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Evaluation of Linseed *Linum usitatissimum (*L.) Varieties for Yield and Yield Components in South Omo Zone, Southern Ethiopia

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Abstract
Adaptability studies on the recently released linseed varieties were conducted in Debub Ari and Bena-Tsemay Districts in 2020 under rain fed conditions in South Omo Zone. The experimens were carried out using a randomized complete block design (RCBD) with three replications and six improved (Berene, Bekoji 14, Jeldu, Tole, Kassu-2, Kulumussa-1) varieties and were used. linseed were, Data on growth, yield and yield related parameters were collected and subjected to analysis using the general linear model procedures of SAS software Version 9.1. The combined analysis of variance result showed that there were significant differences observed among the varieties for the all tested parameters. Grain yield ranged from 1122.96 (kg ha^{-1}) for variety Kulumussa-1 to 674.25 for variety Jeldu. Also, thousand seeds weight ranged from 9.00 (g) for the variety Kassu-2 to 7.58 (g) for the variety Berene. The effect of varieties on grain yield was significant and the best performing varieties of linseed namely Kulumussa-1(1122.96 kg ha^{-1}) and Kassu-2(110.93 kg ha^{-1}) would be recommended for the target areas and similar agro ecologies even though further study should be carried out including a number of recently released varieties for improved linseed production.

Keywords: linseed, grain yield, variety

Introduction

Linseed *(Linum usitatisimum* L*)* is an important oilseed crop which belongs to the family linaceae having 14 genera and over 200 species. The genus Linum has both cultivated and wild species. The wild species have little economic value. The crop is predominantly self-pollinated, but out crossing (<2%) occurs occasionally by insects (Tarekegn *et al*., 2013). Ethiopia is considered the secondary center of diversity, and now the 5th major producer of linseed in the world after Canada, China, United States and India (Birhanu, 2020) [2].

Linseed has long history of cultivation by smallholder farmers, exclusively for its oil in the traditional agriculture of Ethiopia (Ararsa and Adane, 2019) [1]. It is an important rotational crop for cereals and pulses, in Ethiopia linseed has long history of cultivation by smallholders' farmers for household consumption manly used for its edible oil in Ethiopia. However, the byproduct of linseed after oil extraction is used for animal feed. It is a major oilseed and the second most important oil crop after noug (*Guizotia abyssinica* Cass.) in Ethiopia (Birhanu, 2020) [2]. The crop performs best in altitudes ranging from 2200 to 2800 meters above sea level (masl). It is widely cultivated in the high elevations area of Ethiopia especially in Arsi, Bale, Shewa, Gojam, Gonder, Wollo and Wellega. But it is produced in areas as low as 1200 m.a.s.l and as high as 3420 m.a.s. (Wossen *et al*., 2016) [7]. Out of the total grain production coverage in Ethiopia, 6.68% hectare of land was covered by oil seed crops from linseed which shares a total area coverage of 0.62% ha (79044.51 ha); with a total production of 3233448.8 quintals and the national average yield is 11.16 t/ha (CSA, 2017) [4].

Linseed is one of the most important oil crops in Ethiopia. To date, more than 17 improved linseed varieties was released at the national level. In the place where there is no improved variety accessible in the area, evaluating the performance of released varieties is a vital activity. In South omo zone, linseed is cultivated in two highland districts especially Semen Ari, Debub Ari

and some of Bena-Tesmay woreda. It is cultivated in most kebele of Semen Ari woreda, but farmers grow low yielding local varieties. Therefore, to enhance the productivity of linseed, the present study was initiated to evaluate the performance of recently released linseed varieties in the target areas.

Materials and Methods

Description of the study area

The study was conducted at Yirga kebele in Benna-Tsemay woreda and Gedir kebele in Debub Ari woreda of South Omo zone, southern Ethiopia. Yirga is geographically, is located in the south western part of Ethiopia at about 760 Kilometers from the capital (Addis Ababa). Astronomically, Yirga is located between 5°01′–5°73′ N and 36°38′–37°07′ E, The altitude of the areas is 985 m.a.s.l and the annual rainfall of Yirga ranges from 1076.3 mm and Gedir is Located at longitude 036°34' 35.0''E and latitude 05°54' 97.4"N and at an altitude of 1645meters above sea level (masl). The study sites have a bi-modal rainfall pattern with shorter rainy season from March-May and the longest rainy season from August- November. The total annual rainfall is 1852.2 ± 250.7 mm. The annual mean minimum and maximum temperatures are 15.5 ±0.9 ℃ and 18.7 ± 1.4 ℃ respectively.

Treatments and experimental design

The experiment was executed by using six improved linseed varieties namely Berene, Bekoji, Jeldu, Tole, Kassu-2, Kulumussa-1 were collected from Holeta Agricultural Research Center and one local check were used. Field experiment was laid out in a randomized complete block design (RCBD) with three replications. The experimental field land was well prepared by flowing three times convectional tillage practice. A spacing of 20 cm between rows and 5 cm between plants after thinning was use.. Sowing was done by drilling method and later thinned at 5 cm spacing. Seed rate of 25 kg/ha was used. All the filed agronomic management practices such as weeding were done three times based on the recommendations. Thousand seeds weight was weighted by seed counter machine and grain yield was harvested from the middle four harvestable rows and measured by sensitive balance machine

Data collection

Growth, yield and yield related traits data collected as follows: Plant height in (cm) was measured from five randomly selected plants during from each experimental plot. The number of primary branches per plant was recorded from five randomly selected plants and the average number of primary branches per plant was taken. The number of capsules per plant was recorded from five randomly selected plants from each experimental plot. The number of seeds per capsule was recorded from five randomly selected plants from each experimental plot. Thousand seeds weight (g) was measured. Grain yield (g plot $^{-1}$) obtained from the central four harvestable rows of each plot was measured using sensitive balance and converted to kg ha^{-1}.

