

Agronomy – Rabi Crops

Sunflower

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SUNFLOWER

Botanical Name: *Helianthus annuus* L.

Family: Compositae

Chromosome number: $2n=34$

Sunflower also known as 'Surajmukhi'. The seed contains 45-50% good quality oil. Sunflower oil is used for edible purposes. Its oil is a rich source of linoleic acid (66%), which helps in reducing cholesterol in the coronary arteries of the heart. The oil is used for manufacturing hydrogenated oil, soaps and cosmetics. Its cakes contain 40-44% high quality protein and is ideally suited for poultry and livestock. It holds a great promise because of its short duration, photo-insensitivity, wide adaptability and drought tolerance.

Origin and History

The cultivated sunflower is believed to have originated from wild *Helianthus annuus* in the south-western USA. Its cultivation is presumed to began in Arizona and New Mexico about 3000 BC. The tall mono-head sunflower seems to have been developed as early as the 6th century. In 16th century, Spaniards introduced domesticated sunflower from Mexico to Europe as an ornamental plant. In 18th century, it was introduced into Russia from Netherland as ornamental plant and its potential as edible oil source was recognized.

There are over 50 species of genus *Helianthus*. Of which only 2 species, a diploid annual *H. annuus* ($2n=34$) and hexaploid perennial *H. tuberosus* ($2n=102$) are cultivated. The former is grown as an oilseed crop, while the later as a feed crop for its tubers.

Geographic Distribution

Sunflower is cultivated globally on 21.48 m. ha with a production of 26.47 million tonnes. Its cultivation is mainly concentrated in Europe particularly Russian Federation, Argentina, Ukraine etc. (Table 1).

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

Country	Area (mha)	Production (mtonnes)	Productivity (kg/ha)
Russian Fed.	4.708	4.800	1019.5
Argentina	1.822	3.100	1701.4
India	2.100	1.224	582.9
Ukraine	3.427	3.050	890.0
Spain	0.449	0.785	1047.6
USA	0.692	0.929	1342.7
Romania	0.973	1.557	1600.5
France	0.615	1.461	2373.5
China	0.980	1.750	1785.7
South Africa	0.530	0.677	1278.1
Turkey	0.550	0.900	1636.4
World	21.480	26.366	1227.4

Source: FAO Production Year Book, 2004

Sunflower, being a new oilseed crop in India (introduced in 1969) is mainly grown in Karnataka, Maharashtra and Andhra Pradesh (Table 2).

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

State	Area (,000 ha)			Production (,000 tonnes)			Productivity (kg/ha)		
	K	R/S*	T	K	R/S*	T	K	R/S*	T
Andhra Prdaesh	144.0	347.0	491.0	91.0	242.0	333.0	632.0	697	678
Bihar		11.0	11.0		16.0	16.0		1455	1455
Chattisgarh	1.3		1.3	0.7		0.7	580		580
Haryana*		20.7	20.7		30.7	30.7		1483	1483
Karnataka	360.0	765.0	1125	168.0	254.0	422.0	467	332	375
Madhya Pradesh*	1.6	1.9	3.5	0.9	1.0	1.9	563	526	543
Maharashtra	89.0	204.0	293.0	32.0	84.0	116.0	360	412	396
Nagaland*	1.7	1.1	2.8	2.1	1.6	3.7	1235	1455	1321
Orissa	0.8	5.2	6.0	0.5	3.9	4.4	625	750	733
Punjab*		20.0	20.0		32.0	32.0		1600	1600
Rajasthan		0.1	0.1		0.1	0.1		1000	1000
Tamil Nadu	5.9	4.5	10.4	7.6	5.8	13.4	1288	1289	1288
Uttar Pradesh		7.2	7.2		12.3	12.3		1708	1708
West Bengal *		8.5	8.5		5.6	5.6		659	659
India	604.3	1396.2	2000.5	302.8	689.0	991.8	501	493	496

K: Kharif, **R:** rabi, **S*:** Summer, **T:** Total

Source: Hegde and Damodaram, 2005

Climatic requirements

Sunflower though basically a temperate region crop, but varieties adapted to a wide range of agro-climatic zones have been developed. It is raised from 40°S to 55°N latitudes, but major production lies between the latitudes 20° and 55°N and 40°S latitudes. The crop can be raised up to an altitude of 2,500 m.

