ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 4, Issue 3, pp: (100-105), Month: July - September 2016, Available at: www.researchpublish.com

Evaluation of Improved Varieties of Linseed in Dabat District, Northwest highland of Ethiopia

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Abstract: **Linseed (Linum usitatissimum L.) is one of the most important oil crops of Ethiopia and it is considered as the main food crop and the least expensive source of oil for the farmers in many highlands of the country. A study on adaptation of recently released linseed varieties were carried out at Dabat district with the objective of testing the adaptability and creating awareness among farmers. Seven improved varieties with one local variety were evaluated for their agronomic and yield performance on University of Gondar Research site in participatory approach for two consecutive years in 2014/15 and 2015/16 cropping season. Highly significant differences (p< 0.01) were observed among the varieties for the tested parameters except 1000 seed weight. On the other hand there is no significant difference (p> 0.01) between the two cropping seasons (2014/15 and 2015/16) for all parameters except 1000 seed weight in which 2014/2015 cropping season is best for 100 SW. While, year*variety analysis showed that there is no interaction effect between year and varieties on agronomic and yield performance of linseed which indicates all the tested varieties showed stability across years on their agronomic and yield performance. Berene, Belay-96 Jeldu, Geregera, Kassa-2, Kulumsa, Tolle and Local gave grain yield of 1107.23, 1067.23, 1054.43, 1043.33, 1029.45, 994.72, 928.05 and 835.83 kg h-1, respectively. The highest mean grain yield is recorded from variety Berene (1107.23 kg h-1). Therefore, based on yield and other agronomic performance and farmers' evaluation Berene was selected as well adapted variety and for future promotion.**

Keywords: **Adaptation, linseed, variety, year.**

1. INTRODUCTION

Linseed, *Linum usitatissimum* L. (n = 15), also called flax, is an important oilseed crop which belongs to the family linaceae having 14 genera and over 200 species. Linseed is one of the oldest crops known to man and it has been cultivated for both fiber (flax) and seed oil. Its origin is unknown but the Mediterranean has been suggested as a possible center. Linseed is thought to have been an early introduction to Ethiopia (Belayneh & Alemayehu, 1988).

It is grown throughout the world including Canada, Indial, China, United States, and Ethiopia and all over Europe (FAOSTAT, 2013). Linseed is grown mainly for fiber, oil, pharmaceutical and ornamental plants (Coskuner and Karababa, 2007). Apart from food use linseed oil is used in allied industries also due to its polymerization property (Rebole et al, 2002). The plant produces spherical fruit capsules containing around 10 kernels per compartment (Freeman, 1995). The kernels have a crisp and chewy texture and a pleasant, nutty taste. Linseed is the richest source of omega-3 fatty acids. It contains 50-60% linolenic acid which offers several health benefits such as lowering serum cholesterol, reduces blood pressure and thus maintaining the health in cardiovascular diseases, diabetes, asthma and arthritis.

The crop is predominantly self-pollinated, but out crossing (less than 2%) occasionally results from insect activity. On the basis of growth habit, two types (long stemmed and short stemmed) are recognized. Long stem linseed produces a high quality fiber but the oil content of the seed is relatively low. On the other hand, short-stemmed linseed bears larger seeds of high oil content and has a branching tendency (Belayneh & Alemayehu, 1988). It gives better grain yield if it is produced with recommended fertilizer rate of 23/23 kg/ha N2/P2O5 and seed rate of 25 to 30 kg/ha in clay-loam soil.

Linseed Oil content is mainly in the range of 35-44% with drying oil properties which is highly important for the manufacture of paints and varnishes. Linseed oil in Ethiopia has been used for edible purpose in the past many years. The ground seed is of great value for, a number of purposes including gastric pain and the extracted mucilage is used in cosmetic and Pharmaceutical industries (Belayneh & Alemayehu, 1988).

Linseed stands fourth after mustard, sesame and groundnut in edible oil production of the world (Aruchalam, 1981). Linseed has been a traditional crop in Ethiopia and it is the second most important oil crop in production after noug (*Guizotia abyssinica* CASS) in the higher altitudes (Adugna Wakjira, 2007). Ethiopia is considered to be the secondary center of diversity, and now the 5th major producer of linseed in the world after Canada, China, United States and India (Adugna Wakjira, 2007).

Linseed oil is golden-yellow or amber of brown drying oil with peculiar odor and bland taste. The oil polymerizes on exposure to air, soluble in ether, turpentine etc; and slightly soluble in alcohol. The drying property is due to the linoleic ad linolemic groups.

Linseed oil is principally used, being a drying oil, in the paint and varnish industry and also in the manufacture of linoleum, oilcloth, printing and lithographic inks and soft soaps. Locally it is also used for cooking. It is also employed in the preparation of lubricants, greases and polishes.

