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Assessment of improved varieties of linseed in Sagar district, Vindhya plateau Agro-climatic Zone of Madhya Pradesh

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Abstract
Linseed is an important rabi oilseed crop of Madhya Pradesh, it requires moderate to cool temperature during crop period. Its productivity in Vindhya Plateau Agro-Climatic Zone of Sagar 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 steady but slow increase in the yield of linseed over a long period. Drought and high temperature at early and seed filling stage are detrimental 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 on farm trial was carried out at ten farmers' field under rainfed condition with improved technology in two consecutive year in rabi season during 2017-18 and 2018-19 in Sagar district of Madhya Pradesh. Two linseed variety recommended for rainfed condition *viz.* JLS 66 and JLS 67 with improved techniques along with farmers practices (local old and mix variety) were tested. The average higher number of capsules/plant were recorded in the variety JLS 67 (60.35) followed by JLS 66 (61.70) as compared to farmers practices (41.60). The pooled data for two years revealed that the highest yield of JLS 67 i.e. 7.41 q/ha received followed JLS 66 (7.18 q/ha) was recorded as compared to farmers practices which was 3.90 q/ha. Improved management package and practices increased the average net returns by Rs. 19129/ha in JLS 67 followed by 17759/ha in JLS 66, in demonstrated plot while farmers were obtained Rs. 5895/ha by their own practices. On an average benefit cost ratio was 2.12 (JLS 66) and 2.19 (JLS 67) under demonstrated technologies while it was 1.5 in farmers practices.

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

Introduction

Linseed (*Linum usitatissimum* L., 2n = 30, X=15) is an important self-pollinated oilseed and fibre crop in the world that belongs to the genus *Linum* of the family Linaceae, which is native to west Asia and the Mediterranean that has been cultivated since at least 5000 BC (Saghayesh *et al.*, 2014) [6]. The name *Linum* originated from lin or "thread" and the species name *usitatissimum* is a Latin word meaning "most useful". When grown for fibre it is known as 'flax', if grown for seed oil it is called 'linseed' but when it is cultivated for both fibre, and oil it is called 'dual-purpose flax'. It is also popularly known as Alsi, Tisi, Jawas, Aksebija in Indian languages. Every parts of linseed plant are utilized commercially, either directly or after processing in different branches of industry and for food, feed and fibre (Singh, *et al.*, 2011) [8]. Seeds of linseed contain high levels of dietary fibres, abundant micronutrients as well as lignans. Seed of linseed contains 33 to 47 per cent oil. About 20 per cent of the total oil produced is used at farmer level and the rest 80 per cent oil goes to industries in various forms, such as boiled oil, borated oil, eposidized oil, aluminated oil, urethane oil, isomerized oil etc (Dwivedi, 2018) [3]. Its oil has great potential in industries like paints, printing inks, varnishes, resins, enamels, stickers, tarpaulins and soaps. Linseed have also medicinal and therapeutic values. In general, linseed oil is the richest plant source of linoleic (Omega-6 ranges from 16 to 75 per cent) and alpha-linolenic (Omega-3 ranges from 1.5 to 59 per cent) polyunsaturated fatty acids (PUFA), which are essential for humans, since they cannot be synthesized in the organism and must be ingested in food (Sood *et al.*, 2011; Singh *et al.*, 2013; Zuk *et al.*, 2015) [10, 7, 12]. The nutritive value of linseed per 100 gram is carbohydrates 28.88 g, sugars 1.55 g, fat 42.16 g, protein 18.29 g and dietary fibres 27.39 g (Dwivedi, 2018) [3].

