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Influence of dates of sowing and varieties on growth and yield of linseed (*Linum usitatissimum* L.)

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Abstract
The field experiment was conducted during *Rabi*, 2021 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). There were nine treatments which were replicated thrice along with control plot. The experiment was laid out in Randomized Block Design. The results revealed that significantly highest growth parameters i e., plant height (68.14 cm), plant dry weight (9.46 g), Crop growth rate (1.74 g/day/m^2), number of branches/plant (8.31) and yield parametrs i e., number of capsules/plant (58.49), number of seeds/capsule (9.46), seed yield (1.68 t/ha) and stover yield (3.85 t/ha) were recorded with sowing of SHA-2 variety on 21-11-2020. Maximum gross returns (Rs.109713/ha), net returns (Rs.79823.3/ha) and benefit: cost ratio (2.67) were obtained highest in the T_4sowing of SHA-2 variety on 21-11-2020.

Keywords: Dates of sowing, economics, growth, linseed, varieties and yield

Introduction
Linseed (*Linum usitatissimum* L.) is an important oilseed and fiber crop in the world. Linseed has different industrial value and is produced mostly in India, Canada, China, USA, Argentina and Russia (Dean, 2003). Linseed oil is used as edible oil when it is blended with mustard. The oil-cake is good feed for milch cattle and also use as manure. Linseed has roughly 40 percent oil by weight, about 55 percent of which is alpha linolenic acid (omega-3 fatty acid) which has anti- inflammatory action in the treatment of arthritis. It also has the quality in lowering down the cholesterol level in mammals. Overall Linseed play role in the treatment of cancer, arthritis and cardiological diseases. About 80 percent of the oil produced goes to industries, used as drying oil for the manufacture of paints, varnish, linoleum, oil cloth, currency paper, patent leather, printer ink, enamels, plastics, stickers, tarpaulins, soaps and very small fraction of it is used for edible purposes.

Linseed is one of the most important industrial oilseed crops of India and stands next to rapeseed-mustard in rabi oilseeds in area and production. India is the second largest producer of linseed, next to Canada in the world with an area of 5.25 lakh ha, total production of 2.11 lakh tones per annum and productivity of 403 kg/ha. India has 18.8 percent of worlds recorded linseed area but produces less than 10% of total world production. In India, Madhya Pradesh leads in yield and acreage, followed by Uttar Pradesh, Maharashtra, Bihar, Rajasthan, Karnataka and West Bengal also grow linseed in large areas. Madhya Pradesh and Uttar Pradesh together contribute to national linseed production to the extent of about 70 per cent.

Seeding date and its influence on flax performance is linked to weather, with early or later seeded flax having a higher chance of encountering frost or drought (Casa *et al*., 1999). Sowing date plays a key role in the yield of crops and the knowledge of this factor is imperative in working out a strategy for enhancing the yield of oil and fiber. Higher growing season temperatures can have dramatic impacts on agricultural productivity, farm income and food security. Delay in sowing leads to an increase in environmental temperature during reproductive growth of crop resulting in lower seed quality. The adjustment of sowing date plays an important role in improving the quality of seeds for sowing purposes. Seed yield in linseed is highly influenced by environmental factors.

Varieties play an important role in determining the yield of a crop, the potential yield of varieties within its genetic limit is set by its environment. The release of new varieties of linseed is major breakthrough in achieving increased production per unit area. Yield of these varieties can be further improved by providing optimum environment by manipulating agronomic practices. Varieties differ in their yield potential depending upon many physiological processes which are controlled by both genetic makeup and the environment.

Among the different practices, sowing at optimum time plays an important role to exploit the full genetic potentiality of a variety as it provides optimum growing conditions such as temperature, light, humidity and rainfall.

