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Double purpose linseed:

a viable option for doubling farmers' income in the north-western Himalyan region

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Linseed is a rabi *crop, grown both for seed and fibre since long time. In general, the dual purpose linseed varieties bred in warm climates were inferior in fibre fineness than those in cold climates. Improved production techniques of dual purpose linseed for this region will certainly be helpful in changing the production status of linseed, which will not only increase the income of farmers but also help in employment generation for rural and urban masses along with smart earnings of foreign currency to improve agro socio-economy. A good crop of dual purpose linseed can be obtained by adopting Nagarkot, Jeevan and Him Alsi-2 varieties under irrigated situation (2-3 irrigation) during first fortnight of October using 40 kg seed/ha at row distance of 23 cm, fertilizer application of 50:40:20 N:P_2O_5 and K_2O along with need based plant-protection measures. Net monetary return (`/ha) and production economics of dual purpose linseed clearly revealed that the income of farmers can be doubled through the adoption of recommended agro-production technologies. Development of improved varieties having quality fiber with good seed yield, refinements in post-harvest technologies especially retting and scutching and suitable government policies are essential for the promotion of dual purpose linseed.*

Key words: Farmers, Income, Himalayan region, Linseed

LINSEED/Flax (*Linum usitatissimum* L.) is one of the oldest crop plants cultivated for the purpose of oil and fibre. In India, it is mainly cultivated as an annual *rabi* oilseeds crop under input starved and moisture stress situation. Depending upon use, linseed is classified into three types. Varieties grown only for seed/oil are known as seed type linseed, whereas, varieties yielding only fibre are known as flax. Varieties grown for getting both seed and fibre are called dual purpose linseed. The plant architect of all three types of linseed is different from each other. The seed type linseed is shorter with average height of 30 to 50 cm, multi-branched from the base with more number of capsules. The flax plant is taller with average height of 100 to 120 cm with very few branches at the top of the plant. But with advent in research under AICRP on Linseed, such varieties have been developed which can yield good quality fibre as well as seed. Such varieties have average height of 75 to 100 cm and technical height (height between ground to the point where first branch starts) of more than 50 cm with more branches on the upper part of plant. In our country, linseed occupies 3.84 lakh ha area with a production of 1.54 lakh tonne and contributes about 10.81% and 5.31%, respectively to the global area and production.

Recent advances in medical research have found linseed as best herbal source of Omega-3 and Omega-6 fatty acids with immense nutritional/medicinal effect on human body system. Essential Omega-3 fatty acid (ALA) plays an important role in lowering cholesterol, reducing inflammatory disorder like rheumatoids arthritis and providing immunity and cardio-vascular benefits. Linseed is one of the richest sources of lignin (800 times more than any other plant seed except sesame seeds 47 times more) which provides protection against certain form of cancer due to estrogenic and anti-estrogenic activity in the body. The use of different grades/form of fibre and seed (raw or oil) in different products is given in Table 1.

Despite development of nine dual purpose varieties and standardization of agro-production technologies under AICRP on Linseed, flax fibre production is yet to be commercialized and huge quantity of linseed straw (4.75 lakh tonne approx.) remains unutilized for fibre extraction mainly due to lack of

Table 1. Uses of different grades/form of fibre and seed (raw or oil) in different products

Textile industry	**Articles used in defence**
Linen and best quality clothes	Parachute
Suiting shirting (blending with rayon and cotton)	Canvas
Bedsheets, Curtains, Towel	Strong threads for siewing
Paper industry	**Uses of coarse grades of fibres**
High grade paper	Making twine and ropes
Stamp Paper	Carpet/matting/Footmat
Parchment paper	Tiles for making roof (Reinforcement material)
Safety papers used for Currency notes	Good quality bags etc.
Bond paper, Air mail, Bible and other high priced books and writing papers	Decorative items
Rolling papers for cigarettes	Geotextiles
Linseed oil (modified and chemically treated) used in industry	**Raw and roasted seeds**
Paints and Varnishes	Value added edible products (Salted whole linseed, Chutney, Baked products, Salad, mouth fresheners, Laddo, Burfi, South Indian recipes etc.)
Linoleum flooring	
Oil cloth	
Polymer industries	Omega -3 laden eggs
Soft soap makings and packing	
Finishing oil for leather and wooden furniture	**Linseed cake**
Lubricants and greases	Feed for animals
Plasticizers and pyrotechnic composition	Organic manure
Adhesive	
Core oil lining	**Linseed mucilage**
Printing and lithographic Ink	Cosmetic Industry
Wax shoe polishes	Water soluble emulsifying agent, thickner and binder in food products
Oil in medicines	Base for eye ointment
Capsules	Substitute for acacia gum
	Preparation of plywood glues
	Filler in thermosetting resins

