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Effect of sowing window and spacing on yield attributes and yield, quality and economics of linseed (*Linum Usitatissimum* L.) under late sown condition

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Abstract

A field experiment was conducted during *rabi* 2025-26 at the Agronomy Farm, College of Agriculture, Nagpur, to study the effect of sowing window and spacing on yield attributes and yield, quality and economics of linseed under late-sown condition. The experiment was laid out in Factorial Randomized Block Design (FRBD) with four sowing windows and three spacings, comprising twelve treatment combinations replicated three times. The sowing windows were SW₁: 44th MW (29 Oct-4 Nov), SW₂: 46th MW (12-18 Nov), SW₃: 48th MW (26 Nov-2 Dec) and SW₄: 50th MW (10-16 Dec), while spacings were S₁: 30 cm × 10 cm, S₂: 22.5 cm × 10 cm and S₃: 22.5 cm × 5 cm Sowing during 44th MW 29 Oct-4 Nov. (SW₁) recorded significantly higher number of capsules plant⁻¹ (55.64), seed yield plant⁻¹ (4.59 g) test weight (8.08 g), seed yield (996 kg ha⁻¹), straw yield (1932 kg ha⁻¹). Oil content and oil yield, protein content and protein yield, were highest under SW₁ (349 and 232 kg ha⁻¹, respectively). GMR, NMR and B:C ratio was also significantly higher with sowing during 44th MW (29 Oct- 4 Nov). Among spacings, sowing at 30 cm x 10 cm (S₁) recorded the highest capsules plant⁻¹ and seed yield plant⁻¹, whereas spacing of 22.5 cm x 5 cm (S₃) recorded the highest seed yield (1048 kg ha⁻¹), straw yield (2062 kg ha⁻¹), oil yield (354 kg ha⁻¹), protein yield (226 kg ha⁻¹), GMR (₹67,004 ha⁻¹), NMR (₹41,858 ha⁻¹) and B:C ratio (2.66). The interaction between sowing window and spacing was non-significant for the studied yield, quality and economic parameters. Thus, early sowing at SW₁ and closer spacing S₃ were identified as promising practices for productivity and profitability under the experimental conditions.

Keywords: Linseed, Sowing window, spacing, oil content, oil yield, protein content, protein yield, B:C Ratio

Introduction

Linseed (*Linum usitatissimum* L.) is an important oilseed crop valued for its seed, oil and protein. Sowing time and plant geometry are important agronomic factors influencing crop establishment, resource utilization, yield formation, seed quality and profitability. Delay in sowing can shorten the favourable growth period and expose the crop to less suitable conditions during reproductive development. Sowing time is an important agronomic factor determining the environmental conditions experienced by the crop throughout its growth cycle. Delayed sowing shortens the crop growth period and may expose flowering and grain-filling stages to higher temperature and declining soil moisture. Therefore, selection of an appropriate sowing window is particularly important for maintaining yield potential under late-sown conditions. The literature indicates that timely sowing improves growth, yield attributes and productivity of linseed, whereas delayed sowing generally reduces these parameters. Kumhare *et al.* (2022) reported that timely sowing of linseed significantly improved yield attributes, seed yield and economic returns compared with delayed sowing. Similarly, Gohil *et al.* (2016) observed that linseed sown during the fourth week of October recorded higher number of capsules plant⁻¹ and seed yield than the second week of November sowing. Ganvit *et al.* (2019) [6] also reported significant effects of sowing date on growth, yield attributes, seed yield and oil yield, with favourable performance under optimum sowing conditions. Furthermore, delayed planting has been shown to reduce yield components and seed yield owing to shortened crop development and exposure of reproductive stages to unfavourable environmental conditions.

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Therefore, selection of an appropriate sowing window is particularly important for maintaining the yield potential and quality of linseed under late-sown conditions.

