AEXTJ
AGRICULTURAL EXTENSION JOURNAL
ISSN 2582- 564X

Available Online at www.aextj.com
**Agricultural Extension Journal 2025; 9(1):20-24**

**RESEARCH ARTICLE**

# Performance Evaluation of Linseed (*Linum usitatissimum* L.) Varieties in West Arsi Zone, Ethiopia

Beshir Hamido, Usman Kedir

*Adami Tullu Agricultural Research Center, Oromia, Ethiopia*

**Received: 25-12-2024; Revised: 25-01-2025; Accepted: 10-02-2025**

## ABSTRACT

Linseed is the second most important oilseed crop and stands next to rapeseed-mustard in the area of cultivation and seed production in India. Every part of the linseed plant is utilized commercially, either directly or after processing. Linseeds are grown for the extraction of oil from the seeds. Linseed seeds contain high levels of dietary fiber. About 20% of the total linseed oil produced is used by farmers and the rest about 80% goes to industries for the manufacture of paints, varnish, oilcloth, linoleum, printing ink, etc. Despite the multiple uses of the crop in improving soil fertility and nutrient-rich food, there are no more improved varieties in the study areas. Thus, the study was carried out with the intention of evaluating, selecting, and recommending the well-performed linseed varieties to the study areas. Different linseed varieties (viz; Dibenne, Furtu, Kuma, Tolle, and Yadenno) were evaluated using a randomized complete block design with three replications at three locations. The analysis of variance for an individual environment indicated that the total seed yield showed a significant difference ($P \leq 0.05$) at all test environments. The combined analysis of variance for the total seed yield also showed a significant difference ($P \leq 0.05$) amongst the cultivars. The mean seed yield values of the tested varieties averaged across the environments showed that the variety Kuma was found to have the best seed yield (2.07 ton/ha) as followed by the variety Furtu with its mean seed yield of 1.95 ton/ha. The varietal effect had contributed more in varying the total yield performance. Lin and Binns' cultivar superiority measures for stability analysis identified the variety Kuma as the most stable variety. Generally, the variety Kuma was identified to be the most adaptable and the most stable variety as compared to the other tested varieties to the present ecology of study. Therefore, this variety has been recommended to the study areas so that the farmers of the area can use this variety.

**Key words:** Adaptation and performance evaluation, linseed, seed yield

## INTRODUCTION

Linseed (*Linum usitatissimum* L.) is commonly known as Alashi or Alsi. It is an erect annual herbaceous plant 30–120 cm, in height with a slender glabrous and grayish-green stem. The shoot is profusely branched and bushy in character. Leaves are without stipules, 20–40 mm long and 3 mm broad, simple, narrow, and alternate.[1]

**Address for correspondence:**
Beshir Hamido
E-mail: beshirhamido@gmail.com

Every part of the linseed plant is utilized commercially, either directly or after processing. On a very small scale seed is directly used for edible purposes. Although linseed plants have several utilities, it is cultivated commercially for its seed, which is processed into oil, and after extraction of oil; a high protein stock feed is left.[2,3]

The linseed types are grown for the extraction of oil from the seeds. It contains 33–47% of oil. Linseed oil has been used for centuries as a drying oil whose oil content varies from 33 to 45%.[1] The oil is rich in linolenic acid (>66%) and it is a perfect drying oil. Linseed seeds contain high levels of dietary fibers as well as lignin, an abundance of micronutrients, and omega-3 fatty acids. It is good in taste and contains 36% protein, 85% of which is digestible.[4]

About 20% of the total linseed oil produced is used by farmers and the rest about 80% goes to industries for the manufacture of paints, varnish, oilcloth, linoleum, printing ink, etc.[2,3] The flax types are also grown for fiber extraction from the stems. Fibers obtained from the stem are known for their length and strength and are 2–3 times as strong as those of cotton.[5] These plants generally produce fewer capsules and smaller seeds.[4]

Despite the multiple uses of the crop in improving soil fertility and nutrient-rich food, there are no improved varieties recommended to the study areas. Therefore, the study was intended to be conducted with the objectives of evaluating the performance of different linseed varieties and selecting for the relatively best-yielding varieties.

