Biological Forum – An International Journal **15(5): 1389-1394(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Prospects of using different Dates of Sowing for Linseed under different Row spacing System in Sandy Loam Soils of Medziphema

Ruth Kimthenvah, Lanunola Tzudir*, Shivani Kumari, A. P. Singh, D. Nongmaithem, Rekha Yadav and Noyingthung Kikon

Department of Agronomy, SASRD, Nagaland University, Medziphema (Nagaland), India.

(Corresponding author: Lanunola Tzudir)*

(Received: 10 March 2023; Revised: 15 April 2023; Accepted: 23 April 2023; Published: 20 May 2023)
(Published by Research Trend)

ABSTRACT: To find out the effectiveness of different dates of sowing and spacing in linseed (*Linum usitatissimum* L.), a study was carried out during the *rabi* of 2021 at School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus. Among the two dates of sowing D_1 *i.e.*, 10th November and D_2 *i.e.*, 25th November, seeds sown on 10th November were more effective in achieving maximum growth and yield attributes. Maintaining row spacing of 22.5 × 5 cm^2 significantly increased plant height, plant dry weight and CGR compared to other row spacings *i.e.*, 30 × 5 cm^2, 37.5 × 5 cm^2 and 45 × 5 cm^2. For days to 50% flowering and physiological maturity, different dates of sowing showed a significant effect and it was observed that D_1 recorded the maximum duration for 50% flowering and maturity as compared to D_2. Crop sown on 10th November at row spacing of 22.5 × 5 cm^2 had significance influence on the seed yield, stover yield and harvest index.

Keywords: Growth, *Linum usitatissimum*, Sowing, Spacing, Yield.

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is a self-pollinated crop and belongs to the family linaceae, which is indigenous to West Asia and the Mediterranean that has been cultivated since at least 5000 BC (Saghayesh *et al*., 2014). It is generally raised where the average annual rainfall ranges between 45 to 75 cm and the crop is well suited to tracts of low rainfall (Jiotode *et al*., 2017). In India, linseed cultivated area is about 1.799 lakh ha and total production during 2019-2020 is about 1.799 lakh ha and 1.207 lakh tonnes. The major linseed growing states in India are Madhya Pradesh, Jharkhand, Uttar Pradesh, Chhattisgarh, Orissa and Bihar (Ministry of Agriculture & Farmers Welfare, 2021). In Nagaland, area under linseed is about 5870 ha with production of 4770 mt of which 1130 ha of area and 930 mt of production is from Dimapur district (Directorate of Economics and Statistics, Govt. of Nagaland, 2021).

Linseed serves as the best source of omega 3 fatty acid to non-fish eaters. The oil is rich in linolenic acid (>66 %) and its seed contains an abundance of micronutrients and omega-3 fatty acids, high levels of dietary fibre as well as lignin. It tastes good and contains 36 % protein, of which 85 % is digestible and about 5 % N, 1.4 % P2O5 and 1.8 % K2O and it is also used as organic manure (Ganvit *et al*., 2019). The primary fatty acids have anti-inflammatory properties, content health benefits to a number of chronic diseases such as Arthritis, Diabetes and Heart disease (Sarkar and Sarkar 2017). In many parts of country, farmers fail to attempt timely sowing of linseed which results to shorter growth period available to late sown linseed coupled with higher temperature and hot winds during reproductive growth period, which leads to unnatural maturity and ultimately poor grain yield. A plethora of reports indicates growth and yield attributing traits in linseed is significantly affected by sowing dates (Al-Doori, 2012; Maurya *et al*., 2017; Jana *et al*., 2018; Ganvit *et al*., 2019). Furthermore, one of the most important agronomic factor and non-monetary input but has noticeable impact on productivity of crop is the optimum sowing time. Planting dates importantly affect growth character, production and its factor as well as oil yield in flax (Al-Doori, 2012).

Sowing dates have been shown to give differential development conditions such as temperature, precipitation and growth periods. To ensures good seed germination, optimum development of root system as well as timely appearance of seedling and for increasing production per unit area, appropriate sowing date and spacing plays an important role. Proper row spacing improved the utilization of moisture, nutrients and interception of light and thereby increased growth and production potential of a crop. It is well known fact in production of field crops spacing play an important role. Spacing is dependent upon the predicted growth of a specific crop and variety in a given agro-climatic state. Therefore, for increasing the yield per hectare optimum plant spacing is one of the most important factors.

