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Assessment of improved variety of linseed in Jabalpur district Kymore plateau and Satpura hills agro-climatic zone of Madhya Pradesh

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Abstract
Linseed is a foremost *rabi* oilseed crop of Madhya Pradesh, it requires moderate to cool temperature during its major crop growth period. Its productivity in Kymore Plateau Agro-Climatic Zone of Jabalpur district is far below than potential yield of the varieties. Owing to development of improved linseed varieties and requirement of package of practices for different situations of linseed cultivation, there has been a balanced but slow increase in the yield of linseed over a long period. At early and seed filling stage of the crop high temperature and drought are harmful causing yield and quality reduction, low seed replacement ratio, due to lack of availability of high yielding varieties at the time of sowing and lack of technological know-how of recent package of practices. Keeping this in view, the present Front Line Demonstration was carried out at ten farmers' field under irrigated condition with improved technology in two consecutive years in rabi season during 2021-22 and 2022-23 in Jabalpur district of Madhya Pradesh. Linseed variety recommended for irrigated condition viz. JLS 66 with improved techniques along with farmer's practices (local old and mix variety) were tested. The average higher numbers of capsules/plant were recorded in the variety JLS 66 (47.52) as compared to farmer's practices (30.58). The pooled data for two years revealed that the highest yield of JLS 66 was (13.40 q/ha) was recorded as compared to farmers practices which was 9.20 q/ha. Improved management package and practices increased the average net returns by Rs. 51820/ha in JLS 66, in demonstrated plot while farmers obtained Rs. 29940/ha by their own practices. On an average benefit cost ratio was 3.10 (JLS 66) under demonstrated technologies while it was 2.33 in farmers practices.

Keywords: Linseed, improved varieties, capsules/plant, net returns, BCR

Introduction
Linseed (*Linum usitatissimum* L.) is one of the important oil-seed crop of the world from very beginning of the human civilization. It belongs to the genus *Linum* of the family Linaceae, having 13 genera, but only *Linum usitatissimum* (with diploid chromo- some 2n = 30) is the only cultivated species of genus *Linum.* The word 'linseed' is used when it is grown for oil purpose and 'dual purpose flax' when grown for both oil and fibre and word 'flax' is used when it is grown for fibre, it is also popularly known as Jawas, Alsi, Tisi, in our Indian language. Linseed is currently cultivated in many countries like Uruguay, India, Pakistan, China, Russia, U.S.A., Argentina, Japan, Morocco, Australia, Ireland, Scotland, Poland, and a few other European countries. It is widely cultivated in Rajasthan, Bihar, Uttar Pradesh, Assam, Jharkhand followed by other states. Madhya Pradesh has largest growing area (1.16 lakh ha) and production (0.55 lakh tones) with 474 kg/ha productivity.

Nutritional value
Nutritional value of linseed is depended upon various factors such post-harvest handling (processing) and even in the end consumer usage and genetics, growing conditions, biotic and abiotic stresses. Linseed is an amazing source of essential fatty acids and it can be seen as an alternate source of omega-3 fatty acids for vegetarians. It contains about 33 to 47% of oil content which may vary due to a number of factors. Linseed oil is rich in alpha-linolenic acid (ALA) and contains about 55% ALA. It also contains high levels of dietary fiber as well as lignin. Abundance of micronutrient and omega-3 fatty acids is also present. It has a good taste and contains 36% protein out of which, 85% is digestible. It serves as a good source of minerals especially, magnesium (350-431 mg/100g) phosphorous (650 mg/100g), calcium (236-250 mg/100g) and has very lesser amount of sodium (27 mg/100g. It constitutes 98%

triacylglycerol, phospholipids and 0.1% free fatty acids. Linseed oil is rich in polyunsaturated fatty acid [PUFA] (73% of total fatty acid), moderate in monounsaturated fatty acid [MUFA] (18%) and low amount of saturated fat (9%). It is rich and has abundance of both the essential fatty acids, i.e. alpha linolenic acid (ALA), and linolenic acid (LA). Fatty acid profiles of various oilseeds are shown in table 1. From the data given in the table, we can see that linseed contains highest amount of linolenic acid followed by soybeans and others, while sunflower and safflower oils contains higher amount of linoleic acid which may lead to various diseases.