infrastructure support for post-harvest processing *i.e.* retting and fibre extraction from the retted straw. The demand of flax fibre for domestic need is fulfilled through import mainly from Belgium and the Netherlands. The total import value of all commodities (crude oil, seed, fibre, yarn and fabrics) during 2016-17 was 25.77 lakh crore against the total export value of ₹ 18.52 lakh crore resulting in to overall trade deficit of ₹ 7.25 lakh crore. The utilization of fibre from dual purpose linseed for textile purpose and other industries will not only increase the income of farmers but also help in employment generation for rural and urban masses along with smart earnings of foreign currency to improve agro-socio-economy.

Production technology

In view of fibre producing ability of dual purpose linseed without affecting seed or oil yield, the agro-techniques for production of dual purpose linseed in Himachal Pradesh have been developed under AICRP on Linseed. The improved production techniques of dual purpose linseed will certainly be helpful in changing the production status of linseed, which will ultimately improve the economic status of the farmers of the region.

Land preparation

The land should be ploughed 2 to 3 times followed by 2 to 3 harrowing for fine tilth. To conserve moisture, it is advisable to create soil mulch with the help of hoe after each good shower. The well drained, sandy loam or silty clay loam soils having pH of 5.5 to 7.0 are suitable for its cultivation.

Climate

Dual purpose linseed for better fibre yield requires a cool humid climate with mild temperature ranging from 10° C to 27° C, rainfall ranging from 155 to 200 mm and high midday humidity (60-65%) during growing season. Drought and high temperature of about 32°C during flowering reduce yield. The lower temperature along with relative humidity of about 76% promotes the stalk height.

Varieties

Selection of right variety and getting quality seed are essential to obtain high yield. The best suited dual purpose varieties for this region are Jeewan, Nagarkot, Him Alsi-2.

Fertilizer application

Recent studies under AICRP on Linseed revealed that dual purpose linseed and seed type linseed respond equally to fertilizer application. Application of recommended dose of linseed is helpful in realizing the full potential of dual purpose linseed (Table 2).

Seed treatment

Treatment with Bavistin/Thiram @ 2.5 g/kg of seed before sowing for protection against seed borne and soil-borne diseases.

Sowing

First fortnight of October is ideal for sowing, before the ambient temperature becomes too low and to affect germination of seeds. Delay in sowing affect the seed and fibre yield adversely. Seeds @ 40 kg/ha are sown in rows with row-to-row spacing of about 23 cm at 2-3 cm depth.

Irrigation

A minimum of two irrigations are required *i.e.* the first at about 35 days after sowing and second at about 65 days after sowing for raising the good crop of dual purpose linseed. However, third irrigation after completion of flowering can be given, if required and water is available as the case may be.

Weed control

Because of slow growth of linseed during initial stages of crop and less leaf canopy, it competes poorly with mixed weed flora. It is necessary to keep the crop free from weeds for first 35 to 60 days after sowing. Manually two-hand weedings after 4 and 7 weeks of sowing are sufficient to keep the weed population below threshold level. Chemically weeds can be controlled

Different products made from linseed fibre

Different edible and pharmaceutical products made from linseed seed

Varieties	Days to maturity	Yield (q/ha)	Plant height (cm)	Oil (%)	Characteristics
Jeevan	175-180	10 (Seed) 7 (Fibre)	75-90	45.8	Blue flowered, Brown seeded, Rust & wilt resistant, tolerant to frost and lodging
Nagarkot	165-170	14-15 (Seed) 10-12 (Fibre)	65-70	44.0	Erect compact and medium tall, Blue flowered, Brown medium seeded, Rust, wilt and powdery mildew resistant
Him Alsi-2	185-190	10-11 (Seed) 7 (Fibre)	65-70	40.5	Cup shaped white flowered,Brown bold seeded, Rust resistant

Him Alsi-2 Jeevan Nagarkot

Rust

Wilt

Powdery mildew

effectively with given herbicides (Table 3).

The spray should be done with knapsack sprayer fitted with flat fan nozzle. The volume of water to be used for sraying must be 750 to 800 liters/ha.

Table 3. Weeds can be controlled by given herbicides

Common name of herbicides	(a.i.) Dose of chemical (kg a.i./ha)	Commercial dose/ ha	Time of application
Pendimethalin	30 EC 1.0 lt	3.33 lt	Within 48 hr of sowing (Pre.)
Isoproturon	75 WP 1.25	1.67 kg	After 30-35 days of sowing (Post.)
Clodinafop-propargyl	15 EC 0.060	400 g	After 30-35 days of sowing (Post.)

