

Agronomy – Rabi Crops

Safflower

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SAFFLOWER

Botanical Name: *Carthamus tinctorius* L.

Family: Asteraceae

Chromosome Number: $2n=24$

Safflower (*kusum*, *kusumbha*, *kardi*) has been under cultivation in India for its brilliantly coloured florets and the orange red dye (carthamin) extracted from them and seed. The seed contains 24-36% oil. The cold pressed oil is golden yellow and is largely used for cooking purposes. The oil is as good as sunflower oil having enough amount of linolic acid (78%), which is very useful for reducing blood cholesterol content. The unsaturated fatty acids of safflower lower the serum cholesterol.

The oilcake particularly from decorticated seeds is used as cattle feed. Safflower cake contains about 40-45% protein. The green safflower crop can be used as a green fodder for cattle as it is relished by cattle. The oilcake from undecorticated seeds is used as organic manure as it contains about 5% N, 1.44% P_2O_5 and 2.23% K_2O .

Safflower oil has good drying properties and is used in the manufacture of paints, varnishes and linoleum. The oil obtained by hot dry distillation is black and sticky and is used only for greasing purposes. It is also used in the preparation of 'Roghan' which is used in preservation of leather and production of water-proof cloth.



Source: http://en.wikipedia.org/wiki/Safflower_oil

Origin

The cultivated forms of safflower are supposed to have originated either from *Carthamus lanatus* (saffron thistle) or *Carthamus oxyacantha* (wild safflower). According to De Candolle, safflower is probably a native of Arabia. Vavilov expressed the opinion that cultivated forms of safflower perhaps originated from India, Afghanistan and Ethiopia.

Recent evidences, based on occurrence of closely related wild species indicate the probable origin of cultivated species in an area bounded by the eastern Mediterranean and the Persian Gulf (Knowles, 1969), encompassing southern parts of former USSR, western Iran, Iraq, Syria, southern Turkey, Jordan and Israel, where closely related species of safflower are found. Safflower can still be found growing in small patches on field borders or around homesteads over the greater part of tropical Asia, Africa, Persia or wherever Spaniards or Asians have settled the World over (Weiss, 1971).

Introduced into Britain in 1551 from Egypt, safflower was grown by monks and in private herb gardens. Safflower was introduced around 200-300 AD. From China, it was introduced into Japan probably around the third century.

Area and Distribution

Safflower is cultivated in hot and dry climates from Mediterranean to the pacific ocean (between 20°S and 40°N). For dye purpose it is grown as far north as southern Germany and France. The important safflower growing countries are Mexico, India, USA, Kazakhstan, Ethiopia and Australia. (Table 1)

Table 1. Area, production and productivity of safflower in important countries

Countries	Area (m ha)	Production (m t)	Productivity (kg/ha)
India	0.350	0.129	368.6
USA	0.064	0.079	1239.0
Mexico	0.212	0.212	1003.6
Ethiopia	0.072	0.038	527.8
Australia	0.032	0.026	810.0
China	0.012	0.030	2500.0
Argentina	0.030	0.018	600.0
Kazakistan	0.120	0.076	634.2
World	0.964	0.651	675.9

Source: FAO Production Year Book, 2004

In India, it occupies 0.35 million ha with a production of 0.13 million tonnes. India ranks first in the world in respect of acreage accounting for about 36% of the world total. Maharashtra and Karnataka states are major producers (Table 2).

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

State	Area (000, ha)	Production (000 t)	Productivity (kg/ha)
Andhra Pradesh	17.0	5.0	294
Bihar	0.5	0.3	600
Chattisgarh	0.8	0.2	250
Karnataka	95	41.0	432
Madhya Pradesh	0.3	0.1	333
Maharashtra	234	81.0	346
Orissa	1.6	0.7	438
India	349.2	128.3	367

Source: Hegde and Damodaran (2005)

The genus *Carthamus* contains about 25 species (mainly indigenous to Mediterranean) of which only *C. tinctorius* is commercially grown.

Climatic requirements

Safflower is a cool (*rabi*) season crop. The optimum temperature for germination is about 15.5°C. The day temperature in the range 24-32°C at flowering are congenial for higher yields. It is cultivated from sea level to an elevation of 1000 m above sea level. The seed yield and oil content reduces with increasing elevation. When flower buds are being formed or flowering has just commenced, temperature below 0°C may cause considerable damage in the form of sterile heads. At seedling stage, however, the crop can tolerate much lower temperatures (-12 to -10°C). High temperatures at the time of flowering are harmful to the crop. At all the stages of growth, excessive rainfall or humidity increases the infestation of fungal diseases. It is a day neutral plant. However, temperatures are more important than photoperiod in safflower. Short day lengths prolong rosette stage.