Raw linseed oil is used in pharmaceuticals as emollient, demulcent, expectorant and diuretic. The expeller cake is harmless and is a palatable of protein rich (30%) livestock feed it is hot pressed. The poisonous effect of linseed is due to the presence of a cyanogenetic glycoside, phaselounation (linamarin). Cattle poisoning is caused by the hydrocyanic acid or prussic acid which is released by the activity of the enzyme linase on finamarin. Hot pressed linseed cake is harmless as the linamarin traction is not hydrolyzed to HCN owing to the denaturizing of the enzyme linase during cooking.

Linseed requires medium to heavy soils. The linseed plant has a short root system and so needs good soil moisture in the upper soil horizon. It is moderately susceptible to salinity. Fertilizer is not always used as the plant either does not respond or has an unpredictable response.

Several studies have been carried out on linseed genotypes regarding improvement of yield, genotype-environment interaction and phenotypic stability. Even though the hitherto research efforts made resulted in a release of improved linseed varieties, farmers` in the study area are not still using these varieties. This indicates a significant gap between the farmers' fields and the research centers, which is due to the improved linseed varieties not reaching to the farmers. Particularly in Northern western Ethiopia, these improved varieties have not reached to the farmers adequately and hence evaluating the adaptation of the released linseed varieties is of paramount importance to increase yield of the crop and to minimize crop failure due to weather and biotic constraints. In addition, farmers in the region have limited/no access to improved pre- and post-harvest practices that are known to influence the productivity of linseed.

1.1. Objective of the Study:

General objective:

The overall objective of the proposal is to evaluate and select adaptable and acceptable linseed varieties in North Gondar Ethiopia.

Specific objectives:

- To evaluate and promote linseed varieties
- To popularize Linseed varieties to the local farmers and scaling up of the selected variety

2. MATERIALS AND METHODS

2.1. Description of the study area:

The study was conducted for two consecutive seasons (2014/15 and 2015/16) main season at Dabat District in north Gondar zone of Amhara region.

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2.2. Experimental Materials:

For field work, seven released linseed varieties and one local variety were included in the study.

Table.1: Description of Varieties to be used in the Experiment

S.N	Variety	Oil Content (%)
1	Local	NB
2	Tolle	36.0
3	Kulumsa-1	NB
4	Kassa-2	NB
5	Geregera	NB
6	Jeldu	NB
7	Belay-96	36.3
8	Berene	37.0

Source: Holeta Research Center
NB, not available

2.3. Experimental Design and Field Work:

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The size of the experimental plot was 5m x 1.2m (6m^2) with 6 rows in which the four central rows were used for data collection. The total area was 235.8 m2 with spacing of 1.5m between replications and having 20 cm distance between rows. All other agronomic practices were done as per the recommendation

2.4. Collected Data:

The following yield and yield component parameters were collected

1. Grain yield
2. 1000 Seed Weight
3. Plant height
4. Biomass yield
5. Number of Flowering Branch
6. Number of pod per Plant
7. Number of seed per pod

2.5. Data Analysis:

2.5.1. Analysis of variance:

The collected data were analyzed using the standard procedure applicable to randomized complete block design (RCBD) as suggested by Gomez and Gomez (1984) using SAS software programs and list significance difference (LSD) was used for the mean comparison both at 1% and 5% probability level. Correlation analysis was done using genstat 13th edition.

3. RESULTS AND DISSCUSION

Analysis of Variance and Estimation of Variance Components:

Statistical analysis was made on yield, 1000 seed weight, biomass yield, and plant height, Number of pod per plant, Number of flowering branch and Number of seed per pod.

Statistically significant differences among varieties were observed in almost all traits evaluated across each year Table 4. Highly significant differences ($p< 0.01$) were observed among the varieties for yield, biomass yield, plant height Number of pod per plant, Number of flowering branch and Number of seed per pod except 1000 seed weight(Table **3**). On the other hand there is no significant difference ($p> 0.01$) between the two cropping seasons (2014/15 and 2015/16) for all parameters except 1000 seed weight in which 2014/2015 cropping season is best for 100 SW. While, year*variety analysis showed that there is no interaction effect between year and varieties on agronomic and yield performance of linseed which indicates all the tested varieties showed stability across years on their agronomic and yield performance.

Grain yield (kg):

Across years analysis result revealed that Berene, Belay-96, Jeldu,Geraegera and kasaa 2 gave mean grain yield of 1107.23, 1067.43, 1054.43, 1043.33 1029.45 and 994.72 kg respectively. While the lowest mean yield was obtained from local variety (835.83 kg). The high yield obtained from Berene is attributed to Biomass yield, NSPPod and NPPP (Table 3). Year wise, Analysis of variances showed no significant different among varieties on mean yield records. Better performance of Berene variety was consistent across all parameters. It is due to the genetic makeup of the variety.

Plant height:

Among the varieties Geregera gave the highest mean height (87.6 cm) and followed by Belay-96 (81.533 cm) and Kassa-2 (81.00 cm) across years. The shortest mean height was obtained from Local variety (55.600 cm).

1000 Seed Weight:

A non significant difference ($p > 0.01$) was observed among the varieties for 1000 seed weight (Table **3**). But there was significant difference ($p < 0.01$) between the two cropping seasons (2014/15 and 2015/16) for 1000 seed weight in which 2014/2015 (6.125) cropping season is best compared to 2015/2016 (5.375).

