ha, and 46kg and 69kg N/ha. Similarly, there was no significant difference ( $p < 0.05$ ) on grain yield among the three sesame varieties [17-19]. The average grain yield recorded from Setit-1, Setit-2 and Humera-1 was 1124.2, 1099.5 and 1424.0kg/ha respectively. According to Mekonnen et al. [8], the highest sesame grain yield was recorded from Barsan 2.08 ton/ha through application of 46kg N/ha, which is slightly higher than the maximum grain yield obtained from Setit-1 through application of 46kg N/ha. Field experiment reported by Mekonnen et al. [8] indicated that thousand grain weight of sesame varieties (Adi, Barsan and Mehado-80) was increasing with increasing nitrogen fertilizer up to 69kg N/ha; while decreasing with 92kg N/ha. according to Mekonnen et al. [8], the smallest thousand grain weight 2.23g obtained from Adi with application of 0kg N/ha, and the highest thousand grain weight 4.23g recorded from Barsan with application of 46kg N/ha. According to Malik et al. [10], thousand grain weight increased with increasing nitrogen fertilizer, which highest thousand grain weight 3.42gram recorded from application of 80kg N/ha was significantly ( $p < 0.05$ ) higher than the lowest thousand grain weight obtained from the control (0kg N/ha) is similar to the results obtained in this experiment.

## Aboveground biomass (kg/ha)

Aboveground biomass was relatively higher in 2016 than the aboveground biomass obtained in 2017 from the same nitrogen levels (0, 23 and 46kg/ha) and same variety (Setit-1); which might be due to the higher rainfall (distribution and amount) in 2016. Aboveground biomass reported by Mekonnen et al. [8] recorded from three sesame varieties (Adi, Barsan and mehado-80) of same nitrogen fertilizer rates (0, 23 and 46kg N/ha) were higher than the results obtained in these experiments with increasing trend with increasing nitrogen fertilizer rates.

## Harvest index

In this experiment, sesame harvest index was not significantly ( $p < 0.05$ ) affected by application of nitrogen and supplementary irrigation. Sesame harvest indices ranging 27% to 50% in these field experiments are relatively higher the harvest index reported by Mekonnen et al. [8] from field experiment conducted in Gode in Somalia Eastern Ethiopia, under irrigation conditions.

## Conclusion

Sesame grain yield and aboveground biomass were significantly ( $p < 0.05$ ) affected by application of nitrogen fertilizer and supplementary irrigation. The highest grain yield 455kg/ha was obtained from application six supplementary irrigation applications; followed by 423.4kg/ha from application of 46kg nitrogen per hectare. From this experiment, it can be concluded that application of supplementary irrigation can be an important climate change adaptation strategy in areas where late onset and early cessation of rain occur. Besides, application of nitrogen fertilizer under rain-fed condition, accompanied with supplementary irrigation improved sesame productivity.

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