The crop is not fit for tracts of heavy rainfall. The crop grows well in areas having rainfall between 60-90 cm. Waterlogging due to poor drainage or prolonged rains can cause substantial reduction in yield. Frost is also harmful to the crop, especially at seed formation.

Soil and its Preparation

Safflower requires moderate to highly fertile, fairly fertile, fairly deep, moisture retentive and well drained soils for maximum yields. Although its commercial cultivation at present is mostly restricted to medium and deep black soils in peninsular India, but the crop grows well in a variety of soils, e.g. sandy loams, clay loams and alluvial shallow and light textured soils seldom produce economic yields unless frequently irrigated. Low-lying areas should be

avoided as waterlogged conditions are prone to damage by root-rots and wilts. Safflower also thrives fairly well in salt affected areas.

Kharif fallow:

Safflower needs cold-free and weed free seed-bed with a firm sub soil and adequate moisture for germination and stand establishment. In black cotton soils (single cropped *rabi* areas), harrowing 3-4 times during the monsoon is as effective as deep ploughing during summer as soon as the *rabi* crops are harvested only when the field are infected with pernicious weeds.

Kharif cropped areas

When safflower is to be grown after a short duration cereal or legume avoid too deep or repeated tillage after the harvest of *kharif* crops to conserve moisture. If conditions warrant (prefer zero tillage, wherever possible), give 1 or 2 harrowings (Deccan *rabi*) or shallow ploughings/discings followed by planking/harrowing (clay loams, alluvial, sandy loams etc.) immediately after harvest of *kharif* crops. To minimize tillage requirements for safflower, keep *kharif* crops weed free.

Varieties

The varieties and hybrids recommended for different states are given in Table 3.

Table 3. Safflower varieties and hybrids* recommended for different states

State	Variety
<i>Karnataka</i>	A-2, A-300, A-1, S-144
<i>Andhra Pradesh</i>	Manjira (C-438), Sagarmuthyalu (APRR-3)
<i>Tamil Nadu</i>	Co-1**, K-1
<i>Maharashtra</i>	Bhima (S4), Girnar (JLSF-88)*, N-62-8, Tara, NARI-6** Nira (NRS-209), Sharada (BSF-168-4), Nagpur-7, N-630
<i>Madhya Pradesh, Chattisgarh</i>	JSF-1, JSI-7**, JSI-73, JSF-97** , JSF-99,
<i>Uttar Pradesh</i>	Malavika Kusum (HUS-305), T-65**
<i>Bihar, Orissa, Rajasthan</i>	A-300, A 1, S 144, Sagarmuthyalu
<i>All India</i>	DSH-129*, MKH-11*, Parbhani Kusuma (PBNS-12), NARI-NH-1 (PH-6)**/*, NARI-H-15*, Phule kusum, NARI-6**

**** Non-spriny**

Important varieties/ hybrids released recently and their characteristics

JSF-97: This variety was released in 2005 for Madhya Pradesh and Chattisgarh, is non – spiny with 30% oil and seed yields of 1.5 t/ha.

JSF-99: An extra early cultivar released from Indore in 2005 for cultivation in Madhya Pradesh and Chattisgarh with 28% oil content and 1.9 t/ha yield.

AKS 207: This is a spiny variety developed at Akola (Maharashtra) released in 2006 for Vidarbha region of Maharashtra with 30% oil and 1.9 t/ha yield.

NARI-H-15: This is a hybrid developed at Phaltan (Maharashtra) and released in 2005 for irrigated conditions for the entire country with 28% oil and 2.3 t/ha yield. It is tolerant to aphids.

Seed and Sowing

Seed rate and spacing

Healthy seeds of improved varieties should be selected for sowing. Safflower has branching ability, and the optimum population ranges between 1.0 to 1.1 lakh/ha. The seed rate varies from 7 to 20 kg/ha depending on situation.

***Kharif* fallows**

Safflower is less sensitive to changes in seeding rate and row spacings because of its high branching potential. The following are seeding rates and row spacings recommended for different regions to achieve desired plant stands in *kharif* fallows.

Region	Optimum population ('000/ha)	Seed rate (kg/ha)	Row spacing (cm)
Maharashtra, Andhra Pradesh and Karnataka (other than Bellary, Raichur, Chitradurgha districts of Karnataka)	90-100	10	45-60
Tamil Nadu	90-100	10	45
Uttar Pradesh, North-western India (including Delhi and adjoining areas), M.P., Chhattisgarh, Jharkhand, Bihar	90-100	10-15	45
Bellary, Raichur, Chitradurgha districts of Karnataka	60	8	45-60

*Use higher seed rate of 15-20 kg/ha, if soil moisture in the seed zone is scanty.

