



# Yield Attributes and Economics of Linseed (*Linum usitatissimum* L.) Cultivars under Irrigated Uphill Condition of Indian Himalayan Region in Nagaland

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## ABSTRACT

**Background:** Linseed is an upright annual herbaceous plant that grows up to a height of 30-120 cm with slight glabrous, grayish green stem while flax types grow to a height of 80-120 cm with straight culms and fewer secondary branches near the top of the stem. The colour of linseed flowers depends on the varieties. According to Vavilov, the small-seeded type is grown primarily for oil purposes while the bold seeded type is grown primarily for fibre purposes.

**Methods:** The experiment was laid out in Randomized Block Design with three replications and consisted of seven linseed varieties viz., JLS-95, RLC-153, LSL-93, T-397, Shekhar, Priyam and Parvati.

**Result:** Among all the varieties JLS-95 produced higher yield attributes viz., number of capsules plants<sup>-1</sup>, seed yield (Kg ha<sup>-1</sup>) and stover yield as well as statistically superior in variety JLS-95 over the other varieties. The variety JLS-95 recorded maximum gross returns, net returns and B:C compared to the other varieties.

**Key words:** Economics, Irrigated condition, Linseed, Phenological, Varieties, Yield attributes.

## INTRODUCTION

Linseed (*Linum usitatissimum* L.) known as flax belongs to the family Linaceae. It is the second most significant *rabi* oilseed crop in India, coming in second to rapeseed-mustard in terms of area cultivated and seed output. It is an upright annual herbaceous plant that grows up to a height of 30-120 cm with slight glabrous, grayish green stem while flax types grow to a height of 80-120 cm with straight culms and fewer secondary branches near the top of the stem. The colour of linseed flowers depends on the varieties. Linseed has a long and illustrious history, almost as long as civilization itself. According to Vavilov, the small-seeded type, which is grown primarily for oil purposes, appears to have originated in South Western Asia, including India, Afghanistan and Turkey, while the bold seeded type, which is grown primarily for fibre purposes, appears to have originated in the Mediterranean region, including Asia Minor, Egypt, Algeria, Spain, Italy and Greece (Singh *et al.*, 2020). Despite the facts that linseed plants have diverse advantages, commercially, every portion of the linseed plant is used, either directly or after processing, they are farmed commercially for its seed, which is processed into oil and then left as a high protein stock feed once the oil is extracted. The reason for low yield of linseed are poor fertility, inadequate use of fertilizers and traditional crop management practices. Nagaland has good scope to enhance the production at commercial level but due to hilly terrain and topography along with lack of proper storage and post-harvest handling are some of the main reasons for limitation in production in the state (Solo *et al.*, 2021). Linseed oil content ranging from 33 to 45 % has been used

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as a drying oil for millennia (Gill, 1987). The major growing states are Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, Rajasthan, Karnataka and West Bengal. The important linseed growing countries in the world are India, China, Russia, Canada, Argentina and USA. In terms of area under cultivation, India ranks 2<sup>nd</sup> (21.21%) after China in the world for linseed growing.

Linseed oil is being produced in India out of which about 20% of the total used by farmers and the rest about 80% processed to the industries for the manufacture of paints, varnish, soap, oilcloth, linoleum, printing ink, it is also used in a variety of wood finishing goods, as well as finished leather. Flax is also planted as an attractive plant in gardens. Both edible and non-edible oils may be found in abundance in the linseed plant and are high in micronutrients, dietary fibre, manganese, vitamin B<sub>1</sub> and

the important fatty acid viz. alpha-linolenic acid (ALA) a polyunsaturated fatty acid, often known as omega-3 fatty acid, which is abundant in it, which have an important function in lowering the risk of heart disease, diabetes, cancer, rheumatoid arthritis, blood cholesterol levels and providing immune and cardiovascular advantages (Nôková, 2016; You *et al.*, 2019).