Linseed is one of the widely grown economically important species, cultivated in many countries and production share of important countries like Russia (23%), Canada (19.8%), Kazakhastan (19.2%), China (12.4%), USA (7.5%), India (4.3%), Ukraine (3.2%) Ethiopia (3.0%), UK (1.6%) France (1.5%), Sweden (0.6%), Argentina (0.6%), Brazil (0.4%), Belgium

(0.3%), Poland (0.3%) and others (2.3%) of the world. The current worldwide acreage of linseed is 3.27 million hectares with a total annual production of 3.18 million tonnes and productivity of 975.10 kg/ha. India holds fifth rank in area with 320 thousand hectares with annual production of 174 thousand tonnes and productivity of 543.80 kg/ha (FAOSTAT, 2020) [4]. In India, it is mainly cultivated in central regions; however, its cultivation spreads from Himalayas in North to Karnataka in South. The crop is mainly cultivated in the states of Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Maharashtra and Bihar and Odisha. Among the oil seeds crops grown during rabi season in the country, linseed is next in importance to rapeseed-mustard in area as well as production. This crop is generally grown on marginal/sub marginal, 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 rainfed conditions. Thus, these varieties with improved production technologies have turned this crop into high remunerative crop.

Keeping this in view, the overall objectives of the on-farm trial (OFT) is to evaluate and select suitable and acceptable linseed varieties in Sagar district of Vindhya Plateau Agro-Climatic Zone of Madhya Pradesh.

Specific objectives

1. To evaluate the performance of linseed varieties under rain fed condition.
2. To promote linseed varieties to the local farmers and scaling up of the variety among farming communities in a large area.

Methodology

The study was conducted by the Krishi Vigyan Kendra, Sagar for two consecutive year i.e. 2017-18 and 2018-19 during rabi season at Sagar and Rahatgarh block of the district. The farmers of this villages had small and marginal land holdings. The soil of the operational area in Vindhya Plateau Zone was generally deep shallow and medium black soil. Technological differences between improved management package and practices of linseed and farmers practices were studied based on survey and group discussion with farmers 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 on-farm trial was conducted on ten farmers field to assess the performance of linseed variety JLS 66 and JLS 67 which is designated as T_2 and T_3, respectively. The total two hectares area was covered in each year (0.1 ha area each for both the varieties). 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 (Table-1). One control plot was also kept as farmers practice which is designated as T_1. All the on-farm trials were monitored by scientists of Krishi Vigyan Kendra, Sagar 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 on farm trials over farmers' practice was calculated by using the following formula (Choudhary, *et al*., 2009) [1].

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

Results and Discussion

Technological adoption gaps in Linseed

The data presented in Table 1 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 definitely 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 varieties. Unavailability of seed in time and lack of awareness were the main reasons. Seed rate is the key determinant of plant population. To achieve 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. Farmers were not aware about the importance of recommended crop geometry and lack of interest. The recommended time of sowing of linseed crop is first fortnight of October in rainfed areas. Timely sowing also helps the crop to escape from powdery mildew, rust 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 Bavistin and *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. The important weeds of linseed include *Anagallis arvensis*, *Vicia hirsuta*, *Fumaria parviflora*, *Melilotus* spp., *Chenopodium album*, *Phalaris minor* etc. and also parasitized by *Cuscuta* sp. leading to heavy losses of yield. The degree of yield loss by weeds depends upon the nature and magnitude of weed infestation and also provides shelter for insect pest and diseases which affects yield losses. 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. Majority of the farmers are misguiding as there is no requirement of irrigation in linseed crop. Application of the various fertilizers should be recommended only on the basis of soil test while farmers were using imbalanced doses of fertilizers. Similarly, they were applying injudicious doses of pesticide. This might be due to lack of awareness and knowledge about importance of balanced dose of fertilizers and judicious use of pesticides. Farmers were not aware about 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) [9, 11].

Analysis of Yield Attributing Characters, Crop Productivity and Yield Enhancement

The adoption of improved management package and practices *viz.* high yielding varieties seeds, recommended seed rate, seed treatment, time and method 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 yield attributing characters, crop productivity and yield enhancement in linseed crop of two consecutive years i.e. 2017-18 and 2018-19 as shown in Table 2. The results clearly indicated that the average higher number of capsules/plant were recorded in the variety JLS 67 (60.35) followed by JLS 66 (61.70) as compared to farmers practices (41.60). The maximum average number of capsules/plant was recorded in the variety JLS 67 (66.70) during 2017-18 followed by in JLS 66 (65.00) during 2018-19. The number of capsules/plant were increased by 50.42 and 48.47 per cent in the variety JLS 67 and JLS 66 respectively as compared to farmers practices. The average yield of linseed under improved management package and practices was 7.41 and 7.18 q/ha in the variety of JLS 67 and JLS 66 respectively as compared to farmers practice (3.90 q/ha). The linseed variety JLS 66 yielded higher productivity by 8.33 q/ha while the variety JLS 67 produced by 7.45 q/ha during 2018-19. The yield enhancement due to improved management package and practices of linseed was 92.53 and 83.07 per cent in the variety JLS 67 and JLS 66 respectively over farmers practice. 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 effect of on-farm trials over existing practice towards enhanced the yield of linseed crop in location specific rainfed area of the district. The similar trends of crop productivity and yield enhancement in linseed crops has been documented in previous studies (Thakur *et al.*, 2019; Diwan *et al.*, 2019) [11, 2].