Sunflower successfully tolerates temperature range of 8-34°C, indicating its adaptation to the regions with warm days and cold nights. However, it grows well within the temperature range of 20-25°C. The crop performs best with a rainfall of 500-700 mm during the growing period. The amount of linoleic acid decreases with high temperatures at maturity. It is grown throughout the year in peninsular India, but largely confined to spring season in north-west plains zone (Haryana, Punjab and western Uttar Pradesh).

Soil and its Preparation

Sunflower grows well on well drained neutral to moderately alkaline soils, within pH range of 6.5-8.0. Acid and saline soils are not suited to the crop. It performs better than groundnut in heavy black cotton soils of Karnataka and Tamil Nadu.

Sunflower requires well pulverized and weed-free land with adequate moisture. The first ploughing should be done by mould-board plough followed by 2-3 ploughings or harrowings with planking. There should be sufficient moisture at the time of sowing for proper germination, its seed has thick hulls and imbibes water at a slow rate.

Varieties

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

Table 3. Sunflower varieties and hybrids recommended for different states

State	Variety	Hybrid
<i>Tamil Nadu</i>	<i>CO-1, CO-2, CO-3*(TNAU), CO-5</i>	<i>MSFH-1, TCSH-1, TNAU-SUF-10, SH 416</i>
<i>Gujarat</i>	<i>Gujarat sunflower-1, GAU SUF-15*</i>	<i>SH 416,</i>
<i>Maharashtra</i>	<i>SS-56, Surya, Sidheshwar (LS-11), PKVSF-9, TAS 82*</i>	<i>PRVSH-27, MSFH-1, LDMRSH-1 (LSH-1), LDMRSH-3 (LSH-3), TNAU-SUF-10, LSFH-35(Maruti), SH-416</i>
<i>Karnataka</i>	<i>EC 68415(Armavirski)</i>	<i>MSFH-1, DSH-1, TNAU-SUF-10, KBSH-4, RSFH-1 (Tunga), SH 416, KBSH 41, KBSH 42</i>
<i>Andhra Pradesh</i>		<i>MSFH-1, APSH-1, SH 416, NDSH-1 (NDSH 15)</i>
<i>Punjab</i>	<i>Rumsum record</i>	<i>PSFH-67, PSFH-118</i>
<i>Haryana</i>		
<i>All India</i>	<i>PAC 1091, PAC-36, PAC-47, Jwalamukhi (PSCL-5015), Sungene-85, EC 68414(Peredovick), Morden (Cernianka 66), CO-4, DRSF 108,</i>	<i>APSH-11, BSH-1, KBSH-1, MLSFH-17, MSFH-8, MSFH-10, TNAU-SUF-7, MLSFH-82, DRSH-1 (PCSH-243, for rabi and summer seasons), Pro.Sun 09, KBSH 44,</i>

* Mutant



Important varieties/ hybrids released recently and their characteristics

DRSH-1: A hybrid (ARM 243 A x 6D-1) released in 2006 from Directorate of Oilseed Research, Hyderabad with 42-44% oil , matures in 92-98 days with seed yield of 1.3-1.6 t/ha. It is recommended for All India for *rabi* and *zaid* seasons.

HSFH 848: A hybrid (CMS 91 A x RHA 298) released in 2005 with 40-42% oil, maturing 90-92 days to maturity with seed yield of 1.2-1.5 t/ha and is recommended for Haryana.

RSFH 1: A hybrid (CMS 103 A x R64NB) released in 2005 from Raichur for Karnataka with 40-43% oil , maturing in 95-100 days with seed yield of 1.3-1.6 t/ha .

TAS-82: A mutant of Surya, released in 2005 with 40-42% oil, maturing in 90-95 days with 0.8-1.2 t/ha seed yield.

CO-5: A selection from Coimbatore released in 2006 with 40-42% oil, matures in 90-95 days with 0.8-1.2 t/ha seed yield.

Seed and Sowing

Seed rate

Dibbling method of sowing requires 5-6 kg/ha seed. A crop sown by placing seeds in furrows opened by plough needs 8-10 kg/ha seeds. The excess seedlings are thinned 10-15 days after seedling emergence.

Seed treatment

Under dryland conditions, pre-soaking of seeds in water for 12 hours and subsequent drying in shade has been recommended. The seed before sowing should be treated with captan or cerasan @ 3 g/kg seed. Bold and certified seed should be used for sowing. In downy mildew prone areas, seed treatment with apron 35 SD @ 6 g/kg seed is necessary.

