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Asian Journal of Plant Science and Research, 2021, 11 (1):30-32

ISSN : 2249-7412
CODEN (USA): AJPSKY

Adaptation of Improved Linseed (*Linum usitatissimum* L.) Varieties for Seed Yield in Kafa and Benchmaji Zones of South Western Ethiopia

Demeke Lea, Tesfaye Belay*

Bonga Agricultural Research Center, Bonga, Ethiopia

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 improved linseed varieties were carried out at Kefa and Benchi Maji, Shesheonde and Semenbench respectively with the objective of testing the adaptability of linseed varieties for seed yield. Thirteen improved linseed varieties were used for investigation (Yadano, Chilallo, Kassa-2, Belay 96, Berene, Tolle, Jeldu, Bekelecho, Kul-1, Kumo, Furtu, CI-1525 and CI-1652) and one local check were sown in randomized complete block design with three replications from July to December in 2018 in cropping season. Combined analysis of data from the two locations revealed that there is significant difference among varieties for days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, thousand seed weight (gm) and seed yield in kg ha-1. Significant effect of location was observed in all parameters except for thousand seed weight. The interaction of Variety X location was significant for days to maturity, number of branches per plant and number of capsules per plant. The maximum seed yield was recorded in varieties Furtu (1817.02 kg ha-1), Kumo (1752.91 kg ha-1) and Bekelecho (1607.36 kg ha-1). Lowest yield (736 kg/ha-1) was obtained from local check. Variety Furtu and Kumo showed consistence performance in across testing locations to enhance production.

Key words: *Linseed; Seed yield; Adaptability*

Introduction

Linseed (*Linum usitatisimum* L) It is one of the most important oil crops of Ethiopia and it is considered as the least expensive source of oil for the farmers in many highlands of the country. Linseed oil an excellent drying oil used in manufacturing paints, varnishes, soaps, printing inks, oil cloth and linoleum tiles [1]. It is widely grown in areas having an altitude range of 1,800-2,600 meter above sea level with annual rainfall ranging from 750-1,000 mm in Ethiopia. Linseed requires cool temperatures during its growing period to produce good yields. The mean temperature ranges from 10 to 30ºC although the crop grows best within 21 and 22ºC [2,3].

Among oil seed crops linseed covers 0.62% (about 79, 044.51 hectares) of production area with estimated production 6.68% (about 846, 493.53 ha) of oil crop production. In Ethiopia, it is the fourth important oilseed next to sesame, Neug and groundnut both in terms of acreage and total production [4,5]**.** Even in southern Ethiopia particularly Kafa and Bench Maji zone have suitable agro ecologies for production of linseed, the production is very low in the areas because poor extension service and lack of access to improved varieties is the major problem that hampers production of this crop in the study area. The present study was designed to identify the adaptability of improved linseed varieties that gives best yield under agro ecology of the study area.

Materials and Methods

Experimental sites description

Field experiment was conducted from July to December in 2018 main cropping season in two districts, one in Bench Maji zone of Semen Bench and other in Kafa zone of Shesheonde district. Geographical location of experimental site

at Semen bench and Shesheonde district is 6º57'31"N and 35º48'40" E, and 2018 meter above sea level and 7º13' 20" N and 35º52' 50" E, and 2075 meter above sea level, respectively [6-8].

Experimental treatments and design

The experiment was conducted on Thirteen improved linseed varieties (Yadano, Chilallo, Kassa-2, Belay-96, Berene, Tolle, Jeldu, Bekelcho, Kul-1, Kumo, Furtu, CI-1525, CI-1652) including one local check. The trial was arranged in a randomized complete block design with three replications at the 1st week of July in 2018 cropping season on farm of two districts. The size of the plot was 2 m*1.8 m and plant population was maintained by sowing 25 kg seed ha^{-1}. Spacing was 1.5 m, 1 m and 0.3 m, between replications, plots and rows, respectively. The recommended rate of 23/23 N/p2o5 kg/ha fertilizer was applied at sowing. Weeding practices were carried out as per of national recommendation for linseed.

Data collection

Data for seed yield and related traits were taken from four middle rows of each plot, the first and sixth rows were excluded for border effect. Days to maturity was separately taken when 90% crop stands were matured, calculated starting from sowing date. Number of branches per plant, Plant height (cm) and number of capsules per plant were taken at full maturity time from ten randomly selected sample plants.

Data Analysis

Data from both locations were combined and subjected to the analysis of variance (ANOVA) using the statistical Software program of R, version 3.3.4 [9]. Mean separation was carried out using Fisher's Least Significant Difference (LSD) test at 5% probability level and Coefficient of Variance (C.V %) was calculated to observe the relative measure of variation that exists within traits.