Economic Analysis of OFT on Linseeds

The economics of linseed crop production under on-farm trials in rainfed condition were estimated and the results have been presented in Table 3. Different variables like suitable varieties seed for rainfed condition, balanced fertilizers application, seed treatment, time and method of sowing, weed management and plant protection measures etc. were considered as a technological intervention. Economic indicators i.e. net returns and B: C ratio of on-farm trials 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. 35162.50 per hectare in the variety JLS 67 followed by the variety JLS 66 (Rs 33792.50/ha) with improved management package and practices while it was recorded by Rs 18365.00/ha in practices of farmers field. Improved management package and practices increased the average net returns by Rs. 19129/ha in JLS 67 followed by 17759/ha in JLS 66, in demonstrated plot while farmers were obtained Rs. 5895/ha by their own practices. In consequence, average gross monetary returns increased by 47.49% and 45.41% in the variety JLS 67 and JLS 66 respectively while it showed that net increased monetary returns by 68.75% and 68.24% in the variety JLS 66 and JLS 67 respectively, indicating the importance of improved management package and 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 2.12 (JLS 66) and 2.19 (JLS 67) under the assessed technologies while it was 1.5 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) [5, 11].

Table 1: Technological gap between improved management package and existing practices of linseed under rainfed condition

Sl. No.	Particulars	Improved management Package and practices for rainfed condition	Farmers Practices	Technological gap
1.	Variety	JLS 66, JLS 67	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 2: 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	
	T_1	T_2	T_3	T_2	T_3	T_1	T_2	T_3	T_2	T_3
2017-18	42.20	58.40	66.70	38.39	58.06	3.43	6.02	7.36	75.51	114.58
2018-19	41.00	65.00	54.00	58.54	42.78	4.37	8.33	7.45	90.62	70.48
Mean	41.60	61.70	60.35	48.47	50.42	3.90	7.18	7.41	83.07	92.53

Table 3: 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		
	T_1	T_2	T_3	T_1	T_2^*	T_3^*	T_1	T_2^*	T_3^*	T_1	T_2	T_3
2017-18	14000.00	16576.00	16576.00	17125.00	30100.00 (43.12)	36800.00 (53.46)	3125.00	13533.00 (76.90)	20233.00 (84.55)	1.22	1.82	2.22
2018-19	11000.00	15500.00	15500.00	19605.00	37485.00 (47.70)	33525.00 (41.52)	8665.00	21985.00 (60.59)	18025.00 (51.93)	1.78	2.42	2.16
Mean	12500.00	16038.00	16038.00	18365.00	33792.50 (45.41)	35162.50 (47.49)	5895.00	17759.00 (68.75)	19129.00 (68.24)	1.50	2.12	2.19

* Figures in parentheses indicate per cent increase gross and net monetary returns under demonstrated technology over farmers practice

Conclusion and Recommendation

The results indicate that on-farm trials have given a good impact over farming communities of Sagar district as they were motivated by the high yielding varieties of linseed i.e. JLS 66 and JLS 67 with improved management package and practices. To bring impact on linseed production and productivity in rainfed area of Sagar district is to support supply of alternative seed source to the farmers, linseed varieties i.e. JLS 66 and JLS 67 with improved technological interventions were selected for promotion/scaling up in a large scale in similar environmental areas of the district. It also showed that this assessed new technologies will eventually lead to the neighbouring district farmers to discontinue the old technologies and to adopt new technologies for higher production and income generation.

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