Nutrients	Moisture (g)	Fat(g)	Minerals (g)	Total Dietary Fibre (g)	Carbohydrate (g)	Energy (KCal)	Potassium (g)	Calcium (g)	Phosphorus (mg)	Iron (mg)	Vitamin A (mg)	Biotin (mg)	Folic acid (mg)
Amount per 100 g of edible linseed	6.5	37.10	4.80	24.50	28.90	530.0	750.0	170.0	370.0	2.70	30.0	0.6	112

Nutritional value of linseed

Table 1: Fatty acid profile of various oilseeds

Fatty acid	Linseed	Mustard	Soybean	Rice bran	Corn	Sesame	Safflower	Olive	Sunflower
Saturated	10	8	15.7	21.3	14.8	15.7	9.1	15.3	12.8
Monounsaturated	18.5	62.4	24.2	42.4	28.1	40.1	13.9	73.8	22.4
Polyunsaturated	71.8	31.5	59.8	35.9	57.1	45.7	77.3	10	66
Linoleic acid (n6)	16.8	21.6	52.1	34.6	56.1	45.3	76.5	9.4	65.6
Linolenic acid (n3)	55	9.9	7.8	1.2	1	0.4	0.8	0.6	0.5
n6/n3	0.3	2.2	6.7	2	56	113	7.4	16	131

This crop is generally grown on sub marginal/marginal, irrigated as well as un-irrigated (rainfed), input-starved land conditions with use of local old mixed varieties and poor crop management practices as pure and mixed or intercrop, which are responsible as major factors for lower productivity. Recently, several high yielding varieties of the crop have been released which produce higher seed yield with good agronomical practices under both situations. Thus, these varieties with improved production technologies have turned this crop into high remunerative crop.

Keeping this in view, the overall objectives of this Front-Line Demonstration (FLD) is to evaluate and select appropriate and competent linseed varieties in Jabalpur district of Kymore Plateau and Satpura Hills Agro-Climatic Zone of Madhya Pradesh.

Specific objectives

1. To evaluate the performance of linseed variety under irrigated condition.
2. To promote and popularize newly released high yielding linseed varieties among the local farmers and extending up of the variety among farming communities in a broarder area.

Methodology

The study was conducted at Krishi Vigyan Kendra, Jabalpur for two consecutive year i.e. 2021-22 and 2022-23 during rabi season at Kundam block of the district in village badkhera. The farmers of these villages had small and marginal land holdings. The soil of the operational area in Kymore Plateau Zone was generally light soil Gravel and sandy soil, low in O.C., pH-6.0-7.0. Technological differences between improved management package and practices of linseed and farmer's practices were studied based on survey and group discussion with farmer's interactive group (FIG) of linseed growers in selected villages. The technological gap between demonstrated on-farm trials and existing practices was identified and categorized into three levels *viz*., full gap (0), partial gap (1) and technology adoption (2). The FLD was conducted on ten farmer's field to assess the performance of linseed variety JLS 66 and local variety used in farmer practice is designated as T2. The total two hectares area was covered in each year. Trials were conducted with full package and practices *viz*. improved varieties of linseed, proper seed rate (25 kg/ha), seed treatment with fungicide, PSB and *Azotobacter* culture @ 10 g/kg seed, line sowing with balanced dose of fertilizers, weed management, light irrigation at critical crop growth stages and plant protection measures etc. One control plot was also kept as farmer's practice which is designated as T1. The FLD were monitored by scientists of Krishi Vigyan Kendra, Jabalpur right from sowing to harvesting and made to guide them. The primary data on grain yield was collected from the demonstrated and farmers' practices field through a random plot cutting methodology followed by personal interviews. The data on quantitative parameters *viz*., yield q/ha, no. of capsules/plant, gross returns, net returns and benefit cost ratio were recorded and per cent yield increase in FLD over farmers' practice was calculated by using the following formula (Choudhary, *et al*., 2009) [1].

$$\text{Percent increase yield} = \frac{\text{Average Demonstrated Yield- Farmer's average plot yield}}{\text{Farmer's average plot yield}} \text{ x } 100$$

Results and Discussion

Technological adoption gaps in Linseed

The data presented in Table 2 showed that Full gap was identified for use of high yielding varieties, seed rate, crop geometry, seed treatment, weed management, irrigation and technical guidance, which surely was the reason of not achieving potential yield while fertilizer management and plant protection measure showed partial adoption gap. The time of sowing showed no adoption gap. Farmers in general used local or old-age mixed varieties instead of the recommended high yielding and newly released varieties.