Seed Dormancy and Viability

Sunflower seeds have a dormancy period of 10-50 days. The germination inhibitors are present in seed kernel and seed coat are active up to 10 and 45 days after harvesting respectively. thus the dehusked seeds can be germinated from 10th day after harvest up to 75%.

Method of breaking dormancy

Exogenous application of ethrel, benzyl adenine and GA 3 promotes germination of dormant achenes (intact seeds). Pre-soaking of dormant seeds with ethrel solution (25 ppm) equivalent to 40% by volume of seeds was found to be optimum, and is the most effective chemical. Seeds can be soaked for 6 hours and then dried in shade or can be sown directly. If the quantity of seeds is small, they should be soaked for 24 hours in ethrel solution and then sow in prepared field. This treatment gives germination to the extent of 85% or more.

Viability of seeds

Normally sunflower seeds remain viable for 10-12 months. However, in areas of hot humid weather seeds lose viability quickly. At 50 to 85% relative humidity, seeds lose viability within 40-60 days. Pre-soaking seed with water or protein (10^{-5} M concentration) before storing increased the viability period even under high humidity conditions. Short term seed hardening treatment given to 6 months old seeds resulted in extending viability up to 10 months.

Time of sowing

In north India, sunflower is sown during kharif and spring/zaid crop. However, higher yields are obtained during early summer and rabi than kharif season, because of low biotic stress and favourable soil moisture conditions. The sowing date should be adjusted in such a way that flowering period does not coincide with heavy rains because the rains may adversely affect pollination and seed-set. In rabi, the suitable sowing time is between second fortnight of September and first fortnight of October. Summer crop can be sown in January through first week of February (Table 4).

Table 4. Optimum sowing time for sunflower in various states of India

State	Kharif	Rabi	Summer/Spring
Andhra Pradesh	Late June to Mid July (light soil area), Late August (heavy soil areas)	September to 1 st week of October (rainfed), November (irrigated)	Second fortnight of January to first week of February
Karnataka	June-July (rainfed) June last week of July (irrigated)	September to October (rainfed) September (irrigated)	December-January (Region I), January-February (Region II), Mid January to mid-February, irrigated (Region III, IV, V)
Maharashtra	Last week of June to first week of July	First week of October	First week of February
Tamil Nadu	June-July (rainfed)	October-November (irrigated)	December-January
Uttar Pradesh and other non-conventional areas	Last week of July to second week of August (rainfed)	-	Second fortnight of February to first fortnight of March

Method of sowing and spacing

The sowing can be done by corn planter in the furrows. A spacing of 60 cm x 30 cm for tall and 45 cm x 30 cm for dwarf varieties is optimum. However, closer spacing of 45 cm x 30 cm was recommended even for taller varieties, where moisture was not limiting.

The seed should be sown at a proper depth (5-7 cm) so that it remains in contact with the subsoil moisture during germination.

The optimum population varies from 40-74,000 plants/ha depending on variety and availability of moisture. Under dryland conditions, 40-50,000 plants/ha, while under irrigated conditions, 50-60,000 plants/ha is the optimum plant density. A plant density of 55,556 plants/ha (60 cm x 30 cm) in tall cultivars and 74,000 plants/ha (45 cm x 30 cm) in dwarf cultivars/hybrids has been found to be optimum.

Manures and Fertilizers

Sunflower is an exhaustive crop and responds well to manures and fertilizers. A crop of sunflower yielding 1.4 tonnes seed/ha removes 175 kg N, 65 kg P₂O₅ and 225 kg K₂O/ha. Therefore, it is necessary to apply adequate quantity of manure and fertilizers. Application of 10-12 tonnes of FYM or compost/ha is necessary especially in drylands and poorly fertile soils.

A dose of 60-80 kg N, 60-75 kg P₂O₅ and 40 kg K₂O/ha is recommended for tall and long duration varieties/hybrids grown under irrigation. Under rainfed conditions, and short

duration varieties, a dose of 30-40 kg N, 40-50 kg P₂O₅ and 30-40 kg K₂O/ha should be applied.

Split application of N (2/3 at sowing and 1/3 as top dressing 25 days after sowing) is beneficial. In light soils, 3 splits (50% basal + 25% at button stage + 25% at flowering) may be desirable. The top dressing of N should be done immediately after irrigation or based on moisture availability in drylands.

