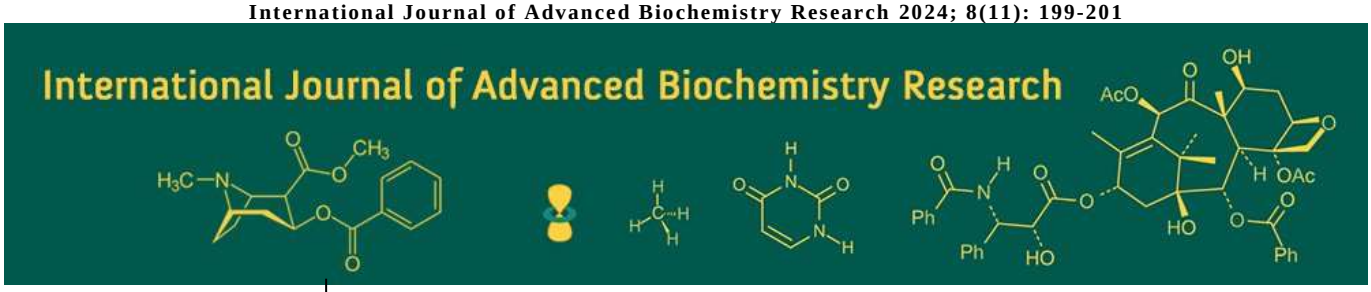

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Influence of different sowing dates on yield and economics of irrigated linseed (*Linum usitatissimum* L.)

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Abstract
Linseed (*Linum usitatissimum* L.) is an annual herbaceous plant and generally requires fairly cool and humid conditions for its optimum growth and yield. Crop growth and development are closely related with dates of sowing which ultimately affect yield and economics. Therefore, experiment was conducted on influence of different sowing dates on yield and economics of irrigated linseed (*Linum usitatissimum* L.) with linseed variety PKV NL-260 during *Rabi*-2023-24 at AICRP on linseed, College of Agriculture, Nagpur. The experiment was laid out in randomized block design with six treatments and replicated four times. Treatment under study were T_1 (Sowing of linseed in last week of October, 44th MW), T_2 (Sowing of linseed in 1st week of November, 45th MW), T_3 (Sowing of linseed in 2nd week of November, 46th MW), T_4 (Sowing of linseed in 3rd week of November, 47th MW), T_5 (Sowing of linseed in 4th week of November, 48th MW) and T_6 (Sowing of linseed in 1st week of December, 49th MW) with spacing 30 cm between row to row on plot with size of 4.8 m x 4.2 m. Other operations were carried out as per recommendations. Results revealed that, treatment T_2 (Sowing of linseed in 1st week of November, 45th MW) produces significantly highest grain and straw yield, gross monetary returns (GMR), net monetary returns (NMR) and B: C (Benefit: Cost) ratio as compared to rest of the treatments.

Keywords: Linseed, sowing dates, PKV NL-260, yield, GMR, NMR, B: C ratio

Introduction
Locally referred to as alsi or jawas, linseed (*Linum usitatissimum* L.) is an annual herbaceous plant in the Linaceae family. Known for its high nutritional and medicinal value, it has become an essential oilseed crop in central India, particularly prized for its health benefits. The seeds are rich in omega-3 fatty acids and lignans, compounds that contribute to heart health and anti-inflammatory properties.

The important oilseed crop cultivated in our nation is linseed (*Linum usitatissimum* L.). It was first cultivated for its oil and fiber (Flax). Linseed stands out among oilseeds due to its exceptional health benefits, primarily attributed to its high concentration of alpha-linolenic acid (ALA), an Omega-3 fatty acid. ALA constitutes approximately 35- 45% of the oil in linseed, making up about 57% of its total fatty acids. This significant Omega-3 content contributes to several anti-inflammatory and anti-cancer properties. Studies suggest that Omega-3 fatty acids, such as those found in linseed, may inhibit the growth of certain tumor types, and play a role in reducing inflammatory conditions like rheumatoid arthritis. Additionally, Omega-3s help to lower blood triglyceride levels, reducing the risk of heart disease. Linseed also contains linoleic acid (LA), an essential Omega-6 fatty acid that complements the health benefits of Omega-3, further enhancing linseed's role in promoting cardiovascular and overall health.