## MATERIALS AND METHODS

A field experiment was carried out at Agronomy research farm in SAS, Nagaland University, Medziphema, entitled "Study on performance of linseed (*Linum usitatissimum* L.) varieties under irrigated condition of uphill in Nagaland" during *rabi* season of 2021-22. The experiment was laid out in randomized block design with three replications and consisted of seven linseed varieties viz., JLS-95, RLC-153, LSL-93, T-397, Shekhar, Priyam and Parvati. The experimental farm is situated at an altitude of 310 m above mean sea level with the geographical location of 25° 45'43" N latitude and 95° 53' 04" N longitude. The soil in the experimental field was sandy loam in texture and well drained. The soil was found to be acidic in pH (4.6), high in organic carbon (1.32 %) and medium in available nitrogen, phosphorus and potassium (290 kg ha<sup>-1</sup>, 16.8 kg ha<sup>-1</sup> and 178.4 kg ha<sup>-1</sup>, respectively). Crop was sown using the line sowing method with 30 cm × 5 cm spacing. A day prior to planting, the field received the prescribed fertilizer application of 40:20:20 kg NPK ha<sup>-1</sup> in the form of urea, single super phosphate and murate of potash. Before sowing, the recommended seed rate of 25 kg ha<sup>-1</sup> were first treated with @ 2 g kg<sup>-1</sup> of Bavistin for 20 min. To record the observations on the crop's growth characteristics, five plants were randomly chosen from each plot. Based on prevailing market price of linseed revenue generated was calculated and accordingly cost of cultivation was calculated.

### Statistical analysis

The data recorded for each character were statistically analyzed by Analysis of Variance (F-test). In cases, when statistical significance was observed, critical difference (CD) was worked out at 0.05 level of significance for comparison.

## RESULTS AND DISCUSSION

### Phenological parameters

#### Days to 50% flowering

When compared to the other varieties, the variety LSL-93 took fewer days (65.00 days) to reach 50% flowering (Table 1), whereas the variety RLC-153 had the maximum time to attain 50% flowering (80.28 days), which was at par with variety Shekhar (79.00 days). Days taken to flowering is a plant feature that measures the physiology of plants to start flowering. The genetics of varieties mostly determines the initiation of flowering, but environmental and management variables can also affect the flowering initiation period. This finding was in accordance with the finding of Sahito *et al.* (2022).

### Days to physiological maturity

According to observations, the variety LSL-93 took lesser number of days to 50% flowering hence reached to physiological maturity (103.33 days) also early as compared to remaining varieties (Table 1). Similarly, as number of days to 50% flowering were maximum in variety RLC-153 (126.00 days) so as days to physiological maturity. Variety T-397 (123.00 days), Shekhar (122.67 days) and Priyam (121.20) were at par with each other for days to physiological maturity. In general, a plant's days to maturity character is determined by its days to flowering. Since, in a species of plant that is identical to it, an early or delayed flowering would result in an equal or opposite delay in the crop's physiological maturity. This finding was in accordance with the finding of Sahito *et al.* (2020).

### Number of seeds capsule<sup>-1</sup>

The number of seeds capsule<sup>-1</sup> (Table 2) were significantly higher in the variety Parvati (8.98) which was found at par with varieties Priyam (8.45), T-397 (8.01), and RLC-153 (7.81) and minimum with variety LSL-93 (6.61) being at par with varieties RLC-153 (7.81), Shekhar (7.42) and JLS-95 (7.21). The number of seeds capsule<sup>-1</sup> might have been influenced by a number of circumstances, including the temperature that prevailed at the time of seeding and the vegetative and reproductive stages. The genetic makeup of the various varieties and how they react to the environment may be the causes of the variances between them. Similar results were also observed by Bhagyalaxmi *et al.* (2022).

### Test weight (g)

It was recorded significantly higher with variety LSL-93 (9.08 g) which was at par with JLS-95 (8.53 g) and lowest in variety Parvati (5.33 g) being at par with variety T-397 (5.43 g) and variety Priyam (5.62 g). Test weight in variety Shekhar was 7.37 and 6.50 in variety RLC-153 (Table 2). As different varieties were having different seed size, which finally resulted in variation in their test weight. Boldest seeds were found in variety LSL-93 which can be due to lesser number of seeds capsules<sup>-1</sup> in this variety. So, photosynthates were going to limited number of seeds which resulted in bigger size of seeds. Genetic constitution

**Table 1:** Effect of different linseed varieties on days to 50% flowering and physiological maturity.

| Varieties                | 50% flowering<br>(days) | Physiological maturity<br>(days) |
|--------------------------|-------------------------|----------------------------------|
| V <sub>1</sub> : JLS-95  | 73.00                   | 115.00                           |
| V <sub>2</sub> : RLC-153 | 80.28                   | 126.00                           |
| V <sub>3</sub> : LSL-93  | 65.00                   | 103.33                           |
| V <sub>4</sub> : T-397   | 74.67                   | 123.00                           |
| V <sub>5</sub> : Shekhar | 79.00                   | 122.67                           |
| V <sub>6</sub> : Priyam  | 73.22                   | 121.20                           |
| V <sub>7</sub> : Parvati | 68.83                   | 111.00                           |
| SEm±                     | 0.39                    | 1.02                             |
| CD (p=0.05)              | 1.21                    | 3.13                             |

