

Agronomy – Rabi Crops

Linseed

Dr. I.P.S. Ahlawat
Head,
Division of Agronomy
Indian Agricultural Research Institute
New Delhi – 110 012

LINSEED

Botanical name: *Linum usitatissimum* Linn.

Family: Linaceae

Chromosome Number: $2n=30$

Among the oilseed crops raised during *rabi*, linseed is next in importance to rapeseed-mustard in area as well as in production. In technical oil production, it ranks first in the country.



Every part of the linseed plant is utilized commercially, either directly or after processing. Seed contains 33 to 47% of oil. On a very small scale, the seed is directly used for edible purposes. About 20% of the total oil produced is used at farmer's level, and the rest 80% oil goes to industries in various forms, such as boiled oil, borated oil, epoxidized oil, aluminated oil, urethane oil, isomerized oil etc. The oil is rich ($> 66\%$) in linolenic acid, and is a perfect drying oil. Hence it is utilized in the manufacture of paints, oil cloth, varnish, pad-ink, printed ink, linoleum etc.

The oil cake is a good feed for milch cattle and poultries and hence priced 50% higher than rapeseed-mustard cake. It is good in taste and contains 36% protein, 85% of which is digestible. It is also used as organic manure. It contains about 5% N, 1.4% P_2O_5 and 1.8% K_2O .

Linseed is globally cultivated for its fibres and is called flax. Fibres are used for the manufacture of linen. The stem yields fibre of good quality having high strength and durability. The weather resistant fibre is lustrous and blends very well with wool, silk, cotton etc. Strong twines, canvas, suitings, shirtings and various indispensable products for defence purposes are manufactured from it. Woody matter and short fibres may be used as raw pulp for making paper of quality comparable with that of currency notes. The rough and strong

linseed fibre can effectively be used for low-cost roofing tiles based on convertible polymers and for fibre-reinforced plastic (FRP).

Origin and History

The genus *Linum* has 20 species spread in warm temperate Europe and Asia and 50 species spread in America. Most of the investigators are of the opinion that the wild flax (*Linum angustifolium*) which is a native of Mediterranean region may be the ancestor of the cultivated species *Linum usitatissimum*. According to Vavilov linseed or flax had two centres of origin. *The small seeded type*: These are grown mainly for oil purpose, and appear to have originated in south-western Asia comprising, India, Afghanistan and Turkey. *The bold seeded type*: These are grown for fibre purpose, and seem to have originated in the Mediterranean region including Asia Minor, Egypt, Algeria, Spain, Italy and Greece.

Geographic Distribution

Linseed is one of the most important crops of the world cultivated in over 2.6 million ha. The important linseed growing countries are India, Canada, China, USA and Ethiopia. India ranks first in the world in respect of acreage accounting for 23.8% of the world total and third in production contributing of 10.2% of the world total. Canada and China are other main linseed producers in the world (Table 1). The productivity is the highest in Romania (1751.4 kg/ha).

Table 1. Area, production and productivity of linseed in important countries (2004)

Country	Area (m ha)	Production (m tonnes)	Productivity (kg/ha)
India	0.630	0.200	317.5
Canada	0.528	0.517	978.8
China	0.550	0.460	836.4
USA	0.208	0.266	1273.7
Ethiopia	0.150	0.077	514.0
Bangladesh	0.070	0.050	714.3
France	0.080	0.054	677.9
United Kingdom	0.031	0.054	1741.9
Russian Federation	0.074	0.058	778.5
World	2.645	1.956	739.5

Source: FAO Production Year Book, 2004

In India, it is cultivated on 0.53 m.ha with a production of 0.21 mtonnes. Its cultivation is mostly confined to Madhya Pradesh, Maharashtra, Chattisgarh, Uttar Pradesh and Bihar. Madhya Pradesh occupies 1st position in India in respect of both area and production (Table 2).

Table 2. Area, production and Productivity of linseed in different states of India (2003-04)

State	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Andhra Pradesh	5.2	1.3	250
Assam	9.6	5.0	521
Bihar	35.0	25.0	714
Chattisgarh	86.0	24.2	281
Himachal Pradesh	2.0	1.0	500

State	Area (000 ha)	Production (000 tonnes)	Productivity (kg/ha)
Jammu & Kashmir	0.6	0.3	500
Jharkand	18.0	5.0	278
Karnataka	13.0	1.0	77
Madhya Pradesh	156.8	70.8	452
Maharashtra	87.0	22.0	253
Nagaland	6.7	5.0	746
Orissa	18.2	7.2	396
Punjab	0.4	0.4	100
Rajasthan	2.3	1.9	826
Uttar Pradesh	78.7	39.9	507
West Bengal	6.0	1.9	317
India	525.5	211.9	403

Source: Hegde and Damodaran, 2005

Classification

Howard and Rahman (1924) classified the Indian linseeds into three main groups based on colour of seed as Yellow or white coloured; Fawn coloured, and Brown coloured.