MATERIAL AND METHODS

A field experiment was conducted at the research farm of the Department of Agronomy, SASRD, NU, Medziphema campus at an attitude of 310 meters above

the mean sea level with the geographical location of 25°45′4″ North latitude and 95°53′0″ East longitude during the *rabi* of 2021-22. The soil of the experimental field was sandy loam in texture, high in organic carbon (1.32%), medium in available N (241 kg/ha), medium in available P (16.8 kg/ha) and available K (178.4 kg/ha) and acidic in reaction (4.6). Linseed variety '*Kota Barani Alsi-4*' was sown on 10th and 25th of November 2021. The experiment was laid in FRBD with eight treatments and three replications. The recommended dose of nitrogen, phosphorus and potassium at the rate of 40 kg $ha^{-1}$of N, 20 kg ha^{-1} of P and 20 kg ha^{-1} of K was applied in the form of urea, single super phosphate and muriate of potash. Entire dose of N, P and K were applied as basal to linseed. Linseed seed was treated with carbendazim @ 2g kg^{-1} of seeds before sowing. Seeds were sown in lines at 22.5 cm × 5 cm, 30 cm × 5 cm, 37.5 cm × 5 cm and 45 cm × 5 cm spacing according to the treatment. All the recommended cultural operations other than the treatments were practiced to raise the crop. Days to physiological maturity was taken from the number of days from the date of sowing to 70% of plants in the plot turn mature capsules was recorded. The data recorded for each character were statistically analyzed by Analysis of Variance (F-test) as per the method suggested by Gomez and Gomez (1976).

RESULTS AND DISCUSSION

Growth attributes of linseed. The growth attributes of linseed i.e., plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and plant dry weight were significantly affected by different dates of sowing and spacing at harvest and the data corresponding to it is presented in the Table 1.

Plant height. Higher plant height (57.98 cm) was recorded under D_1 *i.e.*, 10th November than that of D_2 *i.e.*, 25th November. This could be due to timely sowing which might have enjoyed favourable weather conditions and better availability of mineral nutrients due to favourable soil temperature resulting in more cell division and enlargement which ultimately increased vegetative growth of the plant. Kalita *et al.* (2005) reported that higher plant height was observed under crop sown on 10th November as compared to 21th November (Table 1).

Significantly highest plant height (57.16 cm) was observed in the spacing of 22.5 × 5 cm^2 as compared to the other spacing. The increase in plant height in the closer row spacing could be due to the unavailability of proper sunlight and space between the plants which resulted in vertical growth of the plant. These observations are in accordance with the findings of Vishwanath (2007) who observed that narrow row spacing of 22.5 cm^2 produced taller plants than other wider spacing which indicated inter competition between plants for light. The present results are also in close conformity with those of Kushwaha *et al*. (2006) ; Kanpur and Gohil *et al*. (2016) at Navsari.

Number of branches $plant^{-1}$. Data pertaining to it revealed that treatment D_1*i.e.*,10th November recorded higher number of branches $plant^{-1}$ (5.00). This could be due to better absorption of nutrients at the appropriate time and better vegetative growth during the entire crop growth period which enhanced production of more branches of $plant^{-1}$ (Table 1). Early sowing of crop resulted in higher number of primary branches $plant^{-1}$ than the late sown one Kalita *et al.* (2005) ; Prakash *et al.* (2015).

Treatment with spacing 45 × 5 cm^2 recorded significantly highest number of branches$plant^{-1}$ (4.90). This could be due to less competition between plants and more availability of sunlight, nutrient and space under wider spacing resulting in the production of more branches $plant^{-1}$. Khan *et al*. (2005); Darshini (2018) reported that row spacing of 45 cm recorded a significantly higher number of primary branches $plant^{-1}$.

Number of leaves $plant^{-1}$. Different dates of sowing had a significant effect on the number of leaves $plant^{-1}$ and the highest number (245.75) was observed under treatment D_1 *i.e.*, 10th November. This could be due to timely planting and crop exposure to a suitable environmental condition under early sown crops (Table 1).

Table 1: Effect of different dates of sowing and spacing on the growth attributes of linseed.