## MATERIALS AND METHODS

### Study Area

The study was conducted at three locations, namely, Negelle Arsi (Keraru and Turge Gallo) and Kofele districts for two consecutive years (2021/2022 and 2022/2023 cropping seasons) under rain-fed conditions.

### Breeding Materials, Experimental Design, and Management

Five linseed varieties (viz; Dibenne, Furtu, Kuma, Tolle, and Yadenno) were evaluated during the study by using randomized complete block design with three replications at three locations for two consecutive years.

The plot size was 2 m × 3 m with the total area of a plot was 6 m$^2$. The spacing between rows, plots, and blocks were 30 cm, 50 cm, and 100 cm, respectively. Seed sowing was done by hand drilling and covered slightly with the soil. Hand weeding and all other agronomic management practices were accomplished as per requisition at all locations.

### Data Collection

Data on days to 50% flowering, Plant height (cm), Number of branches per plant, Number of balls per

**Table 1:** Mean value of plant height (PH), das to maturity (DM), number of balls per plant (NBaP$^{-1}$), number of seeds per ball (NSBa$^{-1}$), thousand seed weight (1000SW) and total seed yield per hectare (TSYHa$^{-1}$) of the linseed varieties evaluated at each location during 2021/22 and 2022/23 cropping seasons

| Varieties | Test environments | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Keraru | | | | | | Turge Gallo | | | | | | Kofele | | | | | |
| | PH (cm) | DM | NBaP$^{-1}$ | NSBa$^{-1}$ | 1000SW (g) | TSY | PH (cm) | DM | NBaP$^{-1}$ | NSBa$^{-1}$ | 1000SW (g) | TSY | PH (cm) | DM | NBa P$^{-1}$ | NSBa$^{-1}$ | 1000SW (g) | TSY |
| Dibane | 57.8$^{a}$ | 110.8$^{a}$ | 43.7$^{b}$ | 6.2$^{a}$ | 5.5$^{b}$ | 1.9$^{b}$ | 83.6$^{a}$ | 120.3$^{a}$ | 51.7$^{c}$ | 6.3$^{ab}$ | 5.5$^{ab}$ | 1.8$^{a}$ | 65.5$^{a}$ | 156.5$^{d}$ | 55.3$^{b}$ | 6.5$^{b}$ | 5.6$^{a}$ | 1.8$^{a}$ |
| Furtu | 63.3$^{b}$ | 111.0$^{a}$ | 41.5$^{ab}$ | 6.7$^{ab}$ | 5.7$^{c}$ | 1.9$^{c}$ | 82.7$^{a}$ | 123.8$^{c}$ | 49.8$^{bc}$ | 6.7$^{bc}$ | 5.7$^{bc}$ | 1.9$^{b}$ | 67.5$^{ab}$ | 152.2$^{a}$ | 54.5$^{b}$ | 6.5$^{b}$ | 5.7$^{ab}$ | 1.9$^{b}$ |
| Kuma | 63.8$^{b}$ | 110.3$^{a}$ | 43.5$^{b}$ | 6.67$^{ab}$ | 5.8$^{c}$ | 1.9$^{d}$ | 82.7$^{a}$ | 122$^{b}$ | 51$^{bc}$ | 6.8$^{c}$ | 5.9$^{c}$ | 2.1$^{c}$ | 67.9$^{ab}$ | 154.5$^{c}$ | 55.3$^{b}$ | 6.7$^{b}$ | 5.9$^{b}$ | 2.2$^{c}$ |
| Tolle | 65.3$^{b}$ | 111.0$^{a}$ | 40.7$^{a}$ | 6.2$^{a}$ | 5.4$^{b}$ | 1.9$^{b}$ | 82.0$^{a}$ | 120.3$^{a}$ | 43.5$^{a}$ | 6.0$^{a}$ | 5.4$^{a}$ | 1.8$^{a}$ | 67.8$^{ab}$ | 153.3$^{b}$ | 45.33$^{a}$ | 6.0$^{a}$ | 5.40$^{a}$ | 1.8$^{a}$ |
| Yadenno | 58.3$^{a}$ | 112.0$^{b}$ | 40.7$^{a}$ | 6.2$^{a}$ | 5.2$^{a}$ | 1.8$^{a}$ | 83.3$^{a}$ | 124.8$^{d}$ | 49.0$^{b}$ | 6.0$^{a}$ | 5.7$^{bc}$ | 1.8$^{a}$ | 69.1$^{b}$ | 154.3$^{bc}$ | 52.$^{b}$ | 6.5$^{b}$ | 5.$^{ab}$ | 1.8$^{a}$ |
| GM | 61.7 | 111.0 | 42.0 | 6.4 | 5.5 | 1.9 | 82.9 | 122.3 | 49.0 | 6.4 | 5.6 | 1.9 | 67.6 | 154.2 | 52.5 | 6.4 | 5.7 | 1.9 |
| MSE | 3.9 | 0.36 | 3.59 | 0.16 | 0.02 | 0.001 | 9.88 | 0.23 | 3.62 | 0.09 | 0.05 | 0.01 | 3.72 | 0.69 | 9.74 | 0.10 | 0.07 | 0.01 |
| SE (d) | 1.6 | 0.49 | 1.55 | 0.331 | 0.111 | 0.021 | 2.566 | 0.394 | 1.553 | 0.234 | 0.138 | 0.090 | 1.574 | 0.676 | 2.549 | 0.253 | 0.223 | 0.069 |
| LSD | 3.4 | 1.03 | 3.25 | 0.69 | 0.23 | 0.05 | 5.39 | 0.83 | 3.26 | 0.51 | 0.4 | 0.19 | 3.31 | 1.42 | 5.36 | 0.53 | 0.47 | 0.15 |
| CV | 3.2 | 0.5 | 4.5 | 6.3 | 2.5 | 1.4 | 3.8 | 0.4 | 3.9 | 4.7 | 4.1 | 5.8 | 2.9 | 0.5 | 5.9 | 4.8 | 4.8 | 4.4 |

