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Performance of Linseed (*Linum usitatissimum* L.) Varieties in Foothills of Nagaland under Irrigated Condition

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ABSTRACT

Background: Linseed, being a short duration crop, can be introduced in rice fallow system in order to derive more benefits. Timely and adequate amount of water to the crop in best possible way helps in optimizing agricultural production. At the same time, the need to meet increasing demand for food will require increased production per unit of water. However, the scope of linseed cultivation is very limited in Nagaland. The farmers of the region are not well-acquainted with linseed cultivation and information on varietal performance of linseeds in Nagaland condition is scanty.

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 growth attributes *viz.,* plant height (cm), number of leaves plant^{-1}, number of branches plant^{-1}, plant dry matter (g plant^{-1}), crop growth rate (g m^{-2} day^{-1}) and yield attributes *viz.,* number of capsules plant^{-1}, seed yield (kg ha^{-1}) and stover yield as well was statistically superior in variety JLS-95 over the other varieties.

Key words: Growth attributes, Irrigated condition, Linseed varieties.

INTRODUCTION

Linseed (*Linum usitatissimum* L.,) also known as flax belongs to the family Linaceae. Although it is mostly self-pollinated, up to 2% of it may be cross-pollinated (Tadesse *et al*., 2009). *Linum* is derived from the Celtic word 'lin' which means 'thread' and *usitatissimum* is Latin word for 'most helpful'. Linseed, often known as a dual-purpose crop, is an ancient plant that grows for both oil and fibre but in India it is mostly grown for the seeds, which are used to extract oil (Amir and Sinclaire, 1996).The important fatty acid *viz.* alpha-linolenic acid (ALA) a polyunsaturated fatty acid, often known as omega-3 fatty acid, which is abundant in linseed, 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). Linseed oil is being produced in India 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 *etc*. Linseed is mostly grown as a *rainfed* crop and is susceptible to water stress due to the fall of the water table and scarcity of accessible water. As a result, irrigation scheduling is the most important component in ensuring that the crop receives timely and appropriate water in the most efficient manner possible in order to maximise agricultural productivity. Simultaneously, the requirement to fulfil rising food demand would necessitate higher output per unit of water (Digra *et al*., 2016; Kaur and Vashist, 2016). There have been multiple accounts of linseed having a strong sensitivity to water stress and irrigation. The number of capsules and seeds plant^{-1} or unit area is the major effect of water stress on linseed output, which results in decreasing seed yield. Water stress has been demonstrated to impair seedling development as well as root growth. The physiological mechanisms that allow roots to respond to very negative external water potentials might be the key to linseed's water-stress resilience. It was recently proposed that linseed seedlings detect dryness and then counteract its negative effects by modifying carbohydrate distribution and accumulation, as well as proline and betaine accumulation. Significant seed production gains, on the other hand, have been observed as a result of irrigation (Anastasiu *et al*., 2016). Linseed, being a short duration crop, can be introduced in rice fallow system in order to derive

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more benefits. Timely and adequate amount of water to the crop in best possible way helps in optimizing agricultural production. At the same time, the need to meet increasing demand for food will require increased production per unit of water. However, the scope of linseed cultivation is very limited in Nagaland. The farmers of the region are not well-acquainted with linseed cultivation and information on varietal performance of linseeds in Nagaland condition is scanty.

Objectives

1. To study the growth of linseed varieties.
2. To identify suitable variety under Nagaland condition.

MATERIALS AND METHODS

A field experiment was conducted to determine the "Performance of linseed (*Linum usitatissimum* L.) varieties under irrigated condition of foothills in Nagaland" at Agronomy research farming SASRD, Nagaland University, Medziphema, 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. Planting was done in north-south direction. The weather condition during the conduct of the study was 20-30°C. Plot size was 4 m × 3 m and the net experimental area was 252 m^2. The soil in the experimental field was sandy loam in texture and well drained. The soil found to be acidic in pH (4.6), high in organic carbon (1.32%), medium in available nitrogen, phosphorus and potassium (290 kg ha^{-1}, 16.8 kg ha^{-1} and 178.4 kg ha^{-1}, respectively). The recommended dose of fertilizer *i.e.,* 40:20:20 kg NPK ha^{-1} in the form of urea, single super phosphate and murate of potash was applied in the field a day before sowing. Recommended seed rate of 25 kg ha^{-1} were first treated with @ 2 g kg^{-1} of Bavistin for 20 min before sowing. To record the observations on the crop's growth characteristics, five plants were randomly chosen from each plot.