Plant-protection

Usually the incidence of insects and pest on this crop is almost negligible. Sometimes minor incidence has been reported on moderately resistant or susceptible variety for particular disease in this region.

Rust

Symptoms: Rust is readily recognized by the presence of bright orange and powdery pustules. Rust pustules develop mostly on leaves, but also on stems and bolls. Spread and infections are favoured by high humidity during cool nights, warmer day temperatures and on plants growing vigorously. As the season progresses, the orange pustules turn black. The black pustules are most common on stems.

Control: (i) Use resistant varieties as discussed; and (ii) Spray 0.25% dithane Z-78/Indofil M-45.

Wilt

Symptoms: Early infections may kill linseed seedlings shortly after emergence, while delayed infections cause yellowing and wilting of leaves, followed by browning and death of plants. Roots of dead plants turn ashy grey. The tops of wilted plants often turn downward and form a 'shepherd's crook'. Affected plants occur more commonly in patches but may also be scattered throughout the field.

Control:(i) Use resistant varieties; and

(ii) Treat the seed with Bavistin or Thiram @ 2.5-3.0g/kg of seed before sowing.

Powdery mildew

Symptoms: The symptoms are characterized by a white powdery mass that start as small spots and rapidly spread to cover the entire leaf surface. Heavily infected leaves dry up, wither and die. Early infections may cause complete defoliation of linseed plants.

Control: (i) Use of resistant varieties; and (ii) Spray Sulfex 0.25% in infected areas.

Table 2. Recommended dose of fertilizer for dual purpose linseed

Nutrient (kg/ha)	Fertilizer	Quantity of fertilizer (kg/ha)	Time of application
N (50)	Urea	110	Apply half dose of nitrogen and
P_2O_5 (40)	Single Super Phosphate	250	full doses of phosphorus
K_2O (20)	Muriate of Potash	33	and potash at the time of sowing
or			and rest half dose of nitrogen
	IFFCO (12:32:16)	125	after 3-4 weeks of sowing
	Urea	76	
Sulphur	Elemental sulphur	20	

Harvesting

It is important to harvest linseed crop at optimum stage. It would be advantageous to harvest the crop at yellow ripe stage of stem, when lower two-thirds portion of the stem is defoliated *i.e.* capsule maturity stage without loss of fibre as well as seed quality. Delayed harvesting promotes lignification which in turn impairs the fibre quality. Harvest the crop from ground level.

Deseeding

Make small bundles of the harvested crop, thresh out the seed by beating against hard surface or with mallet (*Mungari*) and subsequently plant stalks are cut into technical height (height from ground level to first fruiting branch).

Retting

It is defined as the process of separating the embedded fibre from the linseed stem through partial rotting by immersion in water. This retting is brought about by a complex enzyme action of microbes naturally present in retting water. Retting is a complex biological and biochemical process and ranks as the single most important factor governing the quality of fibre. Retting is best done in clear, slowly flowing water. Hence canal and even rivulets are best suited for retting. The depth of water should be sufficient to allow the stem bundles to float.


Retting tank


Immersed stalks for retting


Stalks dried in sun after retting

Alternative tanks, ponds or ditches with at least a depth of 1.8 m are used. When retting is done in stagnant water, the minimum ratio of plant material to irrigate water should be 1:20 by volume and pH should be around 6.0 to 7.5 to ensure good results. The retting of the stalk involves following procedure:

(i) Keep out the cut dry stalk separately for its retting

(ii) Place the stalk bundles in retted tank filled with water and leave it for 3 to 4 days or may exceed depending on the climatic conditions and population density of micro-organism. If stalks are floating put some pressure (weight) on it so that stalks remains submerged.

(iii) To check the completion of retting, take out the retted straw from retting tank and press it between for efinger and thumb. If the fibre is easily extracted without break from stalk, it indicates that retting is complete or break the retted straw and pull it backward.

Similarly, if fibre gets easily separated from stalk, it indicates for completion of retting.

(iv) Remove the retted stalks from tank and wash them repeatedly with fresh water, thereafter allow it for sun dry in open air.

The important conditions to observe are:

(a) The water should be clear and non-saline.

(b) The volume of water should be enough to allow the stem bundles to float.

(c) When the bundles are immersed, they should not touch the bottom.

(d) The same retting tank or ditch may not be used repeatedly, particularly if the water becomes too foul and dirty.

(e) Over retting must be avoided. It is better to get under retted straw which can be further retted again for complete retting.

Besides, a micro-organism *Bacillus subtilis* has been identified for microbial retting for this region which can be effectively used for decreasing the retting time without affecting the fibre quality. Same procedure as done for water retting is followed for microbial retting in which inoculum of this bacteria is added for enhancing the retting process.