***Kharif* cropped areas**

Use higher seed rate by 50% for *kharif* fallows to obtain satisfactory stand of safflower than as a sequence crop after short-duration cereals or legumes.

Row spacing

Pure crop : 40-50 cm x 20-25 cm
 Rainfed crop : 60 cm x 30-35 cm
 Mixed cropping : 20-25 cm x 20-25 cm

Seed treatment

The seed should be treated with captan or agrosan GN @ 3 g/kg seed before sowing.

Time of sowing

First week of October to first week of November is the normal planting time of the crop. Delayed sowings may cause flowering to coincide with period (s) of high temperature, resulting in reduced yield. The suitable time of sowing in different states/ regions are given below.

Recommended sowing time for safflower in different regions of India

Region	Recommended sowing time
Andhra Pradesh	
Coastal and Rayalseema areas	October
Telangana	Late September to early October
<i>Bihar and Jharkhand</i>	Second week of October
<i>Bihar and Jharkhand</i>	Second week of October
<i>Gujarat</i>	Last week of October to first week of November
<i>Karnataka</i>	
<i>Rainfed</i>	Second fortnight of September
<i>Irrigated</i>	Mid-September to early November
<i>Madhya Pradesh</i>	Last week of September to first week of October
<i>Chhatisgarh</i>	Second week of October to second week of November
<i>Maharashtra</i>	
<i>Drought prone areas of western Maharashtra and adjoining areas of Marathwada</i>	Second fortnight of September
<i>Assured rainfall areas of western Maharashtra and Marathwada</i>	Last week of September to mid-October
<i>Vidarbha</i>	
<i>Rainfed</i>	Last week of September to first week of October
<i>Irrigated</i>	Second fortnight of October
<i>Orissa</i>	Second week of September to mid-October
<i>Rajasthan</i>	Early to mid-October
<i>Tamil Nadu, Uttar Pradesh</i>	Early to mid-October
<i>Rainfed</i>	Second to third week of October
<i>Irrigated</i>	Mid-October to first week of November

Seeding depth and devices

For better crop stand, follow line sowing using improved seed drills or fertidrills (single or 2 or 3 tyned) available in different regions and recommended tillage practices. In no case, seed should be placed more than 5 cm below the soil as it would hinder germination.

The establishment of optimum stand is often a serious problem in several traditional areas such as Madhya Pradesh, Uttar Pradesh, Bihar and north-western India. Under such situation, devices which could place the seed in the moist zone (single-row dry land deep-furrow seeder or corn planter with adjusted row opener in plateau region of Jharkhand and Malviya seed drill in eastern Uttar Pradesh) should be preferred.

Manures and Fertilizers

In sandy soils, apply 15-20 tonnes/ha of compost or FYM at the time of last ploughing/harrowing. In areas, where irrigations is possible, 40:40:20 kg/ha N:P₂O₅:K₂O should be applied at the time of sowing. The fertilizers should be applied in furrows 8-10 cm deep and 4-5 cm away from the seed at the time of planting.

Fertilizer application in *kharif* fallows

Under favourable conditions of moisture and effective crop management, economic response to N beyond 60 kg/ha are achieved. The recommended economic doses of N for different regions are given below.

Region	Recommended level of N (kg/ha)
<i>Scanty rainfall areas of Maharashtra, southern Tamil Nadu and plateau of Bihar (medium lands)</i>	25-30
<i>Karnataka, Andhra Pradesh, Madhya Pradesh (Malwa plateau), eastern Uttar Pradesh and south-eastern Rajasthan (Udaipur and adjoining areas)</i>	30
<i>Assured moisture areas of Maharashtra (Khandesh tract), Vidarbha and Marathwada</i>	40-50

Safflower growing areas in India are generally deficient in phosphorus. Therefore, a dose of 20-30 kg/ha of P₂O₅ should be applied as basal at sowing.

In Maharashtra, Karnataka and Andhra Pradesh, an additional 10-15 kg N/ha as top dressing should be applied, if seasonal conditions are favourable (high initial stored moisture at planting time, favourable post-planting rains) or wherever facilities exist for 1 or 2 supplemental irrigations. Give top dressing preferably at elongation or flower initiation.