**Table 2:** Effect of different varieties on number of seeds capsule<sup>-1</sup>, test weight, weight of capsule and seed yield.

| Varieties                | No. of seeds capsule <sup>-1</sup> | Test weight (g) | Weight of capsule (g) | Seed yield (kg ha <sup>-1</sup> ) |
|--------------------------|------------------------------------|-----------------|-----------------------|-----------------------------------|
| V <sub>1</sub> : JLS-95  | 7.21                               | 8.53            | 0.077                 | 1089.67                           |
| V <sub>2</sub> : RLC-153 | 7.81                               | 6.50            | 0.063                 | 824.67                            |
| V <sub>3</sub> : LSL-93  | 6.61                               | 9.08            | 0.076                 | 671.33                            |
| V <sub>4</sub> : T-397   | 8.01                               | 5.43            | 0.063                 | 940.67                            |
| V <sub>5</sub> : Shekhar | 7.42                               | 7.37            | 0.073                 | 766.00                            |
| V <sub>6</sub> : Priyam  | 8.45                               | 5.62            | 0.061                 | 854.67                            |
| V <sub>7</sub> : Parvati | 8.98                               | 5.33            | 0.062                 | 943.33                            |
| SEm±                     | 0.40                               | 0.23            | 0.003                 | 34.55                             |
| CD (p=0.05)              | 1.23                               | 0.71            | 0.011                 | 106.47                            |

**Table 3:** Effect of different linseed varieties on oil content and oil yield.

| Varieties                | Oil content (%) | Oil yield (kg ha <sup>-1</sup> ) |
|--------------------------|-----------------|----------------------------------|
| V <sub>1</sub> : JLS-95  | 36.47           | 397.28                           |
| V <sub>2</sub> : RLC-153 | 33.00           | 272.15                           |
| V <sub>3</sub> : LSL-93  | 33.93           | 227.56                           |
| V <sub>4</sub> : T-397   | 43.20           | 405.72                           |
| V <sub>5</sub> : Shekhar | 40.43           | 309.76                           |
| V <sub>6</sub> : Priyam  | 35.07           | 299.99                           |
| V <sub>7</sub> : Parvati | 41.20           | 389.43                           |
| SEm±                     | 0.75            | 15.39                            |
| CD (p=0.05)              | 2.32            | 47.42                            |

**Table 4:** Effect of different linseed varieties on cost of cultivation, gross return, net return and B:C.

| Varieties                | Cost of cultivation<br>(` ha <sup>-1</sup> ) | Gross returns<br>(` ha <sup>-1</sup> ) | Net returns<br>(` ha <sup>-1</sup> ) | B:C  |
|--------------------------|----------------------------------------------|----------------------------------------|--------------------------------------|------|
| V <sub>1</sub> : JLS-95  | 19,384                                       | 56,236.83                              | 36,853.06                            | 1.90 |
| V <sub>2</sub> : RLC-153 | 19,384                                       | 42,783.50                              | 23,399.70                            | 1.21 |
| V <sub>3</sub> : LSL-93  | 19,384                                       | 35,283.50                              | 15,899.70                            | 0.82 |
| V <sub>4</sub> : T-397   | 19,384                                       | 48,470.17                              | 29,086.40                            | 1.50 |
| V <sub>5</sub> : Shekhar | 19,384                                       | 39,750.00                              | 20,366.00                            | 1.05 |
| V <sub>6</sub> : Priyam  | 19,384                                       | 44,386.85                              | 25,003.06                            | 1.29 |
| V <sub>7</sub> : Parvati | 19,384                                       | 48,593.17                              | 29,209.40                            | 1.51 |

of variety LSL-93 can also be the reason for bold seed and maximum test weight. The present finding is in consensus with Lea *et al.* (2021).