Scutching

Now the stalks are ready for scutching. The scutching is defined as beating and scraping of the dried stems to separate the fibres. The fibre is separated from retted stalks either by hand or by breaking and scutching with machinery.

Manual: Take small bundle of retted and dried stalk and beat it by hand mallet (*mungri*) on plane and hard surface. Owing to this the wooden part of the stalk will split out and resultant to this fibre which can be obtained easily. This type of scutching can be done at small-scale rightly at farmers' home.

Mechanical: Small bundles of retted and dried stalks are placed on the feeder side of the machine and allow to run the machine (manually and power operated). The stalks get ruptured and come out from the delivery side. Shake the ruptured stalk by hand resulting in this fibre, which will remain in hand and hard stick split out. If the rupturing of the stalk is not completed in one time, repeat the process again to get the fibre completely free from the wooden part of the stalk.

Hackling

In this process the scutched ûbres are combed in order to remove short fibres, parallelize the long ûbres and also the removal of any extraneous matter (shive).

Hackling is done by hand or through hackling machine.

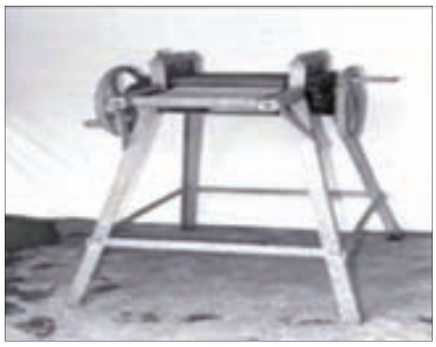
- A wooden comb like instrument is used for dressing or combing of the scutched fibre.
- The hackling machine takes lengths of scutched flax and combs them between hank's successively finer pins. The product of the hackling process is called line fibre. It is operated manually through pedalling. Short fibres and fragments of fibres separated during the scutching and hackling process are recovered and marketed as scutch tow and machine tow respectively.

Production economics

Since profitability is the prime concern of farmers, hence the

Electrical operated machine

Scutching machine



Manual

Manual

Hackling machine

Table 4. Production economics of seed type and dual purpose linseed at Himachal Pradesh

Input	Seed type		Dual Purpose	
	No./Quantity	Cost	No./Quantity	Cost
Human Labour (mandays)	48	9,600	82	16,400
Tractor power (hour)	10	4,250	10	4,250
Seed (kg/ha)	40	1,800	40	1,800
Fertilizers (kg/ha)	$N_{50}P_{40}K_{20}$	3,620	$N_{50}P_{40}K_{20}$	3,620
Irrigation (mandays)	8	1,600	12	2,400
Plant-protection (Rs./ha)	1	1,553	1	1,553
Electricity charges (units)			186	930
Overhead charges		800		1,000
Cost of cultivation		23,223		31953
Yield (kg/ha)	1,200 (Seed)	54,000	1,075 (Seed)	48,375
			725 (Fibre)	72,500
Linseed cake (kg/ha)	666	13,200	590	11,800
Gross returns (₹/ha)		67,200		132,675
Net returns (₹/ha)		43,977		100,722
B:C ratio		2.89		4.15

Note: Rate of seed= ₹ 45/kg, fibre= ₹ 100/kg and linseed cake= ₹ 20/kg

Performance of dual purpose linseed on farmers' fields

economic analysis of the production of seed type and dual purpose linseed is computed on the basis of the feed back received from the farmers. Monetary advantage obtained through cultivation of dual purpose linseed by adopting improved production technologies can be very well accessed through comparison between seed type and dual type linseed-based on the average yield, resources/input used and prevailing price of inputs and produce. Table 4 showed that net monetary return obtained from the dual purpose linseed was quite higher (almost double) than seed type linseed. Thus by cultivating such crop through adoption of suggested scientific ways will surely uplift the economic status of farmers of Himachal Pradesh.

SUMMARY

Because of favourable climatic conditions there is ample scope for exploiting full potential of dual purpose linseed in north-western Himalyan region. Also, in order to make dual purpose linseed crop is more remunerative as well as employment generating, the value addition properties of such varieties with respect to industrial, medicinal and textile uses need to be emphasized and targeted. Processing of such varieties for extracting fibre is an extremely labour intensive process that can help in providing skilled and unskilled employment. The government support to farmers by providing incentives for the installation of scutching machines and construction of retting tanks for adoption of such techniques and further strengthening research institutes to standardize the quality parameters for the grading of fibre can certainly reduce the import bills and paves the way for doubling the income of farmers.

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