

Growth, Yield and Yield Component of Sesame (*Sesamum indicum* L.) as Affected by Timing of Nitrogen Application

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Abstract

Sesame is an important cash crop and plays vital role in the livelihood of many people in Ethiopia. Nitrogen plays a key role in sesame production and it is required in large amount by any crop more than any mineral nutrient. Nitrogen timing is important crop management practices for improving N use efficiency and crop yields. Field experiment was conducted in northern Ethiopia during the rainy season of 2012 with the objective to evaluate the yield and yield response of sesame to nitrogen fertilizer application timings. The experiment was laid out in a randomized complete block design with three replications. Treatments consisted of nine nitrogen application timings viz. 100% of the recommended dose at planting time (T_1), 100% of the recommended dose at first branching stage (T_2), 100% of the recommended dose at early flower initiation (T_3), 100% of the recommended dose at early pod setting (T_4), 50% of the recommended dose at planting time and 50% of the recommended dose at first branching stage (T_5), 50% of the recommended dose at planting time and 50% of the recommended dose at early flower initiation (T_6), 50% of the recommended dose at planting time and 50% of the recommended dose at early pod setting (T_7), 50% of the recommended dose at first branching stage and 50% of the recommended dose at early flower initiation (T_8), 50% of the recommended at first branching stage and 50% of the recommended at early pod setting (T_9). Results revealed that number of branches per plant, plant height, length of capsule bearing zone, number of capsules per plant and seed yield were significantly ($p < 0.05$) influenced by different time of nitrogen application treatments. The maximum values of the parameters, except grain yield, were obtained from T_5 application timing. At the same time, the highest sesame seed yield per hectare was obtained from T_8 application timings.

Keywords: Sesame, *Sesamum indicum* L., nitrogen fertilizer, Nitrogen application timings, seed yield,

Introduction

Ethiopia has a predominantly agricultural economy. This particular sector signifies the growth of all other sectors and consequently, a positive aspect of the whole national economy. It is still the main source of foreign exchange earnings and the largest labor force employer sector. Oilseeds are high value export products standing as the second foreign exchange earner products in Ethiopia. (Abera, 2011). This sector is one of Ethiopia's fastest growing and important sectors, both in terms of its foreign exchange earnings and as a main source of income for over three million Ethiopians (Wijnands, 2009). Oil seeds occupy 6.66 % (about 818,449.30 hectares) of the grain crop area and 3.14% of the production to the national grain total (CSA, 2013). According to CSA (2013) report noug, sesame and linseed cover 2.47% (about 303,627.70 hectares), 1.95% (about 239,532.34 hectares) and 1.04% (about 127,883.03 hectares) of the grain crop area and 0.92% (about 2,124,155.39 quintals), 0.78 % (about 1,813,760.51 quintals) and 0.53% (about 1,220,643.34 quintals) of the grain total, respectively. Cognizant of this, growth and improvement of the oilseed sector can substantially contribute to the economic development at national, regional and family levels.

Among oil seeds, however, sesame (*Sesamum indicum* L.), also known by the local names *Selet* and *Simsim* in Ethiopia, is by far the major export produce in terms of both export quantity and value after coffee. Sesame belongs to the family of Pedaliaceae. Its seed contains approximately 50% oil and 25% protein (Burden, 2005). Worldwide production of sesame is estimated at 3.09 million tones predominantly from Asia and Africa with an average yield of 471.2kg ha⁻¹. Ethiopia ranks sixth among the major sesame producer after Indian, China, Myanmar, Sudan and Uganda contributing 4.7% share to the world production (FAO, 2004).

Ethiopia is debatably believed to be the center of origin and diversity of sesame. This country has high quality sesame seed varieties that are suitable for a wide range of applications, the Humera, Gondar and Wellega types being the major ones (Zerihun 2012). Sesame is an ancient oil crop supplying seeds for confectionery purposes, edible oil, paste, and cake (Weiss, 1983). However, in Ethiopia, sesame is primarily grown as a cash crop in the Northwest and Western lowland areas of the country. Production statistics of sesame indicate a steady increase in area of production due to its appreciable price in domestic and foreign markets while the yield remained static or declining (CSA, 2012). The reason for low productivity is that, poor crop management practices, no or limited use of inputs, monocropping, and non-availability of good varieties with resistance to biotic and abiotic stresses.