Biomass yield:

Berene gave the highest biomass yield (2.6 kg) among all the tested varieties, whereas, Local gave the lowest biomass yield (1.8 kg).

Number of Flowering Branch:

Maximum NFB (12.67) was obtained from Berene and followed by Belay-96 **(12**) and Jeldu (**11.67**). On the other hand, minimum NFB was obtained from local variety.

Number of pod per plant:

Maximum NPPP (48.00) was recorded from Berene followed by Belay-96 (**37.67**) .On the other hand, minimum NPPP was obtained from local variety.

Number of seed per pod:

Maximum NSPPod (9.0) was obtained from Berene and followed by Belay-96 (**8.3**). On the other hand, minimum number of NSPPod was obtained from local variety.

Correlation Analysis:

Correlation among the agronomic parameters is given in table 3. Correlation analysis revealed the presence of positive and highly significant association between yield and biomass ($r = 0.9$), NFB with NSPPod (r= 89). 1000 seed showed positive but no significant different with plant height ($r = 0.14$), NFB ($r= 0.30$) and NPPP ($r = 0.30$) and NSPPod ($r = 0.14$). But it was negatively correlated with biomass yield (r= -0.0292 nonsignificantly (Table 3).

The strong and positive association between grain yield and some of yield related traits provides the opportunity to improve grain yield and other desirable traits simultaneously. On the other hand, those traits that did not have significant correlation with grain yield indicate that selection for increased levels of these traits may not bring significant change in grain yield.

Table.2: Mean grain yield and other agronomic characters of linseed varieties over years (2014 and 2015)

Variety	yield	1000 SW	Biomass	NFB	PH	NPPP	NSPPod
Local	835.83	5.1667	1.8333	4.8	55.600	10.333	6.0000
Tolle	928.05	5.5833	2.0333	9.4	77.467	34.667	8.3333
Kulumsa-1	994.72	6.0833	2.2667	10	80.933	37.333	8.0000
Kassa-2	1029.45	5.3000	2.5333	10.33	81.000	32.000	8.6667
Geregera	1043.33	5.8667	2.5333	10	87.600	34.333	7.6667
Jeldu	1054.43	5.9500	2.5667	11.67	75.333	37.333	7.0000

Belay-96	1067.23	5.9167	2.2667	12	75.800	39.667	8.3333
Berene	1107.23	6.1333	2.6000	12.67	81.533	48.000	9.0000
CV%	13.65728	17.00476	17.73963	23.86567	6.970301	27.69569	10.83300
LSD (5%)	162.25	1.1529	NS	2.8445	6.3209	11.171	1.0059
Mean	1007.535	5.750000	2.329167	10.10833	76.90833	34.20833	7.875000

N.B, LSD = least significant difference, CV = coefficient of variation

NS= none significant difference

Table 3. Mean of 1000 seed weight of linseed varieties over years (2014 and 2015)

Year	Mean
2014	6.125
2015	5.375
CV%	17.00
LSD (5%)	0.576
Mean	5.75

N.B, LSD = least significant difference, CV = coefficient of variation

Table.4: Correlation coefficients among the traits measured from eight linseed varieties tested across two years

%1000_SW	1	-						
Biomass	2	-0.0292	-					
NFB	3	0.3041	0.1957	-				
NPPP	4	0.3000	0.2821	0.8900	-			
NSPPod	5	0.1054	0.3306	0.3442	0.4333	-		
PH	6	0.1421	0.4299	0.4789	0.5211	0.5298	-	
Yield	7	0.1109	0.9024	0.2340	0.3188	0.3623	0.3538	-
		1	2	3	4	5	6	7

Table.5: Mean square values of grain yield and other agronomic characters of Linseed varieties for combined analysis of variance over two years (2014 and 2015)

Source of Variation	DF	PH	NFB	NPPP	NSPPod	Biomass	1000 SW	Yield
Replication	2	9.60	5.34	991.58	1.75	1.52	0.34	229908.00
Variety	7	537.18	35.40	698.27	5.70	0.47	0.78	45795.88
Year	1	0.001	0.001	0.001	0.001	0.001	6.75	26994.31
Variety * Year	7	0.001	0.001	0.001	0.001	0.001	0.41	2710.10
Error	30	28.73	5.81	89.76	0.72	0.17	0.95	18934.29

4. CONCLUSION AND RECOMMENDATION

Based on collected data analysis Berene and Belay-96 showed better agronomic performance and gave better grain yield. To bring impact on total linseed production and productivity in Dabat and similar environment and to foster supply of alternative seed sources to the farmers, Berene and Belay-96 were selected for promotion/scaling up.

ACKNOWLEDGEMENTS

We are grateful to University of Gondar for providing funds for this study. Holetta and Adet Agricultural Research Centers are highly acknowledged for providing the improved seed of linseed for the experiment. Lastly but not the least we would like to acknowledge all individuals who directly or indirectly contribute to the successful completion of the study.

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