GM: Genotypic means, MSE: Mean square of error, SE (d): Standard error of difference, LSD: Least significant difference, and CV: Coefficient of variation. Values with the same letters in a column mean to "not statistically significantly different" plant, Number of seeds per ball, Days to maturity, Thousand seeds' weight, and Total seed yield per hectare were recorded during the study.

### Data Analysis

All the recorded data were subjected to the analysis of variance following the standard procedure for each location. Combined analysis of variance over locations was computed using the Gen-Stat (18$^{th}$ Edition) Statistical Computer Software Programs.

Bartlett's Chi-square test was also considered to determine the validity of the combined analysis of variance and homogeneity of error variances among the environments. The combined analysis was considered after the confirmation of significant differences for interaction effects and homogeneity of the residual variations.

#### *Cultivar superiority measure (P)*

Cultivar Superiority was considered to test the seed yield performance and its stability over the test environments. It measures the mean seed yield performance and its stability simultaneously.[6]

## RESULTS AND DISCUSSION

The variation due to the genotypes was found to be highly significant ($P \leq 0.05$) for their total seed yield per hectare at all test environments (Table 1).

The results of Bartlett's homogeneity test have shown that error variances for the number of seeds per ball (NSBa$^{-1}$), thousand seed weight (1000SW), and total seed yield per hectare (TSYHa$^{-1}$) were found to be homogenous. Therefore, further pooled/combined analysis was demanded for the number of seeds per ball (NSBa$^{-1}$), thousand seed weight (1000SW), and total seed yield per hectare (TSYHa$^{-1}$).

Accordingly, the combined analysis of variance revealed that the varieties had showed a significant difference for their number of seeds per ball (NSBa$^{-1}$), thousand seed weight (1000SW), and total seed yield per hectare (TSYHa$^{-1}$) as shown in the table below.

The combined analysis of variance for total seed yield has showed the presence of a highly significant difference ($P \leq 0.05$) among the genotypes [Table 2]. This shows that the varieties had contributed more in varying the total seed yield performance.