Lack of availability of quality seed on time and lacuna of awareness were the main reasons. Seed rate is the important key determinant of a good plant population. For achieving a desired plant density, seed rate is decided on the basis of seed size, seed purity and germination percentage. Farmers applied higher seed rate than the recommended because they were not aware about importance of proper quantity of seed. Crop geometry is beneficial over broadcasting as it ensures uniform distribution of seeds, placement of seeds at proper depth, better plant stand, easy in cultural operation and also improved drainage. Proper crop geometry reduces the insect pest population and diseases also. It may be sowing by broadcasting method resulted poor germination and uneven plant population.

Lack of awareness among the farmers about the importance of recommended crop geometry. The recommended time of sowing of linseed crop is first fortnight of October in rainfed areas while it is first fortnight of November for irrigated timely sown varieties. Crop when timely sown escape itself from diseases like rust powdery mildew and pod fly menaces. The farmers were much concerned about importance of sowing time but they don't aware it escapes the pest and diseases from the crop. Farmers were not using seed treatment technique through *Trichoderma harzianum* for wilt management and they are also not using seed treatment technique with phosphorous solubilising bacteria (PSB) and *Azotobacter* culture to better utilization of phosphorous and other available nutrients in the soil for good crop health and production, because of lack of knowledge and interest.

Crop suffers from a sever weed infestation during 25-45 days which causes drastic reduction in yield. The reason of not using improved weed management practices were mostly attributed by the farmers to the lack of knowledge behind the importance of weed management practices. Linseed is mostly sown as a rainfed crop. If winter rains fail, give one irrigation at 30-40 DAS and one at pre-flowering stage. Farmers were not aware about correct and timely information and technical guidance because of due to lack of interest and conviction. Similar findings were reported in previous studies (Singh *et al*., 2018; Thakur, *et al*., 2019) [4, 5].

Analysis of yield attributing characters, crop productivity and yield enhancement

The espousal of improved management package and practices *viz.* recommended seed rate, use of newly released high yielding varieties seeds, seed treatment, method and time of sowing, recommended dose of fertilizers, weed management and proper plant protection measures are a pre-requisite for getting higher production in any area. The performance of technological interventions in terms of crop productivity, yield attributing characters, and yield enhancement in linseed crop for two consecutive years i.e. 2021-22 and 2022-23 as shown in Table 3. The results clearly indicated that the average higher number of capsules/plant was recorded in the variety JLS 66 (45.82) as compared to farmer's practices (28.58) during 2021-22. While, it was recorded to be average higher number of capsules/plant (47.58) as compared to farmers practices (30.58) during 2022-23. The numbers of capsules/plant in variety JLS 66 was increased by 55.39% after the 2nd year of demonstration. While, the seed yield/plant was increased by 45.65% in the variety JLS 66 respectively as compared to farmers practices. The seed yield/plant was recorded to be 12.46 in (RP) how so ever it was found to be 8.46 (FP) during 2021-22. While, it was recorded to be 13.40 under (RP) and 9.20 for (FP) during Rabi 2022-23.

Seed yield was found positively correlated with yield attributing traits. Use of improved variety, seed treatment before line sowing, recommended dose of fertilizer for proper supply of nutrients, need based plant protection measure and other agro-techniques might have helped in better crop growth and higher grain yield. The results clearly speak of the positive Majority of the farmers are misguiding as there is no requirement of irrigation in linseed crop. Effect of FLDs over existing practice towards enhanced the yield of linseed crop in location specific irrigated area of the district. The similar trend of crop productivity and yield enhancement in linseed crops has been documented in previous studies (Thakur *et al*., 2019; Diwan *et al*., 2019) [5, 2].

