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Effects of Varieties, Nitrogen Fertilization and Seeding Rate on Growth, Seed and Oil Yield of Linseed

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Abstract
The experiment was carried out for three years from 2016 to 2018 at Wolmera to study the response of different seeding rates and nitrogen fertilizer of linseed varieties. The experiment was arranged in RCBD factorial combination with three replications. Two improved varieties (kassa- 2 and Tolle), three seeding rates (20, 30 and 40 kg/ha) and four Nitrogen rates (0, 23, 46 and 69 kg N/ha) were used. Data was collected and subjected to analysis of variance using SAS/STAT (Windows 9) (SAS Institute, 2004) software. Mean separation was done using list significant difference (LSD test)**.** The analysis of variance revealed non-significant difference for grain yield between the two varieties ($p<0.05$). Seed rate was Significant to affect grain yield but other parameters tasted were not significantly affected by seed rate. Nitrogen rate had a significant effect on all parameters tasted ($p<0.05$ except seed oil content. Higher seed yield (1734.9 kg/ha) was obtained by the application of 69 kg N/ha but it was not statistically different from the yield obtained by 46kg N/ha (1722.5 kg/ha). Interaction effect was not significant enough to alter seed and biomass yield. Partial economic analysis revealed that seed rate of 30 kg/ha and 46 kg /ha nitrogen fertilizer rate were the optimum rates for linseed production at the study area.
Keywords: linseed, nitosol, nitrogen rate, seed rate, yield
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INTRODUCTION

Linseed (Linum usitatissimum) is one of the most versatile and useful crops that has been grown for thousands of years (Gensel and Morris, 2003). Linseed is a rich source of both non-edible and edible oil. Edible linseed oil is used for human consumption and contains a linolenic acid, a polyunsaturated fatty acid exceeding all major plant oils and even fish oil (Hunter 1990) that has nutritional and health benefits (Bickert *et al*., 1994, Heller *et al*., 2010). Beside from linolenic acid, linseed is becoming increasingly popular as a nutritional and functional food due to its high content of therapeutic health promoting substances such as ω-3 fatty acid, valuable protein, dietary fiber, lecithin, and lignans-chemical compounds of major importance for human health (Bhatty and Cherdkiatgumchai, 1990; Ganorkar and Jain, 2013). Oils with high linolenic acid content dry rapidly, which is a trait important to the paint industry (Green & Marshall, 1981).

Among oilseeds, linseed (Linum usitatissimum) stands third next to sesame and noug respectively in areas coverage and total production (CSA, 2017). Among the factors which determine quality, a major role is played by the nutrient supplies, especially N fertilization. Deficient N supplies have a negative effect, particularly on the yield components, and may lead to a lower oil yield, while less effect is exerted on the oil content (Zoltán & IldikóIványi, 2005). Excessive N supplies lead to a substantial decline in both oil content and oil yield, especially above 80-120 kg ha1 N (Hocking & Pinkerton, 1991; 1993). On the other hand, manipulation of crop seeding rate and row spacing can maximize yield (Gubbles and Kenaschuk, 1989; Lafond, 1993). Despite its importance there is limited information available on linseed to develop an efficient agronomic guideline that can guarantee high and good quality seed yield in Ethiopia, especially on the recently released varieties. In particular, information is not available on the response of linseed to management strategies like nitrogen fertilization and the manipulation of the seeding rate to optimize yield. Under intensive conditions, linseed seed yield ranges up to 30 qt/ha, compared to a world average of 10 qt/ha, similar to average yields in Ethiopia. Improvements in linseed cultivation technology are a significant element in meeting the growing domestic requirements for quality linseed oil production for food and industrial purposes. So, the objective of this research were to evaluate the effect of different levels of seeding rates and nitrogen fertilization on growth, seed and oil yield of linseed varieties under Nitosols soil condition.