The mean seed yield values of the tested varieties averaged across the environments showed that the variety Kuma was found to have the highest mean seed yield (2.07 tonha$^{-1}$) as followed by the variety Furtu with its mean seed yield of 1.95 tonha$^{-1}$ [Table 3].

The combined analysis of variance across the environments for total yield revealed that varieties, locations, replications (blocks within environments), years, variety by location interaction (VLI), variety by year interaction (VYI), location by year interaction (LYI), variety by location by year interaction (VLYI) and residual contributed about 57.81%, 7.61%, 3.54%, 0.39%, 8.79%, 1.05%, 0.66%, 0.92% and 19.29%, respectively [Table 4].

**Table 2:** Combined analysis of variance for number of seeds per a ball (NSBa$^{-1}$), thousand seed weight (1000SW) and total yield per hectare (TSYHa$^{-1}$) of the five linseed varieties across locations during 2021/22 and 2022/23cropping seasons

| Traits | Source of variations | | | | | | | | | Total (89) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Replications (2) | Varieties (4) | Locations (2) | Years (1) | VLI (8) | VYI (4) | LYI (2) | VLYI (8) | Residual (58) | |
| Sum squares | | | | | | | | | | |
| NSBa$^{-1}$ | 0.62 | 5.44 | 0.089 | 1.344 | 1.36 | 1.267 | 0.62 | 2.60 | 8.044 | 21.4 |
| 1000SW | 0.42 | 2.70 | 0.515 | 1.493 | 0.638 | 0.64 | 0.33 | 0.252 | 2.701 | 9.69 |
| TSYHa$^{-1}$ | 0.05 | 0.881 | 0.116 | 0.006 | 0.134 | 0.016 | 0.01 | 0.014 | 0.294 | 1.52 |
| Mean squares | | | | | | | | | | |
| NSBa$^{-1}$ | 0.3$^{ns}$ | 1.36** | 0.34$^{ns}$ | 1.34* | 0.17$^{ns}$ | 0.32$^{ns}$ | 0.3$^{ns}$ | 0.32$^{ns}$ | 0.14$^{ns}$ | |
| 1000SW | 0.2$^{ns}$ | 0.68** | 0.26$^{ns}$ | 0.49** | 0.08$^{ns}$ | 0.16$^{ns}$ | 0.2$^{ns}$ | 0.03$^{ns}$ | 0.05$^{ns}$ | |
| TSYHa$^{-1}$ | 0.03$^{ns}$ | 0.22** | 0.01$^{ns}$ | 0.01$^{ns}$ | 0.02$^{ns}$ | 0.004$^{ns}$ | 0.01$^{ns}$ | 0.05$^{ns}$ | 0.01$^{ns}$ | |

"**"stands for highly significant differences at ($P \leq 0.05$); "ns" for non-significant difference; DF: Degree of freedom, VLI: Varieties by location interaction, VYI: Variety by year interaction, LYI: Location by year interaction, VLYI: Variety by location by year interaction and the numbers in the brackets stand for the respective degree of freedom.

**Table 3:** The combined mean values for the number of seeds per a ball (NSBa$^{-1}$), thousand seed weight (1000SW) and total seed yield per hectare (TSYHa$^{-1}$) of the five linseed varieties over the locations

| Varieties | Traits | | |
|---|---|---|---|
| | NSBa$^{-1}$ | 1000SW | TSYHa$^{-1}$ |
| Dibane | 6.33$^{b}$ | 5.51$^{a}$ | 1.84$^{a}$ |
| Furtu | 6.61$^{c}$ | 5.70$^{b}$ | 1.95$^{b}$ |
| Kuma | 6.72$^{c}$ | 5.88$^{c}$ | 2.07$^{c}$ |
| Tolle | 6.06$^{a}$ | 5.38$^{a}$ | 1.83$^{a}$ |
| Yadenno | 6.22$^{ab}$ | 5.52$^{a}$ | 1.81$^{a}$ |
| GM | 6.39 | 5.60 | 1.90 |
| MSE | 0.139 | 0.047 | 0.007 |
| SE (d) | 0.304 | 0.176 | 0.067 |
| LSD | 0.609 | 0.353 | 0.135 |
| CV | 5.8 | 3.9 | 4.3 |