Even though sesame is considered as a low nutrient feeder, organic and inorganic fertilizer application showed yield increment compared to untreated plots (Umar et al. 2012 and Haruna. 2011). Shehu et al. (2010)

recommend NPK fertilizer at a rate of 75 kg N, 45 kg P₂O₅ and 22.5 kg K₂O ha⁻¹ for highest net return in sesame production. Among the nutrients required by plants, nitrogen is taken in large amount by every crop. As a result, nitrogen is the most frequently and widely applied inorganic nutrient in many crops including sesame. Unfortunately, the nitrogen added is not used efficiently and large losses can occur. Nitrogen may be lost by ammonia volatilization during nitrification, denitrification, downward leaching and lost by runoff. Many methods have been recommended for improving the efficiency of fertilizer nitrogen, including selecting plants with high nitrogen efficiency, improving fertilizer management, and developing more efficient fertilizers. From the management practices, synchronization of crop nutrient demand and time of fertilizer application is largely important. The importance of split nitrogen application on different crops was reported by many authors. Arefaine (2013) reported that application of 69 kg nitrogen ha⁻¹ at two equal splits (1/2 dose at sowing + 1/2 at tillering) on tef crop produced high grain and straw yields. According to Mohammad et al (2011), split application of nitrogen during tillering and boot stages increased grain yield of wheat, significantly. Nemati and Sharifi (2012) also reported the significant effect of N application timing on qualitative and quantitative yield, agronomic characteristics and nitrogen use efficiency of corn. This experiment was, therefore, commenced with the objective of determining the best time of nitrogen application on sesame.

Materials and Methods

This field experiment was carried out between July and October, 2012 at Humera Agricultural Research Center, Humera, in Tigray state, Ethiopia, to assess response of sesame to different timing of nitrogen fertilizer application under deep chromic Vertisol. Humera (latitude 14° 15' 55" N and longitude 36° 35' 06" E), is situated in the Northwestern Ethiopia along the border with Sudan and Eritrea. The area is known for its high quality white seeded sesame production to the international market. It is characterized with monomodal type of rainfall distribution pattern in which the rainy season commences in late June to early July and ends in September. The average annual rainfall of the area is about 620mm with average annual temperature from 27°C to 37°C.

The experiment was laid out in a randomized complete block design (RCBD) replicated three times. The experiment consisted of nine timing of nitrogen application treatments viz.

1. 100% of the recommended dose at planting time (T1)
2. 100% of the recommended dose at first branching stage (T2)
3. 100% of the recommended dose at early flower initiation (T3)
4. 100% of the recommended dose at early pod setting (T4)
5. 50% of the recommended dose at planting time and 50% of the recommended dose at first branching stage (T5)
6. 50% of the recommended dose at planting time and 50% of the recommended dose at early flower initiation (T6)
7. 50% of the recommended dose at planting time and 50% of the recommended dose at early pod setting (T7)
8. 50% of the recommended dose at first branching stage and 50% of the recommended dose at early flower initiation (T8)
9. 50% of the recommended at first branching stage and 50% of the recommended at early pod setting (T9)

The plot size was 2.8m*5m and a spacing of 10cm and 40cm were maintained between plants and rows, respectively. The plots were separated by 1.0m unplanted boarder while replications were separated by 1.5 m unplanted boarder. The experimental area was disc-ploughed and harrowed twice to a fine tilt. Phosphorus fertilizer at a rate of 46kg/ha was applied to all treatments at the time of sowing, indiscriminately. The source of phosphorus fertilizer was Triple Super Phosphate. Meanwhile, 46kg/ha nitrogen was applied at different time as per treatment requirement. All other agronomic and cultural operations were kept normal and uniform for all the treatments.

Standard procedures were followed to collect the data on growth and yield parameters. Random samples of ten plants, in each plot, were taken to estimate the following characters; plant height at maturity, number of branches per plant, length of capsule bearing zone and number of capsules per plant. The plots, leaving the borders, were harvested to estimate seed yield per hectare. The generated data were statistically analyzed by using JMP-5, unit business of SAS, computer statistical software programme. Means of significant treatment effects were separated using Tukey HSD test at 5% level of significance.

RESULTS AND DISCUSSION

Growth Traits (Number of branches per plant and plant height)

Results of analysis revealed a significant difference among number of braches per plant of sesame in different nitrogen timing treatments. As depicted in the table below, sesame plant produced more number of branches per plant (4.1) with split application of nitrogen 50% of the recommended at planting and the remaining 50% at branching time. However, it remained at par with nitrogen application timing at 50% of the recommended dose

at planting time and the remaining 50% of the recommended dose at early flower initiation, 50% of the recommended dose at first branching and 50% of the recommended dose at early flower initiation and 100 % of the recommended dose at planting. Minimum number of branches per plant (2.4) was noted with 100% of the recommended dose application of nitrogen timing at early flowering and 100% of the recommended dose application at pod setting stage.