#### Weight of capsule (g)

Weight of capsule was maximum with variety JLS-95 (0.077 g) which was at par with variety LSL-93 (0.076 g) and Shekhar (0.073 g), minimum was found with variety Priyam (0.061 g) which remained at par with variety Parvati (0.062 g), T-397 (0.063 g) and RLC-153 (0.063 g). Test weight was also higher in varieties LSL-93, JLS-95 and Shekhar which finally resulted in maximum weight of capsule in these varieties and similarly lower test weight was there in varieties Parvati, Priyam, T-397 which resulted in minimum weight of capsule (Table 2). This might be due to genetic makeup and reaction to environmental factors of the various

varieties which resulted in variances between them. Similar results were also reported by Bhagyalaxmi *et al.* (2022).

#### Seed yield (kg ha<sup>-1</sup>)

Seed yield (kg ha<sup>-1</sup>) was significantly higher in the variety JLS-95 (1089.67 kg ha<sup>-1</sup>) and minimum was recorded with variety LSL-93 (671.33 kg ha<sup>-1</sup>) which was at par with Shekhar (766.00 kg ha<sup>-1</sup>). The maximum yield of the JLS-95 variety (Table 2) may be attributable to a greater biomass build-up caused by a maximum number of leaves plant<sup>-1</sup>, maximum number of branches plant<sup>-1</sup>, maximum number of capsules plant<sup>-1</sup> and a suitable partitioning as shown by higher yield features. The maximum number of leaves and branches resulted in high photosynthetic rate and also more partitioning towards seed. The genetic makeup of linseed varieties varied in their responses to environmental factors, which had an impact on plant growth and development as well as their capacity to harness growth factors and direct them toward escalating physiological activities such as photosynthesis and the metabolic products, it produces as well as escalating the accumulation of dry matter in the plant. Similar results were recorded by Bhagyalakmi *et al.* (2022).

#### Effect of varieties on nutritional composition

##### Oil content (%)

The highest oil content (Table 3) was recorded in the variety T-397 (43.20%) which was statistically at par with variety Parvati (41.20%) and minimum with variety RLC-153 (33.00 %) which was found at par with variety LSL-93 (33.93%) and Priyam (35.07%). Oil content differed among all the seven varieties which can be due to the genetic potentiality of the genotype. The finding is in agreement with Leilah *et al.* (2018).

##### Oil yield (kg ha<sup>-1</sup>)

Oil yield (Table 3) was recorded significantly higher with variety T-397 (405.72 kg ha<sup>-1</sup>) which was at par with variety JLS (397.28 kg ha<sup>-1</sup>) and Parvati (389.43 ka ha<sup>-1</sup>). The minimum oil yield was found with variety LSL-93 (227.56 kg ha<sup>-1</sup>) which was at par with variety RLC-153 (272.15 kg ha<sup>-1</sup>). As the oil content in variety T-397 was maximum along with good seed yield which finally resulted in maximum oil yield and second highest oil yield was obtained in variety JLS-

95 due to maximum seed yield and good oil content of the variety. Similar were the finding of Leilah *et al.* (2018).

### Economics

As package of practices for all the varieties were same, so cost of cultivation ( $\text{₹ } 19,384 \text{ ha}^{-1}$ ) was same for all the varieties (Table 4). It was observed that the variety JLS-95 recorded the maximum gross returns ( $\text{₹ } 56,236.83 \text{ ha}^{-1}$ ), net returns ( $\text{₹ } 36,853.06 \text{ ha}^{-1}$ ) and B:C (1.90) over all the varieties. It was the result of highest seed yield obtained in variety JLS-95. Minimum gross return ( $\text{₹ } 35,283.50 \text{ ha}^{-1}$ ), net return ( $\text{₹ } 15,899.70$ ) and B:C ratio (0.82) were found in variety LSL-93 due to minimum seed yield in this variety. After variety JLS-95, maximum gross returns, net returns and B:C was found in variety Parvati ( $\text{₹ } 48,593 \text{ ha}^{-1}$ ,  $\text{₹ } 29,209 \text{ ha}^{-1}$  and 1.51, respectively). A similar trend was observed with the findings of Bhagyalaxmi *et al.* (2022).

### CONCLUSION

Based on the findings of the current study, it can be concluded that variety JLS-95 produced higher yield attributes and economics than the other varieties, including number of capsules  $\text{plant}^{-1}$ , weight of capsule (g), seed yield ( $\text{Kg ha}^{-1}$ ), stover yield ( $\text{Kg ha}^{-1}$ ), gross returns, net returns and benefit cost ratio.

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### Conflict of Interest

The authors declare that they do not have any conflict of interest.

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