All P and K fertilizers are applied as basal, 5 cm away in band on both sides of seed line. In acidic soils, liming is essential to overcome calcium deficiency. In soils S and B, and in intensive cropping system, crop should be applied with 20-30 kg S and 2 kg borax/ha.

Water management

Usually no irrigation is needed for *kharif* crop. However, 1 irrigation should be given in case of uneven distribution of rainfall. *Rabi* crop may be irrigated thrice after 40, 75 and 110 days of sowing. Sunflower crop is highly sensitive to water stress between flowering and grain filling stages. Therefore, 1 irrigation may be provided in case of moisture deficiency during this stage.

Irrigation requirement of crop during *zaid* (summer) is relatively higher. It requires 4-8 irrigations at an interval of 10-15 days. Irrigation at grain-filling stage should be light and given on calm and windless evening to avoid lodging.

Among the various stages, bud initiation, button stage, flowering period and seed development stages are critical stages in terms of irrigation. Two to 4 irrigations in black soils and 10-12 irrigations in light soils are often needed. The incidence of *Sclerotinia* stem-rot is more under irrigated conditions especially when the soil drainage is poor.

Weed control

The crop suffers severe weed competition during initial 45 days of growth. The crop should be kept weed free during this period to obtain higher yields. The major weed flora includes *Cynodon dactylon*, *Cyperus rotundus*, *Echinochloa* (Grasses), *Achyranthus aspera*, *Phyllanthus niruri*, *Cynotis sp.*, *Celosia argentina*, *Portulaca oleracea*, *Parthenium hysterophorus* etc. Two hand weedings and 2 intercultivations with hoeing 20-25 days and the other 30-35 days after sowing are quite effective. Pre-emergence application of pendimethalin @ 1.00 kg/ha is also effective. Pre-emergence use of 1.5-2.0 kg/ha of nitrofen or 0.75-1.0 kg/ha prometryne also successfully control the weeds. However, alachlor @ 1.5 kg/ha was more economical.

The crop and its residues have allelopathic effect on weeds due to secretion of chlorogenic acids, scopolin etc.

Cropping systems

Sunflower is grown mostly as a rainfed crop in India. Mixed or intercropping system would greatly help the farmers with assured returns. The important intercropping systems are given in Table 5.

Table 5. Promising intercropping systems of sunflower in different states of India

Intercropping	Row ratio	Regions
Sunflower+groundnut	6:2	Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka
Sunflower+castor	1:1/1:2	Andhra Pradesh, Gujarat
Sunflower+soybean	1:2	Maharashtra and Vidarbha region of Maharashtra
Sunflower+blackgram	1:3	Tamil Nadu and Uttar Pradesh
Sunflower+pigeonpea	2:1/2:2	Maharashtra, Karnataka, Andhra Pradesh
Sunflower+fingermillet	2:4	Karnataka

Sunflower is raised in rotation with several crops. However, raising sunflower after sunflower should be discouraged because of build up of inoculum of diseases pests. Some of the important crop rotations are given below.

Pigeonpea (early)-sunflower

Maize-sunflower

Maize-potato-sunflower

Rice-sunflower

Maize-toria-sunflower

Ratoon sugarcane-sunflower

Sunflower-safflower

Hand pollination

Since sunflower is self-incompatible and depends on insects, mainly bees for pollination and seed-set, it must be ensured that adequate pollinators are present in field for pollen movement and seed-set. Lack of adequate pollinators results in 'chaffy' and partially filled seeds, causing reduced yield. Keeping beehives in the field is therefore necessary.

Harvesting and Threshing

Physiological maturity in sunflower is attained when the back of head turns to lemon-yellow. All heads may not be ready for harvesting at one time. Harvesting may, therefore, be done in 2 or 3 instalments to avoid shattering. The harvested head should be dried well in sun and then only threshed by beating the center of the head with a small stick. The commercial crop may be threshed with available threshers by reducing their speed. Further, sun-drying of the seed is desirable before storage or oil extraction. Moisture in seed should not exceed 10% before storage.

Yield

Depending upon the agro-climatic conditions improved varieties and crop management practices may yield 1.0 and 2.0 tonnes/ha under rainfed and irrigated conditions respectively.

Additional Material

<http://classes.hortla.wsu.edu/hort231/List01/Sunflower.html>