Linseed is predominantly cultivated across the Indian states of Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, and West Bengal, spanning a vast area of approximately 468 thousand hectares and yielding around 1.41 lakh tons each year (Anonymous, 2023) [1]. Madhya Pradesh leads in linseed cultivation, holding the highest share in both area and production, as noted by Marbate *et al.* (2020) [5]. This significant production reflects linseed's adaptability to diverse climates and its growing importance in Indian agriculture. Despite the

potential applications of linseed particularly in composites and bio-based industries, linseed fibre production remains economically marginal (Rennebaum *et al*., 2002) [10]. Temperature plays a crucial role in the growth and development of linseed, particularly during the *Rabi* season. Although it prefers a cool, humid climate for optimal fiber crop production, linseed performs best in moderately cold conditions for seed production, requiring dry weather as it matures.

Research shows that drought during the blooming phase, especially when temperatures exceed 32 °C, significantly reduces the quality, yield, and oil content of linseed. Temperatures at the seedling stage between -8 °C and 3 °C can damage or even destroy linseed crops, though in later stages, the plant can withstand temperatures as low as – 9 °C or lower (Shaikh *et al*., 2009) [8].

Among the agronomic factors impacting linseed productivity, sowing time stands out as a critical, non-financial element. The timing of sowing greatly influences the crop's growth, yield, and oil content, as well as the quality of the resulting flax. Managing the sowing date has proven to be an effective strategy for mitigating the adverse effects of high temperatures and moisture stress during the vital flowering and seed-filling stages (Chauhan *et al*., 2008) [2]. By optimizing sowing time, farmers can enhance crop resilience and improve the overall quality and productivity of linseed.

Methods and Material

An experiment was conducted at AICRP on linseed, College of Agriculture, Nagpur during *Rabi* seasons of 2023-24 under irrigated condition. The soil of the experimental site was clayey in texture. An experiment was laid out in randomized block design with six treatments and replicated four times. For the experiment linseed variety PKV NL-260 was used. Treatment under study were T_1 (Sowing of linseed in last week of October, 44th MW), T_2 (Sowing of linseed in 1st week of November, 45th MW), T_3 (Sowing of linseed in 2nd week of November, 46th MW), T_4 (Sowing of linseed in 3rd week of November, 47th MW), T_5 (Sowing of linseed in 4th week of November, 48th MW) and T_6 (Sowing of linseed in 1st week of December, 49th MW) with spacing 30 cm between row to row on plot with size of 4.8 m x 4.2 m. The sowing was done on treatment based meteorological weeks and harvested at full maturity. The observations were recorded on grain yield and straw yield from net plot area and converted into ha^{-1} yield with the help of hectare factor and statistical analysis was done. Cost of cultivation was calculated and studies on economics were carried out with the help of current market price of linseed.

Results and Discussions

Influence of sowing dates

Seed yield

The data presented in Table 1 revealed that different sowing dates have a significant impact on seed yield plant^{-1} (g) in linseed. Treatment T_2 (Sowing in the 1st week of November, 45th MW) produced the highest seed yield at 953.04 kg ha^{-1}, which was significantly higher than all other treatments. However, treatment T_1 (Sowing in the last week of October, 44th week) achieved a yield of 916.96 kg ha^{-1} which was statistically at par with treatment T_2. In contrast, the lowest seed yield was observed in treatment T_6 (sowing in the 1st week of December, 49th week) and which was 757.85 kg ha^{-1}. This might be due to cumulative effect of improvement in growth and yield attributes such as number of branches per plant, number of capsules per plant, number of seeds per capsule as well as test weight turned into highest yield. These findings are quite in line with the findings of Yadav (2005) [9], Maurya *et al.* (2017) [6], Ganvit *et al.* (2019) [3] and Kumhare (2022) [4].