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

Growth attributes of linseed

The data given in Table 1 revealed that in respect of plant population (m^{-2}), at 15 and 60 DAS, the variety Parvati has the highest plant population at 15 DAS (99.00 m^{-2}) whereas the variety T-397 has the lowest value (94.33 m^{-2}). At 60 DAS the variety Priyam had the highest plant population mortality with 2.17%, whereas JLS-95 had the lowest plant population mortality with 0.66% this could result from a cutworm infestation. For controlling the cutworm, @ 63 ml of Chlorpyriphos was applied on the soil and to prevent the wilting of the leaf, @ 96 g of Indofil was used. Bio-pesticides neem oil (0.5% l^{-1}) was also used to control the insect pest. The Initial and final plant population (m^{-2}) at 15 and 60 DAS were not significantly influenced by different varieties and moreover at the initial stage plant population was maintained in each plot. The findings are in agreement with Shivanand *et al.* (2020). Irrespective of different varieties, plant height of linseed increased with advancement of crop age. At 30 DAS, the variety JLS-95 (14.30 cm) was significantly more in plant height which was at par with variety Shekhar (13.22 cm) and found lowest with LSL-93 (10.68 cm) which was at par with variety RLC-153 (11.04), T-397 (11.49), Priyam (11.77) and Parvati (11.99). At 60 DAS and 90 DAS similar trend was found in the variety JLS-95 has become much taller (46.17 cm and 62.60 cm, respectively) which was found lowest in varietyLSL-93 (21.87 cm and 41.36, respectively) which was at par with variety T-397 (43.92 cm). The observable growth variability may be explained by their genetic ability to use the resources available for their growth and development. The findings of the experiment are consistent with Shivanand *et al.* (2020). The data showed that there was increase in number of leaves $plant^{-1}$ from 30 to 60 DAS and 60 to 90 DAS in different linseed varieties. At

Table 1: Effect of different linseed varieties on plant population, plant height andnumber of leaves $plant^{-1}$.

Varieties	Plant population (m^{-2})		Plant height (cm)			Number of leaves $plant^{-1}$		
	15 DAS	60 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
V_1: JLS-95	98.33	97.67	14.30	46.17	62.60	40.67	335.53	419.53
V_2: RLC-153	95.00	94.33	11.04	36.23	54.43	30.53	314.40	387.20
V_3: LSL-93	97.67	96.33	10.68	21.87	41.36	34.87	156.60	211.47
V_4: T-397	94.33	92.33	11.49	27.26	43.92	33.87	211.27	327.87
V_5: Shekhar	95.33	94.00	13.22	38.68	57.41	38.27	194.93	241.40
V_6: Priyam	97.17	95.00	11.77	33.59	45.02	36.87	283.00	380.73
V_7: Parvati	99.00	98.00	11.99	35.49	50.97	30.27	180.67	285.87
SEm±	1.05	1.25	0.67	0.75	0.88	0.83	2.43	4.94
p value at 0.05	NS	NS	2.06	2.31	2.71	2.56	7.50	15.22
CV	1.88	2.27	9.61	3.79	3.00	4.11	1.76	2.66

30 DAS, variety JLS-95 was bearing significantly maximum number of leaves plant^{-1} (40.67) which was statistically at par with the variety Shekhar (38.27) and minimum number of leaves plant^{-1} were found in variety Parvati (30.27) which remained at par with variety RLC-153. At 60 and 90 DAS, significantly maximum number of leaves plant^{-1} were found in JLS-95 (335.33 and 419.53, respectively) and minimum in variety LSL-93 (156.60, 211.47, respectively). This may be due to difference in genetic makeup of different varieties.