Application of nitrogen at different time caused significant variation in response of sesame plant height. The tallest plant height (118.4 cm) was recorded when the recommended nitrogen dose was applied at two equal splits during planting and branching time. However, this application timing was statistically similar with T₂ (Full dose at first branching stage), T₈ (50% of the recommended dose at first branching stage and 50% of the recommended dose at early flower initiation) and T₇ (50% of the recommended dose at planting time and 50% of the recommended dose at early pod setting) application timings. On the other hand, the shortest plant height (97.0cm) was recorded in full dose nitrogen application timing at early flower initiation (T₃) which was statistically at par with full dose application of nitrogen at early pod setting stage.

Table 1: Number of branches per plant and plant height as influenced by different nitrogen application timings

Treatments	Days to 50% emergence	Days to 50% flowering	Days to 50% maturity	Number of branches/plant	Plant height (cm)
T ₁	3.3	49.7	96.3	2.7bc	104.1bc
T ₂	3.3	50.3	96.0	3.2abc	107.9abc
T ₃	3.3	50.7	95.7	2.4c	97.0d
T ₄	3.3	53.3	92.7	2.4c	101.2cd
T ₅	3.3	53.0	94.0	4.1a	118.4a
T ₆	4.0	50.3	94.0	3.7ab	102.9cd
T ₇	3.3	54.3	92.0	2.9bc	107.8abcd
T ₈	3.7	53.3	94.7	3.9ab	114.3ab
T ₉	3.3	51.0	93.3	2.5c	106.1bcd
SEM (±)	0.1	0.5	0.4	0.13	1.9
CV	14.7	5.5	2.2	21.6	9.1

NB: Levels not connected by same letter within the same column are significantly different

Yield and yield components

As depicted in the table below, sesame seed yield was significantly ($p < 0.05$) affected by application of nitrogen fertilizer at different timings. Maximum sesame seed yield (799.9 kg/ha) was recorded in plots receiving 50% of the recommended dose at early branching and the remaining 50% of the recommended at at early flower initiation. It was, nevertheless, not significantly different from plot receiving 50% recommended nitrogen dose at planting time and 50% recommended nitrogen dose at early pod setting, 50% recommended nitrogen dose at planting time and 50% recommended nitrogen dose at early flower initiation and 50% recommended nitrogen dose at planting time and 50% recommended nitrogen dose at first branching stage. The minimum sesame seed yield (488.3 kg ha⁻¹) was recorded from 100% recommended nitrogen dose application at early pod setting which was also statically par with the other application timings except with application of 50% of the recommended dose at early branching and 50% of the recommended at early flower initiation. The result indicating the enhanced seed yield from split application of nitrogen fertilizer is confirmed by Tadesse et al. (2013) on corn and Abedi et al. (2011) on wheat. The former reported that nitrogen fertilization management rate and timing offers the opportunity for increasing wheat protein content and its quality besides high wheat production.

Means of the treatments for the length of capsule bearing zone were significantly ($p < 0.05$) affected by timing of nitrogen fertilizer application. Maximum capsule bearing zone (62.9cm) was recorded in plots receiving 50% of the recommended nitrogen at planting and the remaining 50% of the recommended at branching which was significantly similar with T₈ (50% of the recommended dose at first branching stage and 50% of the recommended dose at early flower initiation), T₉ (50% of the recommended dose at first branching stage and 50% of the recommended at early pod setting), T₇ (50% of the recommended dose at planting time and 50% of the recommended dose at early pod setting). Alternatively, the lowest length of capsule bearing zone (43.6cm) was recorded in plots treated with 100% of the recommended application at early pod setting.

The data depicted in the table below shows statistically significant ($p < 0.05$) difference of nitrogen application timing regarding number of capsules per plant. Sesame plant produced the highest number of capsules per plant (57.0) when 50% of the recommended nitrogen was applied during planting and the remaining 50% of the recommended at branching stage. Nevertheless, this application timing remained statistically at par with T₆ (50% of the recommended dose at planting time and 50% of the recommended dose at early flower initiation) and T₈ (50% of the recommended dose at first branching stage and 50% of the recommended dose at

early flower initiation) application timings. Minimum number of capsules per plant (38.6) was obtained from plot receiving 100% of the recommended dose at early pod setting stage.

Table 2: Table 1: Number of branches per plant and plant height as influenced by different nitrogen application timings

Treatments	Length of capsule bearing zone (cm)	Number of capsules per plant	yield (kg/ha)
T ₁	47.1cd	42.8cd	548.9b
T ₂	54.0bc	44.7c	569.3b
T ₃	47.3cd	41.7cd	526.0b
T ₄	43.6d	38.6d	488.3b
T ₅	62.9a	57.0a	679.9ab
T ₆	51.3bc	52.7ab	675.5ab
T ₇	56.5ab	51.3b	604.8ab
T ₈	62.7a	53.7ab	799.9a
T ₉	61.2a	39.0cd	561.9b
SEM (±)	1.4	1.3	21.4
CV	13.4	14.6	18.3

NB: Levels not connected by same letter within the same column are significantly different

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