International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(1): 1060-1063

Received: 02-11-2018
Accepted: 06-12-2018

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Effect of sowing dates and crop spacing on growth and yield of linseed

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Abstract
An experiment was conducted during the *rabi* season of 2016-17 at College Farm, Navsari Agriculture University, Navsari, to study the Effect of sowing dates and crop spacing on growth and yield of linseed. The treatments comprised of 4 sowing dates, Viz. D_1: 3rd week of October, D_2: 4th week of October, D_3: 1st week of November and D_4: 2nd week of November in main plots and 3 spacing (S_1: 20 cm x 5 cm, S_2: 30 cm x 5 cm and S_3: 40 cm x 5 cm) in sub-plots, replicated four times in a split plot design. Sowing dates as well as spacing significantly affected growth characters and yield in the year. Significantly higher plant height (59.62 cm), number of branches/plant (9.78), seed yield (1272 kg/ha), stover yield (2908 kg/ha and accrued highest net realization (₹ 73,252/ha) with BCR (4.47) were recorded in sowing on 1st week of November (D_3). Sowing of linseed with narrow spacing S_1 (20 cm x 5 cm) was recorded significantly higher plant height (59.62 cm), seed yield (1262 kg/ha), stover yield (2976 kg/ha) and also reported maximum net realization (₹ 72,565/ha) with BCR (4.43).

Keywords: Sowing dates, growth, spacing, linseed, yield, economics

Introduction
Linseed (*Linum usitatissimum* L.), also known as flax is a member of genus *Linum* in the family Linaceae. It is commonly known as *Alashi* or *Alsi*. 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. It contains 33 to 47% of oil. About 20% of the total oil produced is used at farmer's level and the rest 80% oil goes to industries in various forms such as boiled oil, borated oil, eposidized oil, aluminates oil, urethane oil, isomerizes oil *etc*. The oil is rich in linolenic acid (>66%) and it is a perfect drying oil. Linseed seeds contain high levels of dietary fiber as well as lignin, an abundance of micronutrient and omega-3 fatty acids. It is good in taste and contains 36% protein, 85% of which is digestible. It is also used as organic manure and contains about 5% N, 1.4% P_2O_5 and 1.8% K_2O.

India is an important linseed growing country in the world and it contributes 7 per cent to the world linseed pool. At present, linseed is cultivated in about 2.63 lakh hectares with contribution of 1.26 lakh tones to the annual oilseed production of the country. The average productivity of linseed is 477 kg/ha (2015-16). Major linseed growing states in India are Madhya Pradesh, Uttar Pradesh, Chhatisgarh, Bihar, Rajasthan, Orissa and Karnataka. Madhya Pradesh has largest growing area (1.16 lakh ha) and production (0.55 lakh tones) with 474 kg/ha productivity (Anonymous 2015-16) [2].

Optimum sowing time is one of the most important agronomic factor and non-monetary input but has noticeable impact on productivity of crop. Planting dates significantly affect growth character, yield and its components as well as oil yield in flax (Al-Doori, 2012) [1]. Sowing dates have been shown to provide differential growth conditions such as temperature, precipitation and growth periods. The appropriate sowing date is very important since it ensures good seed germination, as well as timely appearance of seedling and optimum development of root system.

Spacing plays an important role in increasing production per unit area. It is well known fact that spacing plays an important role in production of field crops. Spacing is dependent upon the expected growth of a particular crop and variety in a given agro-climatic condition. Therefore, optimum plant spacing is one of the most important factors in increasing the yield per hectare.

Materials and methods

The present study was conducted on plot No. D-16 of the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari during *rabi* season of 2016-17. The soil of experimental plot was clayey in texture, low in organic carbon (0.44%) and available nitrogen (206.50 kg/ha), medium in available phosphorus (38.20 kg/ha) and high in available potassium (323.18 kg/ha). The soil was found slightly alkaline (pH 7.8) with normal electric conductivity.