The above 3 groups are again sub-divided according to the colour of corolla, mainly white, light blue or purple.

In India, 6 species of *Linum* namely, *L. usitatissimum*, *L. mysorensense*, *L. angustifolium*, *L. grandiflorum*, *L. perenne* and *L. strictum*. Of these 6 species, *angustifolium* and *grandiflorum* have been introduced into the country as ornamental types.

Botanical Description

It is herbaceous annual plant growing to a height of 30-120 cm. Cultivars grown for seed (oil) are usually shorter than those grown for fibre production. The root system is usually shallow. The main tap root is slender and having numerous small lateral roots, that develop in the top 30 cm soil. Stems are narrow and may branch from the base. Seed varieties possess more branches than flax. The leaves are narrow and short, alternate on the stem and sessile. The leaves are linear to lanceolate and blunt at the apex. The inflorescence consists of a terminal panicle that bears numerous flowers. Flowers are usually white or blue, complete and perfect with 5 petals, 5 sepals and fine stamens. Linseed is normally a self-pollinated crop. The fruit is capsule, which is globular in shape. These are divided into 5 locules where seeds are borne. The seeds are flat, shiny and relatively small. The seed colour ranges from white to shining yellow or light brown.

Climatic requirements

Linseed is a cool season crop. The temperature during the vegetative development of the crop should be moderate or cool. Temperature above 32°C accompanied with drought during the flowering stage reduces the seed yield, oil content in seed and also the quality of the oil. Moderate temperatures (21°-26°C) are ideal. At the time of flowering, frost is very harmful to the crop.

The crop is well suited to tracts of low rainfall and is generally raised where the average annual rainfall ranges from 45 to 75 cm.



(Source: <http://en.wikipedia.org/wiki/Flax>)

Soils and its preparation

Linseed can be profitably raised in places where the other crops may fail. Hence, it is often grown on marginal and sub-marginal rainfed soils as pure crop, mixed crop, intercrop and *paira* or *utera* crop. Linseed can be raised in almost all types of soils, where sufficient moisture is available, but it also does better on heavier soils having greater water-retention

capacity. It is also tolerant to wide range of soil pH (5.0-7.0). However, it grows best on well drained loam to clay loam soils rich in humus. In Madhya Pradesh and Maharashtra, linseed is largely raised on black cotton soils having high clay and lime content. It is also raised on light alluvial soils of Uttar Pradesh, Bihar and West Bengal.

Land should be ploughed 2-3 times followed by 2-3 harrowings to bring a fine tilth. To conserve moisture, it is advisable to create a soil mulch with the help of a hoe after each good shower. *Utera* cropped linseed needs no land preparation, as it is broadcast in standing rice crop.

Seed and Sowing

Seed rate, seed treatment, time of sowing and spacing

Linseed is usually sown by broadcast or by drilling in rows. The seed requirement is more in bold seeded varieties and in *utera* cropping system. Treat the seeds with capatan or agrosan GN @ 2.5 g/kg seed before sowing. This ensures a good stand by protecting seedlings against seed borne diseases. An inter-row spacing of 20-30 cm and intra-row spacing of 7-10 cm are ideal. The time of sowing varies from early October to mid November in different states. Rainfed crop requires early sowing. Early sowing also helps the crop to escape from powdery mildew, rust and podfly menaces. The row spacing, seed rate and optimum time of sowing are given in Table 3.

Table 3. State-wise row-spacing, seed rate and optimum time of sowing of linseed

State	Rainfed / Irrigated	Row spacing (cm)	Seed rate (kg/ha)	Optimum time of sowing
Bihar	Rainfed	25	20	Around 15 th October
Uttar Pradesh excluding Bundelkhand	Rainfed	25	25-30	First fortnight of October
	Irrigated	25	30	Up to second fortnight of October
Bundelkhand	Rainfed	25-30	30	First fortnight of October
	Irrigated	30	25	Up to second fortnight of October
Madhya Pradesh	Rainfed	25	30	First to third week of October
	Irrigated	35	20	First week of October to first week of November
	<i>Utera</i>	Broadcast	35	Second to third week of October
Punjab	Rainfed	25	30	Mid-October
	Irrigated	25	30	Mid-October to mid-November
	<i>Utera</i>	Broadcast	40	Mid-October
Karnataka	Rainfed	25-30	20-25	First fortnight of October
West Bengal	Rainfed	25-30	20	First week of October
Himachal Pradesh	<i>Utera</i>	Broadcast	35	October
Maharashtra	Rainfed	25	30	First fortnight of October

Depth of seeding

Depending upon the soil moisture, the seed should be placed 2-3 cm below the soil. However, shallow sowing is always advantageous if there is adequate moisture in the soil.