Treatments	Plant Height (cm)	No. of branches $plant^{-1}$	No. of leaves $plant^{-1}$	Plant dry wt. (g m^{-2})
Date of sowing				
D_1 – 10th November	57.98	5.00	245.75	5.83
D_2 – 25th November	51.11	3.83	190.94	3.44
S.Em±	0.73	0.18	7.99	0.16
CD (P =0.05)	2.20	0.25	24.23	0.50
Spacing				
S_1 - 22.5 × 5 cm^2	57.16	3.92	195.08	5.66
S_2 - 30 × 5 cm^2	56.10	4.02	202.27	5.52
S_3 - 37.5 × 5 cm^2	53.23	4.83	236.47	3.90
S_4 - 45 × 5 cm^2	51.70	4.90	239.57	3.48
S.Em±	1.03	0.25	11.30	0.23
CD (P =0.05)	3.11	0.76	34.26	0.70

While treatment 45 × 5 cm^2 significantly recorded the highest number of leaves (239.57). This could be due to the production of more branches in wider spacing which ultimately resulted in the formation of more leaves $plant^{-1}$.

Plant dry weight (g m^{-2}). The data showed that significantly highest plant dry weight (5.839g m^{-2}) was observed at the first date of sowing D_1 *i.e.,* 10th November (Table 1). This could be due to sowing at the appropriate time and suitable temperature that prevailed during the crop growth period resulting in greater productivity. A Similar finding was given by Gohil *et al.* (2016); Maurya (2013) where early sown crop gave higher plant dry weight than that of the late sown crop.

The effect of different spacing on plant dry weight was significantly higher (5.663 g m^{-2}) under the treatment 22.5 × 5 cm^2. Higher dry matter in narrow spacing could be due to more competition between plants for space and light which made the plant taller in search of sunlight. Darshini (2018) reported higher dry matter in the narrow spacing of 30 cm as compared to wider spacing of 45 cm.

Crop growth rate (g $m^{-2}day^{-1}$). The data on the effect of different dates of sowing and spacing on the crop growth rate were recorded at 30-60 and 60-90 DAS and is presented in the Table 2. The data revealed that there was a significant effect of dates of sowing on the crop growth rate at both the time interval. It was observed that crop growth rate was higher (0.054, 0.133g m^{-2} day^{-1}) on first date of sowing D_1 *i.e.,* 10th November at 30-60 DAS and 60-90 DAS. This could be due to suitable climatic conditions in terms of temperature and other climatic factors during various crop growth periods under early date of sowing.

The different spacing showed a significant effect on CGR at 30-60 DAS and 60-90 DAS. The highest crop growth rate (0.054, 0.127 g m^{-2} day^{-1}) was recorded under treatment 22.5 × 5 cm^2 at both the time interval. This could be due to better vertical growth of crops under closer spacing.

Relative growth rate (g $g^{-1}day^{-1}$). The data on the effect of dates of sowing and spacing on relative growth rate was recorded at 30-60 and 60-90 DAS and are presented in the Table 2.

The different dates of sowing had no significant influence on the relative growth rate at both the time intervals. Similar findings were given by Gous (2008) where he observed first date of sowing D_1*i.e.,* 40th MW recorded higher relative growth than other dates of sowing.

The data revealed that there was no significant effect of spacing on the relative growth rate at 30-60 and 60-90 DAS. Similarly, at 60-90 DAS the spacing of 22.5 × 5 cm^2 recorded the highest relative growth rate.

Table 2: Effect of different dates of sowing and spacing on the crop growth rate (CGR) and relative growth rate (RGR) of linseed.

Treatments	Crop growth rate (g m^{-2} day^{-1})		Relative growth rate (g g^{-1} day^{-1})	
	30 – 60 DAS	60 - 90 DAS	30 – 60 DAS	60 - 90 DAS
Date of sowing				
D_1 – 10th November	0.054	0.133	0.041	0.067
D_2 – 25th November	0.029	0.082	0.042	0.069
S.Em±	0.005	0.008	0.003	0.003
CD (P =0.05)	0.015	0.023	NS	NS
Spacing				
S_1 - 22.5 × 5 cm^2	0.054	0.127	0.038	0.070
S_2 - 30 × 5 cm^2	0.052	0.124	0.042	0.067
S_3 - 37.5 v 5 cm^2	0.031	0.093	0.042	0.066
S_4 - 45 × 5 cm^2	0.028	0.084	0.044	0.069
S.Em±	0.007	0.011	0.004	0.004
CD (P =0.05)	0.021	0.032	NS	NS

Phenological parameters. The data on the effect of dates of sowing and spacing on days to 50% flowering and days to physiological maturity was recorded and is presented in the Table 3.