Materials and Methods

This experimental trial was carried out during *Rabi* 2021 at Crop Research Farm (CRF), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology & Sciences (SHUATS), Prayagraj (U. P) located at 25˚39"42" North latitude, 81˚67"56" East longitude and 98 m altitude above the mean sea level. The experiment laid was out in Randomized Block Design consisting of nine treatments which areT_1: 14- 11-2020 (D_1) + SHA-2 (V_1), T_2: 14- 11-2020 (D_1) + SHA-4 (V_2), T_3: 14- 11-2020 (D_1) + SHA-5 (V_3), T_4: 21-11-2020 (D_2) + SHA-2 (V_1) T_5: 21-11-2020 (D_2) + SHA-4 (V_2), T_6: 21-11-2020 (D_2) + SHA-5 (V_3), T_7: 28-11-2020 (D_3) + SHA-2 (V_1) T_8: 28-11-2020 (D_3) + SHA-4 (V_2), T_9: 28-11-2020 (D_3) + SHA-5 (V_3) replicated thrice to determine the influence of dates of sowing and varieties on growth, yield and economics of linseed. The soil of the trail plot was sandy loam in texture nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), medium in available P and K (15.2 kg/ha and 232.5 kg/ha respectively). The nutrient sources used in the research plot were urea, DAP and MoP to fulfill the requirements of recommended dose of nitrogen, phosphorous and potassium (80 kg N, 40 kg P_2O_5, 40 kg K_2O/ha).Between the period of germination to harvest several plant growth parameters were recorded at equal intervals and after harvest several yield parameters were recorded. In growth parameters plant height (cm), dry weight (g/plant) and number of branches/plant were recorded and yield parameters like capsules/plant, seeds/capsule, seed yield (t/ha) and stover yield (t/ha) were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez, K. A. and Gomez, A. A. 1984).

Growth parameters of linseed

Plant height

Sowing of SHA-2 on 21-11-2020 (D_2) + (V_1) recorded significantly highest plant height (68.14 cm) combination of following sowing date and the variety 14- 11-2020(D1)+SHA-4(V2), 21-11-2020(D2)+SHA-5(V3) and 28-11-2020(D3)+SHA-5 (V3) where recorded on par to the highest. Height of the plants appears to be modified by the adverse weather and it took the normal course of happening. The findings of this investigation fall in line with those observed by Chauhan *et al*. (2008) [5] and Kalita *et al*. (2005) [6]. And the differences in plant height among various varieties are in general, due to their genetic constitution. These results are in line with those Chauhan *et al*. (2008) [5], Bozkurt *et al*. (2007) [4] and Verma *et al*. (2004).

Dry weight (g)

Sowing of SHA-2 on 21-11-2020 (D_2) recorded significantly higher plant dry weight (9.46 g) over rest of the treatments and remained on par with sowing date and the variety 21-11-2020 (D_2) + SHA-4 (V_2) and 28-11-2020 (D_3) + SHA-5 (V_3)where recorded on par to the highest. Might be because of production of more number of branches and leaves and favorable environment available for longer period of crop growth than late sown crop. Data regarding dry weight indicate that dry matter production reduces continuously in subsequent sowing time. These results are in close conformity with the observations of Mondal *et al*. (2005) [8] and Chauhan *et al*. (2008) [5]. The difference in dry-matter production among varieties was mainly due to the difference in their branches, plant height and leaf production capacity. These results are well comparable with Bhushan *et al*. (2006) [3] and Kushwaha *et al*. (2006) [7].

Number of branches/plant

Number of branches/ plant (8.31) was recorded significantly highest Sowing of SHA-2 on 21-11-2020 respectively which was significantly superior over rest of the treatments following sowing date and the variety 21-11-2020 (D_2)+SHA-5(V_3),28-11-2020(D_3)+SHA-4(V_2)and28-11-2020(D_3)+SHA-5(V_3)where recorded on par to the highest. The interesting behavior exhibited by different treatment may be explained by the fact that the second planted crop was exposed to favorable weather during the whole life cycle and thus the different phases of plant life could be completed at appropriate timings. Similar responses were also recorded by Chauhan *et al*. (2008) [5]; Yadav *et al*. (2005) [11]; Kalita *et al*. (2005) [6]. because of different genetic potential of varieties to producing branches. These results are in close conformity with the findings of Chauhan *et al*. (2008) [5] and Kushwaha *et al*. (2006) [7].