Plant spacing, on the other hand, determines plant population and the degree of competition among plants. The present investigation was undertaken to evaluate different sowing windows and spacings under late-sown conditions, with particular emphasis on yield attributes, oil content, oil yield, protein content, protein yield and economic returns (GMR, NMR and B:C ratio). Gohil *et al.* (2016) reported that a row spacing of 30 cm in linseed resulted in higher seed yield and stover yield than wider spacing of 45 cm, indicating the importance of optimum planting geometry for efficient resource utilization. Similarly, Ganvit *et al.* (2019) [6] observed that narrow spacing of 20 cm × 5 cm significantly improved seed yield, stover yield and oil yield compared with wider row spacing. Raj and Gupta (2020) [11] also reported that planting geometry significantly influenced yield attributes, yield and economics of linseed; although wider intra-row spacing improved individual plant yield attributes, closer spacing

produced higher seed yield and economic returns per unit area. More recently, research on row spacing in linseed has shown that narrower row spacing can enhance plant population and seed yield, whereas wider spacing may favour branching, capsules plant⁻¹ and test weight.

Materials and Methods

The experiment was conducted during *rabi* 2025-26 at the Agronomy Farm, College of Agriculture, Nagpur. The soil was clayey in texture, slightly alkaline (pH 7.3), with 0.53% organic carbon, 265.11 kg ha⁻¹ available N, 21.1 kg ha⁻¹ available P and 330.62 kg ha⁻¹ available K. Actual rainfall during the study period was 50.6 mm, with maximum and minimum temperatures of 41.5 °C and 4.1 °C, respectively.

The experiment was laid out in Factorial Randomized Block Design (FRBD) with four sowing windows and three spacings, giving 12 treatment combinations replicated three times (36 plots). Variety PDKV NL-260 was used with seed rate of 20 kg ha⁻¹ and fertilizer dose of 60:30:00 kg N:P₂O₅:K₂O ha⁻¹.

Treatment details

Sr. No.	Particular of experimental treatments	Symbol
A	Factor A- Sowing windows (SW)	
1	44 th MW (29 Oct-4 Nov)	SW ₁
2	46 th MW (12-18 Nov)	SW ₂
3	48 th MW (26 Nov-2 Dec)	SW ₃
4	50 th MW (10-16 Dec)	SW ₄
B	Factor B- Spacing (S)	
1	30 cm × 10 cm	S ₁
2	22.5 cm × 10 cm	S ₂
3	22.5 cm × 5 cm	S ₃

At harvest, number of capsules plant⁻¹, seed yield plant⁻¹ and test weight (g) were recorded. Seed yield (kg ha⁻¹), straw yield (kg ha⁻¹), oil content (%), oil yield (kg ha⁻¹), protein content(%), protein yield (kg ha⁻¹), gross monetary returns (GMR), net monetary returns (NMR) and B:C ratio were determined. Data were analysed under FRBD and significance was assessed at 5% level.

Result and Discussion

Yield attributes

Sowing windows significantly influenced no. of capsules plant⁻¹, seed yield plant⁻¹ of linseed. Sowing during 44th MW (SW₁ : 29 Oct- 4 Nov) recorded significantly higher values, whereas SW₄ recorded the lowest. Test weight was found non-significant, though SW₁ recorded the highest value. The superiority of early sowing may be attributed to the availability of a longer favourable period for vegetative and reproductive development. Delayed sowing shortens the crop duration and exposes reproductive stages to comparatively unfavourable temperature and moisture

conditions, resulting in reduced capsule formation and seed development. Similar results were reported by Maurya *et al.* (2017) [9], who recorded superior capsules plant⁻¹, test weight, seed yield and straw yield with 4 November sowing. Raj and Gupta (2020) [11] also reported superior yield attributes under fourth-week-of-October sowing. Spacing significantly affected capsules plant⁻¹ and seed yield plant⁻¹. Sowing at 30 cm × 10 cm (S₁) recorded significantly higher capsules plant⁻¹ (53.48) and seed yield plant⁻¹ (4.54 g) of linseed, while 22.5 cm x 5 cm (S₃) recorded the lowest values for these individual-plant attributes. This may be due to reduced inter-plant competition for light, moisture and nutrients under wider spacing. However, the response at individual-plant level was different from the response on an area basis. Similar observations regarding better individual plant growth under wider spacing have been reported by Ali *et al.* (2016) [1] and Gaikwad *et al.* (2019) [5]. The interaction was found non- significant.