Data analysis

All the collected data were subjected to analysis of variance using Proc GLM procedures of SAS Software Version 9.1. Mean separations were estimated using Least Significant Difference (LSD) for the comparison among the experimental varieties at 0.05 probability level. The combined analysis of variance over locations was done to test the homogeneity of error.

Result and Discussion

The combined analysis of variance results for mean square showed that there were significant variations observed among the linseed varieties for all the studied traits (Table 1). The present results agreed with finding of Demeke and Tesfaye (2021), who reported that there were significant differences observed among the verities for plant height, the number of primary branches per plant, the number of capsules per plant, and thousand seed weight.

Plant height

The combined analysis of variance result for mean squares depicted that there were significant variations observed among the linseed varieties for plant height (Table 1). Based on the combined mean values, the tallest plant height (62.700 cm) was recorded from variety Kassu-2 and the shortest (46.37 cm) was recorded from the local check (Table 2).

The number of primary Branches per plant

The analysis of variance indicated that there were significant differences observed among the linseed varieties for the number of primary branches per plant (Table 1). The number of primary branches per plant ranged from (3.43) for variety Jeldu to (5.38) for Kulumssa, respectively (Table 2).

The number of capsules per plant

The combined result showed that there were significant variations observed among the linseed varieties for the number of capsules per plant (Table 1). The maximum number of capsules per plant (55.50) was recorded from variety Kassu-2, while the minimum (34.80) was noted from variety Bekoji (Table 2), respectively.

The number of seeds per capsule

The combined analysis of variance results for mean squares showed that there were significant differences observed among the linseed varieties for the number of seeds per capsule (Table 1). The maximum number of seeds per capsule (5.83) was noted for the variety Bekoji, while the minimum was recorded from the variety Kassu-2, respectively (Table 2).

Thousand seed weight

The result depicted that there significant differences observed among the linseed varieties for thousand seed weight (Table 1). Thousand seed weight ranged from (7.58 g) for local check to (9.00 g) for the variety Kassu-2, respectively (Table 2).

Grain yield

The combined analysis of variance results for mean squares showed that there were significant variations observed among the linseed varieties for grain yield (Table 1). The highest grain yield (1122.96 kg ha^{-1}) was recorded from variety Kulumussa-1 and the least (674.250 kg ha^{-1}) was obtained from Kassu-2, respectively (Table 2). This finding is in agreement with the result of Biru *et al*. (2014) who reported that variety Kulumsa-1 gave the highest seed yield, oil content, and oil yield under northwest Amhara region, Ethiopia, indicating the consistency of the variety to wide agro ecology and stable across environments.

Table 1: The combined mean square values for growth parameters, yield and yield components of linseed varieties at Gedir and Yirga, South Omo Zone, Southern Ethiopia, in 2020.

SOV	DF	PH	PBP	CPP	SPC	TSW	GY
Variety	6	171.62*	3.9899*	461.61*	1.7143*	1.895*	172872**
Replication	2	15.25	0.6695	140.59*	2.4524	0.470	17866
Location	1	2474.80*	0.6943	39.63	1.9286	108.482*	1896
Variety*Location	6	27 ns	0.1715 ns	65.79 ns	2.3175 ns	1.260 ns	9140 ns
Error	26	34.34	0.4536	24.53	1.3499	0.765	9672

Note: ns = non-significant, *= Significant at the 0.05 level DF= Degree of Freedom, SOV= Source of Variations, PH= Plant height (cm) PBP = the number of primary branches per plant, CPP = the number of capsules per plant, SPC = the number of seeds per capsule, TSW= thousand seed weight (g), GY=grain yield (kg ha-1)

Table 2: Combined mean values of growth, yield and yield related traits of linseed varieties at Gedir and Yirga, South Omo Zone, Southern Ethiopia, in 2020.

Variety	PH	PBP	CPP	SPC	TSW	GY
Berene	53.62b	3.93b	35.00c	6.50ab	7.58b	841.87b
Bekoji-14	55.30bc	3.70b	34.80c	5.83b	8.25ab	806.77b
Jeldu	52.30cd	3.70b	37.83bc	6.00ab	7.75b	674.25c
Tole	56.93abc	3.77b	35.17c	6.00ab	8.167ab	806.03b
Kassu-2	62.70a	5.32a	55.50a	7.3a	9.00a	1110.93a
Kulumussa	60.05ab	5.38a	52.67a	6.83ab	8.08ab	1122.96a
Local	46.37d	3.43b	42.83b	6.33ab	7.25b	792.06b
CV	10.59	11.12	11.80	18.14	10.91	11.19
LSD (5%)	6.95	0.79	5.87	1.38	1.04	116.71

Note: Means with the same letter (s) in the same column are not significantly different at $p<0.05$. LSD: least significant difference, CV = Coefficient of variation, PH= plant height (cm), PBP = the number of primary branches per plant, CPP = the number of capsules per plant, SPC = the number of seeds per capsule, TSW= thousand seed weight (g), GY=grain yield (kg ha^{-1}).

Conclusion and Recommendation

Based on the present result, varieties Kulumsa-1 and Kassu-2 gave higher yield and these varieties could be recommended to the farmers in the study areas and other similar agro-ecologies for production through extension and demonstrations even though further study is needed across year and locations.

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