Varieties

The linseed varieties recommended for different states are given in Table 4.

Table 4. Linseed varieties recommended for different states

<i>State</i>	<i>Variety</i>
<i>Madhya Pradesh</i>	Jawahar-1, Jawahar-17, Jawahar-18, Jawahar-552, Jawahar-7, Jawahar linseed-9, Jawahar-23, T-397, Sheetal, Pusa-2, Padmini (LMH-62), Kiran (RLC-6), Parvati (LMH-16-5)
<i>Uttar Pradesh</i>	BAU-204-1, Garima (LHCK-39), Gaurav, Hira, Jawahar-23, Jeevan (DLP-21), T-397, Swetha (LHCK-131), Subhara (LHCK-21), Shekhar (LCK-9313), Mukta, Sheetal, RL-993, Padmini, Neelum, Meera (RL-933), Shikha (LCK-8528), Laxmi-27, Rashmi (LCK-9216), Parvati
<i>Bihar</i>	BAU-204-1, Gaurav, Jeevan, T-397, Swetha, Subhara, Sekhar, RL-993, Shikha, Rashmi, RL-914
<i>Orissa</i>	Jawahar-23, Sheetal, Pusa-2, Padmini, Kiran
<i>West Bengal</i>	BAU-204-1, Gaurav, Jeevan, Swetha, Subhara, Sekhar, Neela, RL-993, Meera, Shikha, Rashmi
<i>Assam</i>	Gaurav, Jeevan, T-397, Swetha, Subhara, Sekhar, RL-993, Meera, Shikha, Rashmi
<i>Maharashtra</i>	C-429, Jawahar-23, S-36, Jagadamba (RLC-4), NL-97, Sheetal, Pusa-2, Kiran
<i>Rajasthan</i>	Jawahar-23, Triveni, T-397, Surabhi, Sheetal, RL-993, Pusa-3, Pusa-2, Padmini, Meera, Kiran, LC-54, Rashmi
<i>Punjab</i>	Jeevan, Surabhi (KL-1), Pusa-3, LC-185, LC-54, Sheela (LCK-9211), K2
<i>Haryana</i>	Jeevan, Surabhi, Pusa-3, Pusa-2, LC-54, Sheela, K2
<i>Himachal Pradesh</i>	Janaki, Himalini, Jeevan, Surabhi, Pusa-3, Pusa-2, LC-185, LC-54, Sheela, K2
<i>Karnataka</i>	Jawahar-23, Sheetal, Pusa-2, Kiran

Manures and Fertilizers

Linseed crop is generally grown without manuring. Application of 8-10 tonnes of FYM or compost/ha at the time of final field preparation is beneficial. In vertisols of Madhya Pradesh and alluvial soils of Bihar, best crop is raised with use of FYM and castor cake.

Improved varieties of linseed respond to fertilizers. Seed purpose crop require 60-90 (irrigated) and 40 (rainfed) kg N/ha, whereas, dual purpose crop needs still higher N dose (120 kg/ha). Similarly higher P fertilization (50 kg P₂O₅/ha) of dual purpose crop is necessary in comparison to rainfed (20 kg/ha) and irrigated (40 kg/ha) seed crop. Response to 20 kg/ha

each of S and Zn is increasingly observed in irrigated crop under intensive cropping systems. Under irrigated conditions, half the dose of N with full amount of P, S and Zn should be applied as basal at sowing. The remaining N is applied with the first irrigation 35 days after sowing. The state-wise recommended fertilizers are given in Table 5.