Table 1: Effect of Sowing windows and Spacings on yield attributes of linseed

Treatment	No. of capsules plant ⁻¹	Seed yield plant ⁻¹ (g)	Test weight (g)	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	GMR	NMR	B:C
A. Sowing windows								
SW ₁ - 44 th MW (29 Oct- 4 Nov)	55.64	4.59	8.08	996	1932	63,624	38,478	2.53
SW ₂ - 46 th MW (12 Nov- 18 Nov)	51.25	4.16	7.89	948	1825	60,530	35,384	2.41
SW ₃ - 48 th MW (26 Nov- 2 Dec)	44.36	3.32	7.23	870	1717	55,634	30,488	2.21
SW ₄ - 50 th MW (10 Dec- 16 Dec)	35.73	3.04	7.06	703	1439	45,058	19,912	1.79
SE (m) ±	0.59	0.09	0.08	34	70	2,212	2,212	-
CD at 5%	1.74	0.27	NS	99	204	6,635	6,635	-
B. Spacing								
S ₁ - 30 cm × 10 cm	53.48	4.54	7.89	736	1448	47,056	21,910	1.87
S ₂ - 22.5 cm × 10 cm	48.81	3.66	7.71	853	1675	54,530	29,384	2.17
S ₃ - 22.5 cm × 5 cm	37.98	2.98	7.12	1048	2062	67,004	41,858	2.66
SE (m) ±	0.68	0.08	0.07	30	60	2,564	2,564	-
CD at 5%	1.97	0.23	NS	87	177	7,432	7,432	-
Interaction (SW × S)								
SE (m) ±	1.14	0.16	0.13	59	121	4727	4727	0.19
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
G.M.	46.75	3.73	7.57	879	1728	56,204	31,058	2.24

Seed and Straw yield (kg ha⁻¹)

Sowing window significantly influenced seed yield and straw yield of linseed. Sowing during 44th MW (SW₁: 29 Oct- 4 Nov) recorded significantly higher grain yield (996 kg ha⁻¹) and straw yield (1932 kg ha⁻¹) of linseed compared to all other sowing windows, whereas SW₄ (50th MW: 10 Dec- 16 Dec) recorded the lowest values (703 and 1439 kg ha⁻¹, respectively). The higher seed and straw yields of linseed under timely sowing may be attributed to the availability of a longer favourable growth period, better vegetative growth and more favourable temperature and moisture conditions during the reproductive and grain-filling stages. Similar results were reported by Gohil *et al.* (2016), who observed that linseed sown during the fourth week of October produced significantly higher seed yield (804 kg ha⁻¹) and stover yield (2543 kg ha⁻¹) than sowing during the second week of November.

Spacing significantly affected seed yield and straw yield of linseed. Spacing of 22.5 cm x 5 cm (S₃) recorded significantly higher seed yield (1048 kg ha⁻¹) and straw yield (2062 kg ha⁻¹) of linseed, whereas spacing of 30 cm x 10 cm (S₁) recorded the lowest values of seed and straw yield (736 and 1448 kg ha⁻¹, respectively). The higher yield of linseed under optimum spacing may be attributed to better plant population, efficient utilization of available light, moisture and nutrients, and reduced inter-plant competition, which together favour greater biomass production and translocation of assimilates towards seeds. Similar findings were reported by Gohil *et al.* (2016), who recorded significantly higher seed yield (832 kg ha⁻¹) and stover yield (2743 kg ha⁻¹) with 30 cm row spacing compared with 45 cm spacing in linseed. Gaikwad *et al.* (2019) [5] also reported that 30 x 5 cm spacing produced significantly higher seed yield than 45 cm x 5 cm and 30 cm x 10 cm spacing, although wider spacing favoured individual plant characters. The interaction between sowing window and spacing was non-significant.

GMR, NMR, B:C ratio

Economic returns of linseed declined progressively with delayed sowing. Sowing during 44th MW: 29 Oct- 4 Nov (SW₁) recorded significantly higher GMR (₹63,624 ha⁻¹), NMR (₹38,478 ha⁻¹) and B:C ratio (2.53) as compared to all other sowing windows, while sowing during 50th MW (SW₄: 10 Dec- 16 Dec) recorded the lowest GMR, NMR, B:C ratio. The higher economic returns under timely sowing may be attributed to better crop