Economic analysis of OFT on linseeds

The economics of linseed crop production under Front Line Demonstrations in irrigated condition were estimated and the results have been presented in Table 4. Different variables like suitable seed of higher yielding varieties for irrigated condition, seed treatment, time and method of sowing, weed management balanced dose of fertilizers application and plant protection measures etc. were considered as a technological intervention. Economic indicators i.e. net returns and B: C ratio of FLDs conducted clearly revealed that in linseed crop, the net returns and BC ratio from the recommended practices were substantially higher than control plot (farmers practice) during both the years of assessment of technology. Average higher gross returns were recorded by Rs. 76356 Rs./ha per hectare in the variety JLS 66 with improved management package and practices while it was recorded by Rs 52897 Rs./ha in practices of farmers field. Improved management package and practices increased the average net returns by Rs. 50335Rs./ha in JLS 66, in demonstrated plot while farmers were obtained Rs. 28199Rs./ha by their own practices. The higher profitability under improved management package and practices was attributed to higher values of yield attributes and grain yield of linseed compared to farmers practice. The higher gross and net monetary return realized by the farmers indicate the economic feasibility of the technology. The data presented in Table 3 also revealed the cost of cultivation were higher under improved management package and practices

during both the years owing to use of quality inputs and other technologies than the farmers' field. On an average benefit cost ratio was 3.24 (JLS 66) under the assessed technologies while it was 2.45 in farmers practices. These results are in close conformity with the findings were previously recorded in the case of oilseed crops (Patil, *et al*., 2018; Thakur *et al*., 2019) [3, 5].

Table 2: Technological gap between improved management package and existing practices of linseed under irrigated condition

Sl. No.	Particulars	Improved management Package and practices for irrigated condition	Farmers Practices	Technological gap
1.	Variety	JLS 66	Local old mix	Full gap (100%)
2.	Seed rate	25-30 Kg/ha	40-50 kg/ha	Full gap (100%)
3.	Crop geometry	Line sowing with seed drill (25-30 x 7-10 cm) and 2-5 cm below in the soil	Broadcasting	Full gap (100%)
4.	Sowing time	1st fortnight of October	1st fortnight of October	No gap
5.	Fertilizer dose	30:30:15:15::N:P:K:S Kg/ha	Imbalanced use of fertilizers	Partial gap
6.	Seed treatment	Bavistin @ 2.0 g/kg seed, *Trichoderma harzianum* @ 5 g/kg seed, PSB and *Azotobacter* culture @ 10 g/kg seed	No seed treatment	Full gap (100%)
7.	Weed management	Isoproturon 75% WP @ 1 kg/ha + 2, 4 D (Na) @ 0.5 kg/ha at 30-35 DAS or One at 25 DAS and 2nd at 45 DAS	No weeding	Full gap (100%)
8.	Irrigation	Two light irrigation Ist at 30-40 DAS and IInd at just before flowering for good yield	No irrigation	Full gap (100%)
9.	Plant protection measure	Need based pesticide spray for rust, powdery mildew and bud fly management	Injudicious use of pesticide	Partial gap
10.	Technical guidance	Time to time	No technical guidance	Full gap (100%)

Table 3: Yield and yield attributing characters under improved and farmers practice

Year	No. of capsule/plant		Capsule increase in percent over farmers' practice	Yield (q/ha)		% increase in the yield over farmers' practice
	T1	T2	T2	T1	T2	T2
2021-22	28.58	45.82	60.32%	8.46	12.46	47.28%
2022-23	30.58	47.58	55.59%	9.20	13.40	45.65%
Mean	29.58	46.70	57.95%	8.83	12.93	46.46%

Table 4: Economic performance linseed varieties with improved technology and farmers practices

Year	Gross cost (Rs/ha)		Gross returns (Rs/ha)		Net returns (Rs/ha)		Benefit cost ratio	
	T1	T2	T1	T * 2	T1	T * 2	T1	T2
2021-22	20458	26460	49354	72333	26458	48850	2.41	3.22
2022-23	22500	24560	56440	80380	29940	51820	2.50	3.27
Mean	21479	25510	52897	76356	28199	50335	2.45	3.24

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