Table 1: Effect of Dates of sowing and Varieties on Growth parameters of Linseed at harvest

	Treatment	Plant height (cm)	Plant dry weight	Number of branches/plant
1	14- 11-2020 (D1) + SHA-2 (V1)	63.41	8.32	6.73
2	14- 11-2020 (D1) + SHA-4 (V2)	65.59	8.64	6.95
3	14- 11-2020 (D1) + SHA-5 (V3)	64.45	8.38	6.86
4	21-11-2020 (D2) + SHA-2 (V1)	68.14	9.46	8.31
5	21-11-2020 (D2) + SHA-4 (V2)	64.98	9.20	6.96
6	21-11-2020 (D2) + SHA-5 (V3)	66.41	8.68	8.08
7	28-11-2020 (D3) + SHA-2 (V1)	65.18	8.63	6.96
8	28-11-2020 (D3) + SHA-4 (V2)	64.55	8.42	8.01
9	28-11-2020 (D3) + SHA-5 (V3)	65.73	9.23	8.09
S.Em		0.8263	0.1100	0.2290
CD (p=0.05)		2.6516	0.3269	0.6804

Effect on yield and yield attributes of linseed

Number of Capsules/plant (58.49) was recorded significantly highest Sowing of SHA-2 on 21-11-2020 which was significantly superior over rest of the treatments and remained on par with sowing date and the variety 21-11- 2020 (D2) + SHA-4 (V2) and 28-11-2020 (D3) + SHA-5 (V3) where recorded on par to the highest. The interesting behavior exhibited by different dates may be explained by the fact that

the second sown crop was exposed to favourable weather during the whole life cycle and thus the different phases of plant life was completed at appropriate timings, which resulted in production of more number of branches/plant and ultimately more number of capsules. Similar responses were recorded by Al-doori *et al.* (2012) [22]; Ibrahim *et al*. (2009); Mohapatra *et al.* (2009). Due increased the production of photosynthates, The differences in number of capsules among various varieties are in general, due to their genetic constitution. Similar findings were reported by Kushwaha *et al.* (2006) [7], Dubey *et al.* (2001), Ram *et al.* (2002) and AIi *et al*. (2002).

Number of seeds/Capsules (9.46) was recorded significantly highest Sowing of SHA-2 on 21-11- 2020 which was significantly superior over rest of the treatments and remained on par with sowing date and the variety 21-11-2020 (D2) + SHA-4 (V2), 21-11-2020 (D2) + SHA-5 (V3) and 28-11-2020 (D3) + SHA-2 (V1)where recorded on par to the highest. It is influenced by favorable environment particularly that of temperature prevailed during the time of sowing and vegetative and reproductive stages. Al-doori *et al.* (2012) [2] and Mohapatra *et al*. (2009) also reported similar findings and these results are consequences of similar genetic potential of varieties to seeds formation. Similar results reported by Bhushan *et al.* (2006) [3], AIi *et al.* (2002) and Khan *et al.* (2000).