GM: Grand means, MSE: Mean square of error, SE (d): Standard error of difference, LSD: Least significant difference and CV: Coefficient of variation. Values with the same letters in a column mean to "not statistically significantly different"

**Table 4:** Percent contribution of varieties, locations, replications (blocks within environments), years, variety by location interaction (VLI), variety by year interaction (VYI), location by year interaction (LYI), variety by location by year interaction (VLYI) and residual effects on seed yield over the locations

| Source of variations | Sum square | Sum square (%) |
|---|---|---|
| Replications (2) | 0.054 | 3.54 |
| Varieties (2) | 0.881 | 57.81 |
| Locations (2) | 0.116 | 7.61 |
| Years (1) | 0.006 | 0.39 |
| VLI (4) | 0.134 | 8.79 |
| VYI (2) | 0.016 | 1.05 |
| LYI (2) | 0.01 | 0.66 |
| VLYI (4) | 0.014 | 0.92 |
| Residual (34) | 0.294 | 19.29 |
| Total | 1.524 | 100 |

The numbers in the brackets represent the degree of freedom

**Table 5:** Lin and Binn's Cultivar Superiority values for five linseed varieties over the locations

| Varieties | Means | Cultivar superiority | Ranks |
|---|---|---|---|
| Dibane | 1.84 | 0.0326 | 3 |
| Furtu | 1.95 | 0.0097 | 2 |
| Kuma | 2.07 | 0.0000 | 1 |
| Tolle | 1.83 | 0.0348 | 4 |
| Yadenno | 1.81 | 0.0379 | 5 |

The varietal effect was found to have the highest sum of squares value with a highly significant mean of square. This allowed the varieties to have the largest percent contribution (57.81%). This indicates that the varieties were highly diverse, causing most of the variation to the total seed yield (Table 4).

The cultivar superiority values were also measured for each of the tested varieties at three testing environments.

Those genotypes with the lowest cultivar superiority values would be considered as the most superior genotype in terms of stability in a given set of environments.[6]

Accordingly, the variety Kuma was found to have the smallest cultivar superiority value (0.0000) with a higher mean seed yield (2.07 ton/ha) as shown in the Table 5. This indicates that the variety Kuma was found to be more stable with a wider adaptation as compared to the other evaluated varieties.

## CONCLUSION AND RECOMMENDATION

The variation due to the genotypes for their total seed yield per hectare showed a highly significant difference ($P \leq 0.05$) at all test environments. The combined analysis of the tested varieties across the environments has also shown a significant difference ($P \leq 0.05$) for the total seed yield. Accordingly, the variety Kuma was found to have the highest mean seed yield (2.07 ton/ha).

The observed highest variation to the total variations was attributed to the varietal effects. This in turn shows that the varieties had contributed more (57.81%), playing a leading role in varying the overall yield performance.

Lin and Binns cultivar superiority measures for stability analysis identified the variety Kuma as the most stable variety with its cultivar superiority value of 0.0000 and the largest mean seed yield (2.07 ton/ha). Generally, in the present study, the variety Kuma was identified to be the most adaptable and the most stable variety as compared to the other tested varieties to the present ecology of study.

## REFERENCES

1. Gill KS. Linseed. New Delhi: Indian Council of Agricultural Research; 1987.
2. Sankari HS. Linseed (*Linum usitatissimum* L.): Cultivars and breeding lines as stem biomass producers. J Agron

Crop Sci 2000;184:225-31.
3. Kurt O, Bozkurt D. Effect of temperature and photoperiod on seedling emergence of flax (*Linum usitatissimum* L.). J Agron 2006;5:541-5.
4. Al-Doori SM. Influence of sowing dates on growth, yield and quality of some flax genotypes (*Linum usitatissimum* L.). Coll Basic Educ Res J 2012;12:733-46.
5. Taylor M. Flax Profile. Canada: Agricultural Marketing Resource Centre; 2012.
6. Lin CS, Binns MR. A superiority measure of cultivar performance for cultivar x location data. Can J Plant Sci 1988;681:93-198.