establishment, longer favourable growth duration and improved seed and straw yield, which resulted in greater gross returns. Since the cost of cultivation remained relatively similar among sowing windows, the higher gross returns under optimum sowing consequently resulted in higher net monetary returns and B:C ratio. Kumhare *et al.* (2022) reported that linseed sown during the 44th MW (29 October-4 November) recorded the highest GMR (₹44,688 ha⁻¹), NMR (₹23,436 ha⁻¹) and B:C ratio (2.10), and attributed the higher GMR mainly due to the higher seed and straw yield obtained under favourable sowing conditions. Similarly, Raj and Gupta (2020) [11] reported that sowing linseed during the 4th week of October resulted in the highest GMR (₹56,745 ha⁻¹), NMR (₹39,145 ha⁻¹) and B:C ratio (2.22), indicating that timely sowing enhanced productivity and profitability. Among spacings, sowing at 22.5 cm x 5 cm recorded significantly higher (S₃) GMR (₹67,004 ha⁻¹), NMR (₹41,858 ha⁻¹) and B:C ratio (2.66), demonstrating its economic superiority under the present conditions. The higher economic returns under S₃ may be attributed to better plant distribution and efficient utilization of available light, moisture and nutrients, which enhanced yield per unit area and consequently increased gross and net returns. The higher NMR and B:C ratio under S₃ indicate that the additional returns obtained from higher productivity were sufficient to offset the cost of cultivation. Similar findings were reported by Raj and Gupta (2020) [11], who observed that planting geometry significantly influenced the economics of linseed and that optimum spacing resulted in higher economic returns per unit area. Chopra and Badiyala (2016) [4] also reported that favourable spacing improved seed yield and economic returns in linseed owing to better growth and yield formation under suitable environmental conditions. Interaction effects were non-significant.

Quality parameters

The grand mean oil content was 34.59%. Oil content was not significantly affected by sowing window or spacing. Oil yield was significantly influenced by both factors sowing during 44th MW (29 Oct- 4 Nov) significantly higher oil yield of linseed recorded, while sowing at 22.5 cm x 5 cm (S₃) recorded the highest oil yield (354 kg ha⁻¹) which was significant by superior over other spacings. The higher oil yield under S₃ was associated with greater yield per unit area. Interaction was non-significant.

Table 2: Effect of sowing windows and spacings on quality parameter oil content (%), oil yield (kg ha⁻¹), protein content (%), protein yield (kg ha⁻¹) of linseed

Treatment	Oil content (%)	Oil yield (kg ha ⁻¹)	Protein content (%)	Protein yield (kg ha ⁻¹)
A. Sowing windows				
SW ₁ - 44 MW (29 Oct- 4 Nov)	35.08	349	23.09	232
SW ₂ - 46 MW (12 Nov- 18 Nov)	34.81	330	22.92	217
SW ₃ - 48 MW (26 Nov- 2 Dec)	34.46	300	22.60	197
SW ₄ - 50 MW (10 Dec- 16 Dec)	34.02	239	22.09	155
SE (m) ±	0.4	16	0.09	4
CD at 5%	NS	50	0.25	11
B. Spacing				
S ₁ - 30 cm x 10 cm	35.13	259	23.69	174
S ₂ - 22.5 cm x 10 cm	34.90	298	22.96	196
S ₃ - 22.5 cm x 5 cm	33.75	354	21.53	226
SE (m) ±	0.3	17	0.07	3
CD at 5%	NS	51	0.22	10
Interaction (SW x S)				
SE (m) ±	0.5	28	0.15	6
CD at 5%	NS	NS	NS	NS
GM	34.59	304	22.73	199

Protein content and protein yield were significantly influenced by sowing window and spacing. Sowing during 44th MW (SW₁) recorded the highest protein content (23.09%) and protein yield

(232 kg ha⁻¹) which was significantly superior over other sowing windows, while SW₄ recorded the lowest values. Sowing at 30 cm x 10 cm (S₁) recorded the highest protein content (23.69%),

whereas sowing at 22.5 cm x 5 cm (S₃) recorded the highest protein yield (226 kg ha⁻¹) which were significantly superior over other spacings. Thus, wider spacing favoured protein concentration, while closer spacing favoured protein production per hectare. Interaction was non-significant.

Conclusion

Sowing during the 44th MW (SW₁; 29 Oct-4 Nov) recorded significantly higher yield attributes and yield, oil yield, protein yield and economic returns in linseed. Spacing of 22.5 cm x 5 cm (S₃) produced significantly higher seed yield, oil yield, protein yield, GMR, NMR and B:C ratio of linseed although 30 cm x 10 cm (S₁) was superior for individual-plant yield attributes and protein content.

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