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Effect of sowing dates on yield attributes and yield of linseed (*Linum usitatissimum* L.) varieties

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Abstract
Linseed (*Linum usitatissimum* L.) is an important rabi oilseed crop in India. The high nutritive values of linseed increase its market demand for human nutrition, cosmetic, pharmaceutical and textile industry. However, the decreasing trends in area and yield in linseed due delay in sowing urge the need of optimization of sowing dates. In present investigation linseed genotypes were shown in three different dates and analysed for grain & fibre yield, and net return. Our studies showed that sowing in last week of November significantly increased grain & fibre yield, and also net return.

Keywords: Linseed (*Linum usitatissimum* L.), oilseed crop, sowing time, seed yield, fibre yield

Introduction
Linseed (*Linum usitatissimum* L.) is a self-pollinated crop commonly known as, tisi, Linum, and linen etc. It is mainly grown for its multipurpose oil and fibre in the world (Kajla *et al*., 2015) [7]. It is an annual herbaceous plant belonging to Linaceae family, which is native to west Asia and the Mediterranean that has been cultivated since at least 5000 BC (Saghayesh *et al*., 2014) [11]. All parts of this plant have extensive and varied uses. It has an industrial value and is also used as proteinaceous feed for livestock as well as for human (Raundal *et al*., 2015) [9]. Linseed serves as the best omega 3 fatty acid source to the non-fish eaters. Apart from human consumption there is huge demand of linseed oil in commercial industries for making of paint, varnish and printing ink. India ranks first in terms of area under linseed cultivation and third in production in world. In India, linseed cultivated about 4.68 lakh ha and total linseed production is 1.63 lakh tones (Maurya *et al*., 2017) [8].
It is an important rabi oilseed crop in India and occupies 468 thousand ha area with productivity of 349 kg ha-1 (DES, Agricultural Statistics at a Glance, Govt. of India, 2010). It is grown under rainfed (63%), utrea (20%) and irrigated (17%) conditions (Rokade *et al*., 2015) [10]. However, there has been a continuous decline in linseed area in the country during the last few decades so to sustain linseed production mainly in rainfed area. One of the main reasons behind decline in area is due to late harvesting of paddy crop. In many parts of country farmers fail to undertake timely sowing of linseed which results to shorter growth period available to late sown linseed coupled with high temperature and hot winds during reproductive growth period, which leads to forced maturity and ultimately poor grain yield. A plethora of reports indicates that sowing dates of linseed significantly affect growth and yield attributing traits (Al-Doori, 2012; Maurya *et al*., 2017; Jana *et al*., 2018; Ganvit *et al*., 2019) [1, 8, 6, 4]. Optimization of sowing time is one of the most vital agronomic factors which has obvious impact on production and productivity of crop (Ganvit *et al*., 2019) [4]. Therefore, in present investigation an attempt was undertaken to optimize the sowing dates of few high yielding linseed varieties of Bihar region and net returns to the farmers were also calculated.

Methods
The present study was conducted during rabi season at Agricultural Research Institute, Patna, RAU, Pusa. Four linseed genotypes namely PKDL-62, Parvati, LCK-6028 and Sikha were used present study. The experiment was laid out in split plot design with three replications. Seeds were sown in previously opened furrows with three different sowing dates, i.e. S. DI: 22nd November, S. DII: 7th December and S. DIII: 22nd December in irrigated condition. Plot size was kept as 12 square meter. Recommended dose of fertilizers and irrigation were applied to all plots. The data were recorded for different characters during the course of investigation. The economics was calculated on the basis of different inputs and output.

Result and Discussion

Plant height

The plant height of all the genotypes shown in different dates of sowing was evaluated at maturity. The significantly taller plant was observed in all the genotypes sown on 22nd November compared to other sowing dates. The similar results were also observed in previous studies (Ganvit *et al*., 2019; Ganga *et al*., 2015; El-Mohsen *et al*., 2013) [4, 3, 2]. The higher plant height in timely swing might be due to favourable climatic conditions like temperature and other growth parameters during crop growth (Ganvit *et al*., 2019) [4].

Effect on yield and yield attributing traits

Yield and yield attributing traits were analysed in all the genotypes in different dates of sowing at maturity. Significantly higher number of capsules/plant was observed in under treatment S. D1i.e. 22nd November. Number of seeds/capsule in treatment S. D1 (22nd November) produced significantly higher number of seeds/capsule. The higher number of capsules/plant and number of seeds per capsule were due to timely sowing of seeds and exposure to favourable weather during the entire growth period (Ganvit *et al*., 2019) [4]. Our results were in accordance with other previous studies (Ganga *et al*., 2015; Maurya *et al*., 2017) [3, 8].

Grain and fibre yield

Seed yield analysis was performed in all treatment. Our analysis showed significantly higher grain yield in S. D1 for all the four genotypes studied (Table 1). Linseed genotype Sikha showed highest grain yield (1376 Kg/ha) in all the different date of sowing (Table 1). However, the fibre yield (FY) in LCK-6028 was highest in S. D1. The FY is also highest in LCK-6028 among all the other genotypes studied. The higher grain and fibre yield in S.D1 were due to timely planting. The results were supported by several similar studies (Ganga *et al*., 2015; Maurya *et al*., 2017; El-Mohsen *et al*., 2013) [3, 8, 2].

Effect on economics

Among various sowing dates S. D1 recorded the highest net returns compared to other late sowing dates. The highest net return was observed in Shikha (₹37,655/-) followed LCK-6028 (₹37,450/-). The S.DIII observed least net return in all the genotypes studied (Table 1). The decrease in net return as delay in sowing dates was supported by previous studies also (Gohil *et al*. 2016; Maurya *et al*. 2017; Ganvit *et al*., 2019) [5, 8, 4].

Table 1: Seed yield and economics of linseed influenced by different sowing dates of sowing

Entries	Sowing date-I			Sowing date-II			Sowing date-III		
	G. Y. (kg/ha)	F. Y. (kg/ha)	NMR (Rs)	G. Y. (kg/ha)	F. Y. (kg/ha)	NMR (Rs)	G. Y. (kg/ha)	F. Y. (kg/ha)	NMR (Rs)
PKDL – 62	0840	0386	22,100	0726	0324	17,005	0705	0174	10,625
Parvati	1194	0517	35,895	0972	0429	25,790	0894	0295	19,240
LCK-6028	1180	0563	37,450	0963	0448	25,735	0568	0328	12,710
Shikha	1376	0447	37,655	1174	0348	27,980	0643	0276	12,690

Conclusion

In present investigation it has been concluded that sowing date was a very important management tool in maximizing grain and fibre yield. Our results revealed that for linseed production, sowing in last week of November are preferable compared to sowing in 1st and last week of December.

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