The experiment was laid out in split plot design with four levels of sowing dates, i.e. D_1: 3rd week of October, D_2: 4th week of October, D_3: 1st week of November and D_4: 2nd week of November in the main plots and three levels of spacing, viz. S_1: 20 cm x 5 cm, S_2: 30 cm x 5 cm and S_3: 40 cm x 5 cm in the sub plots, replicated four times. Required quality of seed as per treatment was calculated for experimental area. The seeds were drilled 3-4 cm deep in previously opened furrows as per treatments and covered properly with soil. Five plants were selected randomly from each net plot and tagged for recording growth and yield attributing parameters. Oil content of seed was determined by soxhlet apparatus as per the method suggested by Tiwari *et al.*, 2011 [14]. The statistical analysis of data recorded for different characters during the course of investigation was carried out through the procedure appropriate to the Split plot design as described by Cochran and Cox, 1967 [4].

Result and Discussion

Effect of sowing dates

Effect on growth parameters

Plant height

The significantly taller plant (59.62 cm) was observed under the treatment D_3 (1st week of November). This is probably due to timely sowing which might have enjoyed favourable climatic conditions in terms of temperature and other parameters during crop growth and also on account of better availability of mineral nitrogen to the plants due to favourable soil temperature which have resulted in better utilization of carbohydrates to form more protoplasm resulting in more cell division and enlargement. These results lend support to those reported by Al-Doori (2012) [1] at Mosul and Ganga *et al.* (2015) [6] at Varanasi (Table 1).

Number of branches/plant

Significantly higher number of branches/plant (9.78) recorded under treatment D_3 (1st week of November). This might be due to favourable weather during entire crop period coupled with nutrient absorption at appropriate time. These results also corroborate with the findings of Kalita *et al.* (2005) [8] at Assam and Ganga *et al.* (2015) [6] at Varanasi (Table 1).

Effect on yield

Seed yield

The treatment D_3 recorded significantly higher seed yield (1272 kg/ha) of linseed by 6.35 and 11.19 per cent over D_2 and D_1, respectively. Higher seed yield might be the result of cumulative effect of improvement in growth and yield attributes such as number of branches/plant, number of capsules/plant, number of seeds/capsule as well as 1000 seed weight. The timely sown crop received favourable weather conditions for longer duration and recorded better growth and yield attributes and resulted in greater productivity. Superiority of timely planting might be due to prevalence of favourable climatic factors such as temperature and light energy, which provide the plant full chance to develop well canopy and biomass and its increased capacity to absorb enough water and nutrients, and consequently possessed more effective productive organs. The results lend support to those reported by El-Mohsen *et al.* (2013) [5] at Egypt; Ganga *et al.* (2015) [6] at Varanasi and Maurya *et al*. (2017) [12] at Varanasi (Table 1).

Stover yield

Significantly higher straw yield (2908 kg/ha) was recorded under the treatment D_3 which superseded by 13.46 per cent over D_1. Higher straw yield under treatment D_3 might be due to more favorable period for vegetative growth in terms of plant height obviously resulted into more straw yield. These findings are in cognizance with the results of El-Mohsen *et al.* (2013) [5] at Egypt and Ganga *et al.* (2015) [6] at Varanasi (Table 1).

Effect on economics

Among various sowing dates D_3 recorded the highest net returns of ₹ 73,252/ha with BCR of 4.47. These findings are substantiated with those reported by Gohil *et al.* (2016) [7] at Navsari and Maurya *et al*. (2017) [12] at Varanasi (Table 1).

Effect of spacing

Effect on growth parameters

Plant height

The significantly tallest plant (59.73 cm) was observed under the treatment S_1 (20 cm x 5 cm). Higher plant height might be due to unavailability of sufficient space and sunlight which forced the plants to grow vertically rather than horizontly. The present results are in close conformity with those of Kushwaha *et al*. (2006) [10, 11] at Kanpur and Gohil *et al.* (2016) [7] at Navsari (Table 1).

Number of branches/plant

Significantly higher number of branches/plant (9.76) recorded under treatment S_3 (40 cm x 5 cm). This might be due to sufficient availability of sunlight and nutrient which increased plant growth and development. The present results are in cognizance with those of Khan *et al*. (2005) [8] at Multan and Gohil *et al.* (2016) [7] at Navsari (Table 1).