In Table 2 the data showed that from 30 to 60 DAS, number of branches plant^{-1} were significantly higher in variety JLS-95 (3.20, 6.40, respectively) and minimum in variety Shekhar and LSL-93 (1.93, 2.27, respectively) which was at par with variety T-397 and Shekhar (2.00, 2.51, respectively). The JLS-95 variety put more effort into encouraging the development of lateral buds, which led to an increase in the number of branches since it was more susceptible to environmental influences. The crop's genetic composition and environmental conditions, both of which have a substantial impact on the crop's ultimate seed yield, result in a bigger number of branches plant^{-1}. The results were similar with the findings of Mohammed *et al.* (2020) and Bhagyalaxmi *et al*. (2022). The data showed that with the advancement of crop age, there was increase in dry matter of plant. At 30 DAS maximum dry matter plant-^{1} was found in variety JLS-95 (0.143 g) which was minimum with variety Parvati (0.053 g) which was at par with variety T-397 (0.067 g). At 60 and 90 DAS, dry matter plant^{-1} was also significantly highest in variety JLS-95 (0.81 g, 2.85 g, respectively) and minimum in variety T-397 (0.34 g) at 60 DAS and in variety LSL-93 (1.32 g) at 90 DAS found at par with variety T-397 (1.39 g). The difference in dry matter plant^{-1} among different linseed varieties might be due to difference in plant height, number of leaves and number of branches among different varieties. This result was correlated with the findings of Mohammed *et al.* (2020) and Shivanand *et al.* (2020). At 30-60 DAS, CGR (g m^{-2} day^{-1}) was significantly higher with variety JLS-95 (1.48) and found lowest with variety T-397 (0.61) which was at par with variety RLC-153 (0.66) whereas, at 60-90 DAS it was significantly higher with variety JLS-95 (4.54) and was found lowest in the variety LSL-93 (1.63). Significantly higher CGR in JLS-95 may be due to more number of branches which resulted in more photosynthesis and finally more dry matter accumulation. This finding is in agreement with Sameer *et al.* (2021). At 30-60 DAS, RGR was found significantly higher with variety Parvati (0.072) and was found minimum in the variety RLC-153 (0.044) which was at par with variety Shekhar and Priyam (0.047, 0.049, respectively), whereas at 60-90 DAS it was found significantly higher with variety Priyam (0.052) and minimum with variety LSL-93 (0.027). This may be due to different varieties that produced different content of plant dry matter (g plant^{-1}).

Yield attributes of linseed

In Table 3 it was observed that the number of capsules plant^{-1} were significantly higher with variety JLS-95 (82.13) and found lowest with variety LSL-93 (29.13). Number of capsules plant^{-1} in variety Parvati (66.00) were at par with variety T-397 (63.07). Variety Priyam (62.60) and T-397 (63.07) were at par. Number of capaules^{-1} were 49.77 in variety RLC-153 and 33.93 in variety Shekhar. Number of branches plant $^{-1}$ in variety JLS-95 were significantly more at 30 as well as 60 DAS which finally resulted in high rate of photosynthesis and maximum number of capsules. As variety LSL-93 showed minimum number of branches at 60 DAS which finally resulted in minimum number of capsules plant^{-1}. These findings are corroborative to those of Maurya *et al.* (2017), Alam *et al.* (2019) and Shivanand *et al.* (2020). Seed yield (kg ha^{-1}) was significantly higher in the variety JLS-95 (1089.67 kg ha^{-1}) and minimum was recorded with variety LSL-93 (671.33 kg ha^{-1}) which was at par with Shekhar (766.00 kg ha^{-1}). The maximum yield of the JLS-95 variety may be attributable to a greater biomass build-up caused by a maximum number of leaves plant^{-1}, maximum number of branches plant^{-1}, maximum number of capsules plant^{-1} and a suitable partitioning as shown by higher yield features. Similar results were recorded by Prakash *et al.* (2015) and Bhagyalakmi *et al.* (2022). Stover yield was significantly higher with variety JLS-95 (1753.33 kg ha^{-1}) which was at par with variety Priyam (1653.33 kg ha^{-1}) and

Table 2: Effect of different linseed varieties on number of branches plant^{-1}, plant dry matter, crop growth rate and relative growth rate.