Results and Discussion

Analysis of variance indicated that, the longest days to maturity were recorded for varieties Furtu (122.17), Ci-1525 (122.16) and Ci-1652 (122.16) kul-1 (118.67), Bekelech (116.83) and local (111.83) (Table1). There was significant difference among the verities for plant height. Maximum plant height was noted in variety kul-1 (95.50 cm) followed by varieties, kumo (93.56 cm) and Ci-1652 (92.76 cm). Whereas; the lowest plant height was recorded in local variety (64.61 cm). Maximum total number of branches per plant was recorded in varieties Furtu (15.83), kumo (14.71) and kul-1 (14.53). In contrary, the lowest magnitude of total number of branches per plant was recorded in local variety (8.30). Like another trait, there was significant difference among tested varieties for number of capsules per plant. The highest number of capsules per plant was observed in variety Furtu (72.70), followed by bekelecho (64.63) and Kumo (62.03). On other hand, the minimum number of capsules per plant was recorded in variety Jeldu (44.36). There was significant difference among varieties for 1000 seed weight. Variety kul-1 had the largest seed size 6.5gm/1000 seeds followed by varieties Bekelecho 6.46 gm/1000 seeds and Yadano 6.16 gm/1000 seeds. Opposing to this, local variety had the smallest seed size 3.50 gm/1000 seeds. The maximum seed yield was recorded in varieties Furtu (1817.02 kg ha^{-1}), Kumo (1752.91 kg ha^{-1}) and Bekelecho (1607.36 kg ha^{-1}). Whereas, the lowest seed yield was collected from varieties, Local variety, Jeldu and Ci-1652 with respective values of 736, 1172.36 and 1212.22 kg ha-1 (Table 2). The yield for variety Furtu, Kumo, and Bekelecho exceeded local variety by 59.49% and 58% and 54.42%, respectively.

Table 1: Mean square value of combined analysis of variance of six seed yield and related traits of 13 improved linseed seed varieties grown at both locations (Semen Bench and Shesheonde)

SOV	DF	DTM	PH	BNPP	NCPP	TSW	SLD(kgha^{-1})
Variety (V)	13	48.65***	329.8***	26.58***	349.40***	2.850**	438787***
Replication (R)	2	3.08	120.7	57.67	830.86	1.53	826310
Location (L)	1	27.42**	3384.6***	330.03***	2124.07***	0.10^{ns}	4643183**
Variety*Loc (LxV)	13	7.27*	55.1^{ns}	11.60*	417.57***	0.38^{ns}	60399ns
Error	54	3.34	35.1	6.50	104.15	1.14	72619
CV (%)		1.52	6.75	21.03	18.04	19.54	19.67

Note: DF= Degree of Freedom, SOV= Source of Variation, DTM= Days To Maturity, PH= Plant Height, BNPP=Branch Number Per Plant, NCPP= Capsule Number Per Plant, YLD (kgha^{-1}) =Yield Kilogram Per Hectare. Ns = Non-significant, *= Significant at the 0.05 level, **= Significant at 0.1 level, *** = Significant at 0.001 level

Table 2: Mean performance of seed yield and related traits of linseed varieties combined for both locations (Semen bench & Shesheonde)

Variety	DTM	PH(cm)	BNPP	NCPP	TSW(g)	SLD (kgha^{-1})
Yadano	121.83^{ab}	84.650^{e}	13.50^{abc}	61.83^{abcd}	6.16^{ab}	1492.64^{bcde}
Chilallo	121.50^{ab}	89.26^{abcde}	11.18^{cde}	57.50^{bcde}	5.33^{ab}	1270.07^{def}
Kassa-2	121.83^{ab}	88.46^{bcde}	12.28^{bcd}	56.76^{bcde}	5.83^{ab}	1266.39^{def}
Belay 96	119.83^{bc}	87.73^{bcde}	12.33^{bcd}	49.50^{ef}	5.00^{b}	1349.30^{cdef}
Berene	120.50^{abc}	85.86^{de}	12.33^{bcd}	50.76^{cdef}	5.33^{ab}	1300.97^{cdef}
Tolle	119.16^{c}	89.60^{abcde}	11.43^{cd}	53.46^{bcdef}	5.33^{ab}	1373.90^{cdef}
Jeldu	120.50^{abc}	87.21^{bcde}	11.15^{cde}	44.36^{f}	5.50^{ab}	1172.36^{f}
Bekelecho	116.83^{d}	86.08^{cde}	13.43^{abc}	64.63^{ab}	6.46^{ab}	1607.36^{abc}
kul-1	118.67^{cd}	95.50^{a}	14.53^{ab}	61.60^{abcd}	6.50^{ab}	1549.79^{abcd}
kumo	119.83^{bc}	93.56^{ab}	14.71^{ab}	62.06^{abc}	5.50^{ab}	1752.91^{ab}
furtu	122.17^{a}	91.83^{abcd}	15.83^{a}	72.70^{a}	6.00^{ab}	1817.02^{a}
Ci-1525	122.16^{a}	92.36^{abcd}	9.86^{de}	57.80^{bcde}	5.33^{ab}	1271.32^{def}
Ci-1652	122.16^{a}	92.76^{abc}	11.08^{cde}	48.63^{ef}	5.50^{ab}	1212.22^{ef}
Local	111.83^{d}	64.61^{f}	8.30^{e}	50.16^{def}	3.50^{c}	736^{g}
Means	119.90	87.82381	12.11	56.55	5.46	1369.50
CV (%)	1.52	6.75	21.03	18.04	19.54	19.67
LSD(P<05)	2.11	6.86	2.95	11.81	1.23	311.92

Conclusion

According to the combined analysis of variance over two locations, varieties Furtu and Kumo showed better agronomic performance and gave highest seed yield. Thus, these varieties are found to be well adapted and high yielding among the tested varieties in the study areas. Therefore, Furtu and Kumo were selected as top ranking and could be suggested for production under Semen Bench and Shesheonde district and similar agro ecologies.

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