Effect on yield

Seed yield

The treatment S_1 (20 cm x 5 cm) recorded significantly higher seed yield (1262 kg/ha) of linseed by 9.17 percent over S_3. Higher seed yield might be more number of plants per unit area resulted in higher yield per unit area. As narrow spacing sown crop have more number of plants per unit area and reduction in yield per plant might be compensated with yield from more number of plants per unit area. But there is a optimum plant population level at which yield per plant decrease with narrow spacing is compensated with yield from more number of plants per unit area. This equilibrium plant population where yield per unit area is higher with given plant population is considered optimum crop spacing. These results lend support to those reported by Kushwaha *et al*. (2006) [10, 11] at Kanpur; Saoji *et al*. (2007) at Gondia (M. S.) and Gohil *et al.* (2016) [7] at Navsari (Table 1).

Stover yield

Significantly higher straw yield (2976 kg/ha) was recorded under the treatment S_1 (20 cm x 5 cm). Higher straw yield might be due to healthy vegetative growth in terms of plant height obviously resulted into more straw yield. These

findings are in cognizance with the results of Kushwaha *et al*. (2006) [10, 11] at Kanpur; Chaudhary (2009) at Kanpur and Gohil *et al.* (2016) [7] at Navsari (Table 1).

Effect on economics

In case of spacing highest net returns **(**₹ 72565/ha**)** was recorded under the treatment S_1 (20 cm x 5 cm) with 4.43 BCR. These findings are substantiated with those reported by Kumari *et al*. (2012) at Pantnagar (Uttarkhand) and Gohil *et al.* (2016) [7] at Navsari (Table 1).

Interaction effect

Seed yield

Interaction effect between sowing dates and spacing was found to be significant in terms of seed yield (kg/ha) in linseed. However significantly higher values of seed yield (1429 kg/ha) was observed in treatment combination of D_3S_1 (1st week of November and 20 cm x 5 cm) and remained at par with D_4S_1. These results are in conformity with those reported by Saoji *et al.* (2007) [13] at Gondia (M. S.); Gohil *et al.* (2016) [7] at Navsari (Table 2).

Table 1: Effect of sowing dates and spacing on growth parameters, yield and economics of linseed

Treatment	Plant height (cm)	Number of branches/plant	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Total cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
Sowing dates (D)							
D_1	55.86	9.16	1144	2563	16370	64223	3.92
D_2	56.23	9.39	1196	2798	16370	67910	4.15
D_3	59.62	9.78	1272	2908	16370	73252	4.47
D_4	57.77	9.67	1248	2817	16370	71553	4.37
S.Em. ±	0.67	0.14	22	73	-	-	-
C.D.at 5%	2.13	0.44	70	234	-	-	-
Spacing (S)							
S_1	59.73	9.11	1262	2976	16370	72565	4.43
S_2	56.54	9.63	1227	2678	16370	70056	4.28
S_3	55.84	9.76	1156	2660	16370	65082	3.98
S.Em. ±	0.95	0.20	22	104	-	-	-
C.D.at 5%	2.78	0.57	65	303	-	-	-
Interaction (D x S)							
S.Em. ±	1.91	0.40	60	207	-	-	-
C.D.at 5%	NS	NS	Sig.	NS	-	-	-

(D_1: Third week of October, D_2: Forth week of October, D_3: First week of November, D_4: Second week of November, S_1: 20 cm × 5 cm, S_2: 30 cm × 5 cm, S_3: 40 cm × 5 cm)

Table 2: Seed yield (kg/ha) of linseed as influenced by interaction effect of sowing dates and spacing

Sowing Dates (D)	Spacing (S)		
	S_1	S_2	S_3
Seed yield (kg/ha)			
D_1	1140	1198	1093
D_2	1163	1227	1197
D_3	1429	1242	1146
D_4	1318	1239	1188
S.Em. ± 44 C.D. at 5% 129			

Conclusion

Sowing of linseed crop either during 1st week of November or 2nd week of November along with spacing 20 cm x 5 cm is recommended.

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