Varieties	Number of branches plant^{-1}		Plant dry matter (g plant^{-1})			Crop growth rate (g m^{-2} day^{-1})		Relative growth rate (g g^{-1} day^{-1})	
	30 DAS	60 DAS	30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS
V_1: JLS-95	3.20	6.40	0.143	0.81	2.85	1.48	4.54	0.058	0.042
V_2: RLC-153	2.53	2.93	0.110	0.41	1.69	0.66	2.84	0.044	0.047
V_3: LSL-93	2.27	2.27	0.107	0.58	1.32	1.05	1.63	0.056	0.027
V_4: T-397	2.00	3.13	0.067	0.34	1.39	0.61	2.33	0.055	0.047
V_5: Shekhar	1.93	2.51	0.107	0.44	1.42	0.74	2.19	0.047	0.040
V_6: Priyam	2.40	3.00	0.095	0.41	1.95	0.70	3.43	0.049	0.052
V_7: Parvati	2.07	5.13	0.053	0.46	1.61	0.90	2.56	0.072	0.042
SEm±	0.13	0.18	0.005	0.01	0.02	0.02	0.05	0.002	0.001
p value at 0.05	0.40	0.55	0.014	0.02	0.07	0.06	0.16	0.007	0.002
CV	9.56	8.50	8.20	2.70	2.34	3.89	3.25	7.003	2.487

Table 3: Effect of different varieties on number of capsules plant^{-1}, seed yield, stover yield and harvest index.

Varieties	No. of capsules plant^{-1}	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
V_1: JLS-95	82.13	1089.67	1753.33	38.38
V_2: RLC-153	49.77	824.67	1550.00	37.08
V_3: LSL-93	29.13	671.33	1400.00	32.43
V_4: T-397	63.07	940.67	1436.67	39.56
V_5: Shekhar	33.93	766.00	1450.00	34.14
V_6: Priyam	62.60	854.67	1653.33	34.07
V_7: Parvati	66.00	943.33	1476.67	37.79
SEm±	1.03	34.55	65.66	1.09
p value at 0.05	3.17	106.47	202.34	3.35
CV	3.22	6.88	7.43	5.21

minimum with variety LSL-93 (1400.00 kg ha^{-1}) which was at par with variety Parvati (1476.67 kg ha^{-1}), Shekhar (1450.00 kg ha^{-1}), T-397 (1436.67 kg ha^{-1}) and RLC-153 (1550.00 kg ha^{-1}). This may be due to maximum plant height, number of leaves and branches plant^{-1}in variety JLS-95 which finally resulted in highest stover yield. As plant height, number of leaves and branches plant^{-1} were minimum in LSL-93 so as the stover yield. This may be also due to favourable environment and photosynthesis activity which increased the accumulation of dry matter in the plant. This finding is in consensus with those of Ahmad *et al.* (2017) and Emam (2019). The data revealed that harvest index in variety T-397 (39.56%) was significantly higher and was at par with variety JLS-95 (38.38%), RLC-153 (37.08%), Parvati (37.79%) and it was found minimum with variety LSL-93 (32.43%) which was at par with variety Shekhar (34.14%) and Priyam (34.07%). This could be a result of improved dry matter conservation from sources to sinks, hence the superiority of the variety T-397, JLS-95, RLC-153 and Parvati may be attributable to its superiority in biological and seed yield. Minimum harvest index in variety LSL-93 can be the result of minimum seed as well as stover yield. The present finding is in with agreement with Mohammed *et al.* (2020).

CONCLUSION

The variety JLS-95 produced higher growth attributes, including plant height (cm), number of leaves plant^{-1}, number of branches plant^{-1}, plant dry matter (g plant^{-1}), crop growth rate (g m^{-2} day^{-1}) and yield attributes, including number of capsules plant^{-1}, seed yield (kg ha^{-1}) and stover yield, as well as was statistically superior in variety JLS-95 over the other varieties, according to the results of the current experiment. The performance of the variety JLS-95 was discovered to be the best suited under the irrigated conditions of Nagaland.

Conflict of interest: None.

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