Straw yield

The data presented in Table 1 revealed that different sowing dates have a significant impact on seed yield plant^{-1} (g) in linseed. Treatment T_2 (sowing in the 1st week of November, 45th MW) achieved the highest straw yield and which was 1523.04 kg ha^{-1}. However, it was statistically at par with T_1 (sowing in the last week of October, 44th MW) with yield 1502.08 kg ha^{-1}. The lowest straw yield was recorded in T_6 (sowing in the 1st week of December, 49th MW) and which was 1386.60 kg ha^{-1}. This may be attributed due to the higher plant height, number of capsules and primary and secondary branches per plant which ultimately results in higher straw yield. Similar results were reported by Rahul Raj and Gupta (2020) [7].

Economic

The data collected on the GMR, NMR, B: C Ratio in linseed, as shown in Table 1 indicated that different sowing dates had a significant effect on GMR, NMR, B: C Ratio. In case of GMR, treatment T_2, involving sowing in the 1st week of November (45th MW), achieved the highest GMR at 59419. This was followed by T_1, where sowing took place in the last week of October (44th MW), yielding a GMR of 57,737. In contrast, the lowest GMR was observed in treatment T_6, with sowing in the 1st week of December (49th week), resulting in a GMR of 47,893. The general mean GMR across all treatments was 54,266. Similar results are in close accordance with Ganvit *et al.* (2019) [3].

The net monetary return (NMR) for linseed was notably impacted by different sowing dates. Treatment T_2, with sowing in the 1st week of November (45th MW), produced the highest NMR at 38,334. This was followed by T_1, where sowing occurred in the last week of October (44th MW), yielding an NMR of 36,652. Conversely, the lowest NMR was recorded in treatment T_6, which involved sowing in the 1st week of December (49th MW), resulting in an NMR of 26,807.77. The general mean NMR across treatments was 33,563. Similar results are in close accordance with Ganvit *et al.* (2019) [3].

The benefit-cost (B: C) ratio for linseed showed a marked difference based on sowing dates. Treatment T_2, with sowing in the 1st week of November (45th MW), achieved the highest B: C ratio at 2.81, indicating a superior economic return. This was followed by T_1, with sowing in the last week of October (44th MW), which achieved a B: C ratio of 2.74. The lowest B: C ratio was observed in T_6, where sowing occurred in the 1st week of December (49th MW), yielding a B: C ratio of 2.27. These findings are quite in line with the findings of Rahul Raj and Gupta (2020) [7].

Table 1: Influence of different sowing dates on yield and economics of irrigated linseed

Treatments	Yield		Economics		
	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B: C ratio
T_1 - Sowing of linseed in last week of Oct (44th MW)	916.96	1502.08	57737	36652	2.74
T_2 - Sowing of linseed in 1st week of Nov (45th MW)	953.04	1523.04	59419	38334	2.81
T_3 - Sowing of linseed in 2st week of Nov (46th MW)	889.71	1475.89	56043	34959	2.66
T_4 - Sowing of linseed in 3st week of Nov (47th MW)	857.54	1453.98	54054	32970	2.56
T_5 - Sowing of linseed in 4st week of Nov (48th MW)	808.93	1415.62	51043	29958	2.42
T_6 - Sowing of linseed in 1st week of Dec (49th MW)	757.85	1386.60	47893	26808	2.27
SE(m) ±	12.08	9.21	611	611	-
C.D. at 5%	36.63	30.05	1842	1842	-
GM	864.00	1459.53	54265	33563	2.57

Conclusion

On the basis of the field experimentation it is concluded that, treatment T_2 (Sowing of linseed in 1st week of November, 45th MW) was found to be optimum for achieving significantly highest seed and straw yield, gross monetary returns (GMR), net monetary returns (NMR) and B:C ratio as compared to rest of the treatments.

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