MATERIALS AND METHOD

The experiment was conducted for three years (2016- 2018 in main cropping seasons) around Holetta areas, Wolmera district in the central highlands of Ethiopia. Holeta is located between 09° 03 ′ N latitude and 38° 3 0 ′ E longitude, 30 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. The environment is seasonally humid and the major soil type of the trial sites is Eutric Nitisol (IUSS, 2015).

The experiment was designed in a randomized complete block design with three replication. The treatments

were a factorial combination of two varieties early maturing (Kassa 2) and late maturing (Tolle) varieties, three seeding rates (20, 30 and 40 kg ha-1) and four Nitrogen rates (0, 23, 46 and 69 kg N ha-1). In all plots, Phosphorus as triple superphosphate (TSP) was band applied at planting at the rate of 20 kg P /ha. Urea was used as the source of N, which was applied in a band half at planting and the remainder side dressed at tillering stage of the crop. A gross plot size of 2m width and 3m long was used. The seedbed was plowed three times before planting. Seed was drilled using 20cm spacing between rows. Other cultural and management practices were carried out as per the recommendations.

Data collection and Analysis

Composite soil sample was collected before planting for analysis of pH, OM, total N and available P in each year. Linseed yield and yield related data collected includes plant height, number of capsules/plant, seed yield, biomass yield and seed oil content. Finally, data was subjected to analysis of variance using SAS/STAT (Windows 9) (SAS Institute, 2004) software. Mean separation was done using list significant difference (LSD test). Finally, simple partial budget analysis were carried out.

RESULTS AND DISCUSION

Some of the soil characteristics of the three trial fields used for the experiment each year was presented below (Table 1). According to the mean result values, the experimental area was slightly acidic (pH=4.86), low in total nitrogen content (0.134%) and medium in available p (6.93ppm) and organic matter content (1.64%).

Table 1: Soil characteristics of the study areas (three year)

Parameters	Year 1	Year 2	Year 3	Mean
Soil pH(1:2.5 H2O)	4.9	4.7	5.0	4.86
Total N (%)	0.13	0.16	0.12	0.134
Available P (ppm)	5.2	8.4	7.2	6.93
Organic matter (%)	1.82	1.5	1.62	1.64

The analysis of the three year data indicated that the two varieties were not significantly different in all yield and yield related parameters tasted except seed oil content. Variety kassa 2 recorded significantly higher seed oil content than variety Tolle (Table 2).

The main effect of seed rate did not significantly affect any of the parameters tasted except seed yield. Similar to these findings Njuguna *et al.* (2008) reported that seed rates had no significant effects on plant height, spikes/m2 and 1000-seed weight. According to this research, as seed rate increases seed yield also show an increment. Seed yield obtained by the lowest seed rate (20kg/ha) was significantly different from the seed yield obtained from the seed rate of 30kg/ha but the seed yield difference due to 30 kg/ha and 40 kg/ha seed rates were statistically not significant (Table 2).

Nitrogen rate was significantly affected all parameters tasted except seed oil content (Table 2) similar to the findings of Zoltán & IldikóIványi, 2005. As nitrogen level increases the seed yield increment was recorded in which the higher seed yield was obtained by the application of 69 kg N/ha but it is not statistically different than the yield obtained by 46 kg N/ha (Table 2) in this research. Similar findings have been reported by other researchers where application of nitrogen caused increased production of capsules (Dybing, 1964; Gad and El-Farouk, 1978; Hocking,1995). This increase in number of capsules per plant due to increase in nitrogen might be attributed to increase in vegetative growth which resulted in more number of capsules being carried by each plant. Plant height increases with increase in nitrogen level for both linseed varieties. This finding is in line with the findings of Ali *et al*., (2011). Additionally, linseed biomass yield also increase with increase in nitrogen level as indicated on the (Table 2). Colnenne *et al*., 1998 also reported an increase in biomass yield with increase in nitrogen level. Interaction effect of seed rate and nitrogen rate was not significantly affect any of the parameters tasted.