Maximum Seed yield (1.68 t/ha) was recorded significantly highest Sowing of SHA-2 on 21-11- 2020 which was significantly superior over rest of the treatments and remained on par with sowing date and the variety 21-11-2020 (D2) + SHA- 4 (V2) and 28-11-2020 (D3) + SHA-5 (V3) where recorded on par to the highest. The favourable weather conditions such as temperature and precipitation which were the optimum degree for vegetative and reproductive stages that resulted in high photosynthetic products accumulated in the source (leaves) and transported to the sink (seeds) and ultimately resulted in higher grain yield Similar results have also been reported by Singh *et al*. (2011) [9] and Aldoori *et al*. (2012) [2]. High yield of SHA-2 may be attributed to its higher biomass accumulation due to higher number of branches, leaves and its proper partitioning as evident from equally higher harvest index and good yield attributes i.e. no. of capsules, seeds /capsules and test weight. These findings are similar to that of Chauhan *et al*. (2008) [5], Bhushan *et al*. (2006) [3]. Maximum Stover yield (3.85 t/ha) was recorded with sowing date and the variety 21-11- 2020 (D2) + SHA-2 (V1) respectively which was significantly superior over rest of the treatments and remained on par with sowing date and the variety 21-11-2020 (D2) + SHA- 4 (V2) and 28-11-2020 (D3) + SHA-5 (V3). Due to more favourable periods for vegetative growth of crop than late sown crop as evident from experiment. These findings are in close conformity to those of Chauhan *et al*. (2008) [5] and Ahmad *et al*. (2006) [1]. And Variety SHA-2 was efficient in utilizing biomass towards grain formation as evident from its high harvest index (34.58%), which might have led to reduce its straw yield and its vice-versa for Garima. These findings are in close conformity with those of Verma *et al*. (2004).

Table 2: Effect of Dates of sowing and Varieties on yield attributes and yield of Linseed.

	Treatment	No. of capsules/Plant	No. of seeds/capsule	Seed Yield (t/ha)	Stover yield (t/ha)
1	14- 11-2020 (D1) + SHA-2 (V1)	45.80	8.32	1.42	3.26
2	14- 11-2020 (D1) + SHA-4 (V2)	45.00	8.52	1.35	3.10
3	14- 11-2020 (D1) + SHA-5 (V3)	47.53	8.55	1.36	3.14
4	21-11-2020 (D2) + SHA-2 (V1)	58.49	9.46	1.68	3.85
5	21-11-2020 (D2) + SHA-4 (V2)	54.54	9.37	1.60	3.65
6	21-11-2020 (D2) + SHA-5 (V3)	53.07	8.97	1.40	3.20
7	28-11-2020 (D3) + SHA-2 (V1)	45.53	9.11	1.37	3.11
8	28-11-2020 (D3) + SHA-4 (V2)	50.16	8.47	1.44	3.31
9	28-11-2020 (D3) + SHA-5 (V3)	55.24	8.84	1.59	3.65
S.Em+		1.3485	0.2072	0.0548	0.1189
CD (p=0.05)		4.0067	0.6155	0.1628	0.3533

Economics

The Sowing of SHA-2 variety of linseed on 21-11- 2020 recorded highest Gross returns, net as well as B:C ratio.

Table 3: Effect of Dates of sowing and Varieties on Economics of Linseed.

	Treatment	Cost of cultivation (kg/ha)	Gross return (ha)	Net return (ha)	B:C Ratio
1	14- 11-2020 (D1) + SHA-2(V1)	29890	92518.7	62628.7	2.10
2	14- 11-2020 (D1) + SHA-4(V2)	29650	88010.9	58360.9	1.97
3	14- 11-2020 (D1) + SHA-5(V3)	29500	88815.7	59315.7	2.01
4	21-11-2020 (D2) + SHA-2 (V1)	29890	109713	79823.3	2.67
5	21-11-2020 (D2) + SHA-4 (V2)	29650	103902	74252.4	2.50
6	21-11-2020 (D2) + SHA-5 (V3)	29500	91286	61786	2.09
7	28-11-2020 (D3) + SHA-2 (V1)	29890	88818.9	58928.9	1.97
8	28-11-2020 (D3) + SHA-4 (V2)	29650	94005.4	64355.4	2.17
9	28-11-2020 (D3) + SHA-5 (V3)	29500	103852	74351.7	2.52

Conclusion

Based on the findings of the investigation it may be concluded that the treatment with sowing date and the variety 21-11-2020 (D2) + SHA-2 (V1)performed exceptionally in all growth, yield parameters and in obtaining higher seed yield of linseed, gross returns, net returns and B: C ratio. Hence, sowing date and the variety 21-11-2020 (D2) + SHA-2 (V1) is beneficial under Uttar Pradesh Conditions.

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