Days to 50% flowering. The data revealed that there was a significant effect of dates of sowing on days to 50% flowering (Table 3). It was observed that the duration taken for 50% flowering was higher (77.43) under treatment D_1 *i.e.,* 10th November as compared to D_2 *i.e.,* 25th November. This could be due to the rising of temperature during flowering period in the late sown crop which resulted in a shorter duration for days to 50% flowering. The findings are in line with that of Singh (2015); Parmar (2015).

The data showed that there was no significant effect of spacing on days to 50% flowering. Gohil *et al.* (2016) also found that there was no significant effect of spacing on days to 50% flowering. The above findings are in conformity with that of Ashok (2015); Raju (2018); Vishwanath (2007).

Days to physiological maturity. The different dates of sowing had a significant influence on days to physiological maturity. The highest duration for maturity (140.67) was observed under treatment D_1*i.e.,* 10th November (Table 3). Treatment D_2 *i.e.,* 25th November recorded the lower duration for maturity which could be due to rising temperature and rapid vegetative growth quickening maturity of the crop. Similar results were reported by Prakash (2013); Shaikh *et al.* (2009). There was no significant effect of spacing on days to physiological maturity.

Yield attributes of linseed. The data on the effect of dates of sowing and spacing on the yield attributes *i.e.,* number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$,

test weight and seed yield and stover yield was recorded and is presented in the Table 4.

Number of capsules plant^{-1}. The data showed that the highest number of capsules plant^{-1} (28.26) was significantly observed under treatment D_1*i.e.,* 10th November and the lowest number of capsules plant^{-1}was recorded under treatment D_2 *i.e.,* 25th November. This could be due to favourable environmental conditions, particularly that of temperature that prevailed during the whole growing period of the crop which resulted in the production of more branches plant^{-1} providing more sites for reproductive structures and ultimately increasing the number of capsules plant^{-1}. Jana *et al*. (2018) reported that linseed sown on 15th November produced the highest number of capsules plant^{-1} as compared to 22th and 29th November.

The data revealed that the highest number of capsules plant^{-1} (28.18) was significantly recorded under treatment 45 × 5 cm^2 and the lowest number of capsules plant^{-1} was recorded under treatment 22.5 × 5 cm^2. This could be due to sufficient availability of light, space, moisture and nutrients between plants under widely spaced conditions. These observations are in accordance with the findings of Vishwanath (2007).

Table 3: Effect of different dates of sowing and spacing on days to 50% flowering and days to physiological maturity of linseed.

Treatments	Days to 50% flowering	Days to physiological maturity
Dates of sowing		
D_1 – 10th November	77.43	140.67
D_2 – 25th November	72.60	135.83
S.Em±	0.39	0.33
CD (P =0.05)	0.55	1.00
Spacing		
S_1 - 22.5 × 5 cm^2	74.14	1.00
S_2 - 30 × 5 cm^2	74.18	137.83
S_3 - 37.5 × 5 cm^2	75.83	137.67
S_4 - 45 × 5 cm^2	75.92	138.46
S.Em±	0.55	139.03
CD (P =0.05)	NS	NS

Number of seeds capsule^{-1}. The effect of different dates of sowing and spacing on the number of seeds capsule^{-1} was non-significant. Similar findings were reported by Parmar (2015) different sowing dates did not show a significant effect on the number of seeds capsule^{-1}. Similar findings were presented by Raj and Gupta (2020); Raju (2018).

Test weight (g). The different dates of sowing and spacing didn't affect the test weight significantly. The result was similar with the finding of Jana *et al.* (2018); Vishwanath (2007); Vitthal (2014).

Seed yield (kg ha^{-1}). The different dates of sowing and spacing showed a significant effect on seed yield. The highest seed yield (979.17kg ha^{-1}) was recorded under treatment D_1*i.e.,* 10th November as compared to D_2*i.e.,* 25th November. This could be due to appropriate sowing time and crop exposure to favourable climatic conditions such as temperature and light energy, which resulted in better yield formation. The results are in close conformity with the findings of Kalita *et al.* (2005).