Table 5. Statewise recommended dose of fertilizers (kg/ha) for linseed

State	Situation	N:P ₂ O ₅ :K ₂ O
Bihar	Rainfed	40:20:0
Uttar Pradesh excluding Bundelkhand	Rainfed irrigated	40:20:0 70:30:0
Madhya Pradesh	Rainfed irrigated	30:15:0 70:30:0
Punjab	Utera, rainfed irrigated	20:0:0 40:0:0 65:0:0
Karnataka	Rainfed	40:20:0
West Bengal	Rainfed	40:20:0
Himachal Pradesh	Utera	20:0:0
Maharashtra	Rainfed	40:20:0

Water management

Linseed is a crop of rainfed areas (> 90%). However, it responds well to irrigation. Branching, flowering and capsule formation stages are critical for irrigation. Two irrigations are sufficient to obtain good yields. First irrigation should be applied 30-40 days after sowing and the second just before flowering. However, 3 irrigations (35, 55 and 75 days after sowing) have proved very effective.

Weed control

This crop is usually dwarf statured, and therefore suffers severe competition by weeds. Initial 3-6 weeks after sowing is critical period of crop-weed competition. The uncontrolled weeds can reduce yields by 25-40%. The losses are more in rainfed and *utera* cropping systems primarily due to competition for moisture followed by nutrients.

The important weeds of linseed include *Anagallis arvensis*, *Vicia hirsuta*, *Fumaria parviflora*, *Melilotus* spp., *Chenopodium album*, *Phalaris minor* etc. The crop is parasitized by *Cuscuta* sp. leading to heavy losses of yield. Post emergence (2-3 weeks after sowing) application of Pronomide @ 1.5 kg/ha and crop rotation with cereals have been recommended for its effective management. Weeds can also be controlled by 2 weedings after 3 and 6 weeks of sowing. When crop is 8-15 cm tall or just before branching, post-emergence application of MCPB @ 0.5 kg/ha can effectively control annual broad leaved weeds.

Cropping systems

Linseed is a component of various sequential and intercropping systems. Higher monetary returns can be realized if linseed is grown as a pure crop instead of a mixed or intercrop. It is usually grown in rotation with hybrid maize, sorghum, pearl millet, soybean, groundnut, cowpea etc. The intercropping systems suitable for different states are listed below.

Cropping system	Row ratio	States
Linseed + chickpea	2-3:1	West Bengal, Bihar, Bundelkhand region of Uttar Pradesh, Madhya Pradesh, Punjab, Maharashtra, Karnataka
Linseed + wheat	2-3:1	West Bengal, Maharashtra, Karnataka, Uttar Pradesh
Linseed + sunflower		Karnataka
Linseed+ potato	3:1	Bundelkhand region of Uttar Pradesh

Piara or utera cropping

This system has been in practice for efficient use of residual moisture in rice fields, where tillage is a problem. About 25% of the linseed area (0.5 million ha) is under *utera* cropping. The area under linseed is increasing with the decline in *khesari* (*Lathyrus*) cultivation. In this practice, linseed is broadcast in the standing rice fields, when the rice crop is between flowering and dough stages. Linseed is allowed to complete its life-cycle under moisture stress, with inadequate nutrients and plant protection measures, resulting in poor yields. To raise the yield levels, the following package of practices should be adopted.

Improved varieties should be raised for the purpose of more productivity and good quality oil. Heavy textured soils with good water-retention capacity are ideal for this system. Adequate FYM or green manure should be applied along with phosphate fertilizers to rice. A dose of 20 kg N/ha should be applied 2 or 3 days before linseed is sown using a seed rate of 35-40 kg/ha. In *cuscuta* infested areas *cuscuta* seeds should be removed from the seed lot before sowing. Sowing linseed when rice is at the dough stage proves to be the best. Manual weeding should be given once or twice. Crack system of sowing is a new method, which can be followed in areas where sufficient water is available. In this method 5 cm deep cracks are allowed to develop in the field, when the rice crop is at the boot-leaf or panicle formation stage and the field is irrigated. After keeping the water standing for 5-7 days, the normal practice of *utera* is followed. This method has been found to give 50-100% more yields and has no adverse effect on rice yields.

Harvesting and Threshing

The crop takes about 130-150 days to mature. At maturity, the leaves become dry, capsule turns brown and the seed becomes shiny. After harvesting, bundle the plants and leave them on threshing floor for 4-5 days for drying. Threshing is done by beating the plant with sticks or trampling by bullocks.

Yields

The crop yield varies from place to place depending on the climate, soil, technology and variety. A well managed crop may yield 1.5-2.0 tonnes of seeds/ha. In linseed; oil to seeds crushed is 33% while cake to seeds crushed is 67%.

Additional Links

<http://en.wikipedia.org/wiki/Flax>

http://www.missouriplants.com/Bluealt/Linum_usitatissimum_page.html