Fertilizer application in *kharif* cropped areas

Response of safflower to fertilizer application in the cereal/legume-safflower sequence system in drylands depends mainly on the occurrence of rains at the time of planting or immediately thereafter. Whenever chances of receiving rains at the seeding time are remote (as in Madhya Pradesh, Rajasthan, Bihar and Uttar Pradesh), it is advisable to apply recommended dose of fertilizers to the first crop, viz. *kharif* cereal/legume and grow the second crop of safflower on residual fertility unless otherwise there are rains at the time of planting or there is provision for pre-planting irrigation (if so apply 20-25 kg N/ha). In all

other potential double cropped areas of Maharashtra, Karnataka and Andhra Pradesh, the recommended dose of N to safflower can be reduced by 10-15 kg/ha, if the preceding legume crop receives its full dose of fertilizers.

Method of application

Apply the entire quantity of fertilizers as basal dose using bullock drawn ferti-seed-drill wherever available; otherwise drill the fertilizer preferably 1-2 weeks prior to recommended planting time with the help of local seed-drills and then seed adjacent to fertilized rows. For maximum efficiency, fertilizer should be placed deep in the seed furrows (10 cm below the soil in Deccan *rabi*; 10-15 cm in Uttar Pradesh, Bihar, north-western India).

Water Management

Although the crop is grown without irrigation, but higher yields are obtained with irrigation. The seasonal consumptive use varies from 250-300 mm. No response to irrigation is observed when soil contains 200-250 mm/m moisture at the time of sowing. The flowering and grain-filling stages are more sensitive to water stress conditions. One irrigation 30 days after planting helps in better growth of the crop. In soils that crack, apply irrigation well before cracks develop for better control of water.

Weed management

Safflower is very susceptible to weed competition during its rosette stage which lasts about 25-30 days in Deccan region and 60 days or more in other parts with prolonged winter. The field should be kept weed-free during this critical phase through timely weeding and interculture once or twice 25-30 or 45-50 days after planting depending on the length of rosette period and the severity of weed infestation. Pre-plant application of trifluralin @ 0.5 kg/ha or EPTC @ 0.5 kg/ha or pre-emergence application of atrazine @ 0.75 kg/ha or Alachlor @ 1.5 kg/ha can be used for effective weed control in safflower.

The black soils start losing subsoil moisture rapidly as they begin cracking from December onwards. To delay cracking, close them superficially with dust mulch as and when they appear and thereby minimize moisture losses. Give one additional interculture or hoeing using manual/bullock-drawn hoes/harrows/sweeps in December well before the crop canopy is closed and the spines become problematic.

Cropping Systems

It is mostly raised as a mixed crop with wheat, barley, gram, lentil, *rabi* sorghum, coriander etc. Three rows of safflower are planted after every 9, 12 or more rows of main crop. Safflower is sown as a border crop around wheat, barley, gram, *rabi* sorghum and coriander plots in order to prevent trespass by stray cattle. A pure crop is rotated with greengram, cowpea, blackgram, groundnut, cotton, pearl millet, sorghum, upland rice, soybean, maize, *Setaria*, sesame etc. in different parts of the country.

Intercropping

In its traditional belt, safflower is more popular as a mixed or intercrop with other *rabi* crops (wheat, sorghum, linseed, coriander and gram) than as sole crop. A sole crop of safflower is, however, more profitable. The following intercropping systems are suggested for different regions in the country.

Region	Suggested intercropping systems	Ratio of base crop to intercrop
<i>Andhra Pradesh, Maharashtra, Karnataka</i>	Wheat+safflower	2-3:1
	Gram+safflower	2-3:1
	Linseed+safflower	2-3:1
	Coriander+safflower	2-3:1
<i>Madhya Pradesh</i>	Gram+ safflower	2:1 or 6:2
	Linseed+ safflower	2:1 or 6:2
<i>Eastern Uttar Pradesh and Bundelkhan region</i>	Linseed+ safflower	2-3:1
	Gram+ safflower	2-3:1

Harvesting and Threshing

The high yielding varieties of safflower mature in 115-140 days in Maharashtra, Karnataka and Andhra Pradesh and 150-180 days in other areas, viz., Malwa plateau, south-eastern Rajasthan, northern India, Uttar Pradesh. Harvest the crop preferably in the early hours when shattering would be minimum and spines are relatively soft. Cut the plants with the help of sickles at the base or wherever possible uproot (black soils) and stalk them in the field in the form of small and well-pressed heaps till they are fully dried. For easy handling and transport to the threshing yard, use improvised socks and gloves made from gunny bags to protect legs and hands against spines. Thresh either by beating with sticks or with the help of bullock drawn stone-rollers or if available, power-operated thresher.

Yield

With improved agronomic practices, safflower can yield, on an average 1.0-1.2 t/ha under scanty moisture conditions and 1.5-2.0 t/ha under favourable moisture situations. Hybrids can yield 2.0-2.5 t/ha.

Additional Resources:

<http://www.bioversityinternational.org/Publications/Pdf/498.pdf>