The data showed that there was a significant effect of spacing on seed yield. Treatment 22.5 × 5 cm^2 gave the highest seed yield (909.17 kg ha^{-1}) and was found to be statistically at par (897.00 kg ha^{-1}) with 30 × 5 cm^2. This could be due to more plant population under narrow spacing and better absorption of nutrients which is responsible for enhancing the growth and yield of the plant. The results are in accordance with the findings of Vishwanath (2007).

Stover yield (kg ha^{-1}). The different dates of sowing showed a significant effect on stover yield. The highest stover yield (1838.75 kg ha^{-1}) was recorded under treatment D_1 i.e., 10th November as compared to D_2 *i.e.,* 25th November. This could be due to appropriate sowing time and more vegetative growth in terms of plant height obviously resulted in higher straw yield. This could be due to appropriate sowing time which provides the plant full chance to develop well canopy and biomass and its increased capacity to absorb enough water and nutrients, and a more favourable period for vegetative growth in terms of plant height obviously resulted in more straw yield. Similar findings were reported by El-Mohsen *et al*. (2013) in Egypt.

Similarly, there was a significant effect of spacing on stover yield. Treatment 22.5 × 5 cm^2 gave the highest stover yield (1755.43 kg ha^{-1}) and was found to be statistically at par (1742.00 kg ha^{-1}) with 30 × 5 cm^2. Stover yield was higher under narrow spacing due to more plant density per unit area and better plant height under narrow spacing which resulted in higher straw yield.

Harvest index (%). The data showed that the highest harvest index (34.69 %) was recorded under first date of sowing D_1 (10th November). This result was similar to the finding of Parmar (2015).

Among the spacing, 22.5 × 5 cm^2 significantly recorded the highest harvest index (33.88 %) and was found to be statistically at par (33.85 %) with 30 × 5 cm^2. The findings are in agreement with the one reported by Vishwanath (2007); Raj and Gupta (2020).

Table 4: Effect of different dates of sowing and spacing on the yield attributes and yield of linseed.

Treatments	No. of capsules plant^{-1}	No. of seeds capsule^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
Date of sowing						
D_1 – 10th November	28.86	8.59	6.86	979.17	1838.75	34.69
D_2 – 25th November	22.58	8.48	6.54	647.58	1440.22	30.90
S.Em±	0.94	0.04	0.11	14.93	28.72	0.46
CD (P =0.05)	2.84	NS	NS	45.28	87.12	1.41
Spacing						
S_1 - 22.5 × 5 cm^2	23.12	8.57	6.80	909.17	1755.43	33.88
S_2 - 30 × 5 cm^2	24.05	8.56	6.76	897.00	1742.00	33.85
S_3 - 37.5 × 5 cm^2	27.53	8.53	6.67	748.00	1556.67	32.12
S_4 - 45 × 5 cm^2	28.18	8.51	6.57	699.33	1503.83	31.33
S.Em±	1.32	0.05	0.15	21.11	40.62	0.66
CD (P =0.05)	4.01	NS	NS	64.04	123.20	1.99

CONCLUSIONS

It can be concluded from the experiment that the first date of sowing i.e., 10th November sowing was found to be suitable for producing higher yield attributes as compared to D_2 i.e., 25th November. 2. Among the spacing, 22.5 × 5 cm^2 was found effective for producing higher seed and stover yield and harvest index as compared to wider spacing. The spacing of 25.5 × 5 cm^2 and 30 × 5 cm^2 were found to be statistically at par in terms of seed, stover yield and harvest index. 3. The treatment combination of 10th November + 30 × 5 cm^2 recorded the highest B:C ratio (2.51) over the other treatments and thus found to be economically feasible treatment for linseed.

FUTURE SCOPE

More years of studies need to be conducted to find out the most suitable date of sowing and spacing since one year data cannot be considered for general recommendation under any circumstances.

Conflict of Interest. None.

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How to cite this article: Ruth Kimthenvah, Lanunola Tzudir, Shivani Kumari, A. P. Singh, D. Nongmaithem, Rekha Yadav and Noyingthung Kikon (2023). Prospects of using different Dates of Sowing for Linseed under different Row spacing System in Sandy Loam Soils of Medziphema. *Biological Forum – An International Journal*, *15*(5): 1389-1394.