Partial budget analysis revealed that seed rate of 30 kg/ha and 46 kg /ha nitrogen fertilizer rate was the optimum rates due to the fact that it gave the highest net benefit (Table 3). Linseed grain yield response to different nitrogen level indicated that there is an increase in grain yield with increase in nitrogen level and the highest grain yield was attained at the highest nitrogen level (69kgN/ha) but the net benefit result indicated that even if the highest grain yield is recorded at this high nitrogen level 46kgN/ha is economically profitable with maximum net benefit (49837.9Birr/ha) than 69kgN/ha as indicated in detail on (Table 3).

Table 2: The Main effects of varieties, seed rate and N rates on linseed yield & yield related parameters & seed oil content

Treatment	Mean PH (cm)	Mean No. capsules/ plant	Mean Biomass yield (kg/ha)	Mean Seed Yield (kg/ha)	Mean Seed Oil content (%)
Varieties					
Kassa 2	82.986a	23.7a	2996.3a	1177.82a	41.62a
Tolle	83.014a	23.48a	3097a	1194.61a	41.13b
Seed rate (Kg/ha)					
20	82.396a	24.6a	2919.2a	1133.5b	41.43a
30	82.583a	23.4a	3076.8a	1195.5a	41.39a
40	84a	22.8a	3144.7a	1229.6a	41.3a
Nitrogen rate (kg N/ha)					
0	73.972c	16.02c	2272.9c	427c	41.519a
23	82b	23.63b	3011.7b	860b	41.427ab
46	87a	26.35a	3317.2ab	1722.5a	41.333ab
69	89a	28.48a	3585.7a	1734.9a	41.22b
CV(%)	5.26	15.26	16.26	8.53	1.005

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

Table 3 : Partial Budget analysis for seeding rate and nitrogen application

Treatment No.	Seed Rate (kg/ha)	Nitrogen Rate (kg N/ha)	Average Seed yield (kg/ha)	Adjusted Yield (kg/ha)	Gross income (Birr/ha)	Total variable cost (Birr/ha)	Net benefit (Birr/ha)
1	20	0	388.6	349.74	11541.4	800	10741.4
2	20	23	807.8	727.02	23991.7	1396.5	22595.2
3	20	46	1704.3	1533.87	50617.7	1993	48624.7
4	20	69	1718.4	1546.56	51036.5	2589.5	48447
5	30	0	426.5	383.85	12667.1	1200	11467.1
6	30	23	820.2	738.18	24359.9	1796.5	22563.4
7	30	46	1806.6	1625.94	53656	2393	51263
8	30	69	1778.7	1600.83	52827.4	2989.5	49837.9
9	40	0	435	391.5	12919.5	1600	11319.5
10	40	23	925.8	833.22	27496.3	2196.5	25299.8
11	40	46	1720.3	1548.27	51092.9	2793	48299.9
12	40	69	1802.5	1622.25	53534.3	3389.5	50144.8

Where, price of linseed grain per 100kg=3300 birr and price of linseed seed per 100kg=4000birr; and the price of 100kg Urea=1193Birr was considered.

CONCLUSION

This research trial was carried out for three successive years to investigate best seed and nitrogen rate for linseed production at the study area in which two linseed varieties (Tolle and kassa 2) were used as a taste crop. The statistical data of three year indicated that: there was no significant grain yield difference observed between the two varieties but relatively high yield was recorded from the late maturing variety 'Tolle'. The varieties were significantly different only in seed oil content in which high seed oil content is recorded from kassa2 variety. Significant grain yield difference was observed due to seed rates but other parameters tasted were not significantly affected due to the main effect of seed rates. Nitrogen rate had a significant effect on all parameters tasted except seed oil content. Linseed grain yield response to different nitrogen level indicated that there is an increase in grain yield with increase in nitrogen level and the highest grain yield was attained at the highest nitrogen level (69kgN/ha) but the net benefit result indicated that 46kgN/ha is economically profitable with maximum net benefit (49837.9Birr/ha) than 69kgN/ha. So, based on partial budget analysis and above results 30kg/ha seed rate and 46kgN/ha were profitable for linseed production at the study area. Besides, it is recommended that this experiment would be further confirmed in other areas and soil types for linseed production in general.

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