



Safflower

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History

Safflower (*Carthamus tinctorius* L) is a herbaceous annual and a member of the Asteraceae/Compositae (sunflower) family. It is native to parts of Asia, the Middle East, and Africa. It was grown mainly for its flowers, which were used in making dyes for clothing and food. Today, it is grown mainly for its oil.

Safflower evaluations in the U.S. started in 1925 in the Great Plains, but commercial production did not begin until the 1950s. Production is concentrated in the western United States and the Canadian prairie provinces.

California grows about 50 percent of U.S. safflower. North Dakota and Montana are the next major areas of commercial production. South Dakota, Idaho, Colorado, Arizona, and Nebraska also produce the crop, but on small acreage.



Description

Safflower is an annual broad-leaved plant adapted to the western United States. It grows well in both dryland and irrigated areas. It is a drought-tolerant plant.

The plant is thistle-like, with a main stem and a number of branches. It stands 1 to 4 feet tall at maturity. Its taproot can penetrate 8 to 10 feet depending on subsoil temperature and moisture.

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Photo courtesy of Arizona Extension Service.

If planted in April in the Pacific Northwest (PNW), safflower takes 1 to 2 weeks to germinate. After emergence, it stays 2 to 4 weeks in the rosette stage.

Early growth and development is slow, but growth is rapid from the stem elongation stage. Flower buds (heads) form from mid- to late June, and flowering occurs by mid- to late July. Flowering may continue over an extended period.

Each plant produces a number of flower heads. Flower petals are red, white, yellow, or orange. Each head contains 20 to 100 seeds. The seed is the same size as plump barley. Seeds are glossy white, brown, or white with gray, black, or brown stripes.

On average, safflower is ready to harvest about 35 to 40 days after the peak of flowering.

Table 1. Description of several safflower varieties.

Variety	Origin ¹	Hull type ²	Oil type ³	Relative Performance ⁴					Disease Tolerance ⁵	
				Yield	TWT	Oil	Height	Maturity	Alternaria	Bacterial blight
S-541	ST	STP	Lino	v.good	m.high	v.good	m.tall	med.	S	MS
S-208	ST	N	Lino	good	med.	good	med.	m.early	S	S
Hartman	MT, ND	STP	Lino	fair	med.	fair	med.	m.late	T	T
Oker	MT, ND	STP	Lino	poor	low	good	m.short	early	T	MT
Girard	MT, ND	STP	Lino	good	med.	good	m.tall	m.late	T	T
Finch	MT, ND	N	Lino	v.good	v.high	fair	med.	med.	MT	T
Saffire	Can.	N	Lino	poor	med.	poor	short	v.early	S	S
Centennial	MT, ND	STP	Lino	v.good	med.	v.good	m.tall	med.	MT	MT
C/W 4440	CalWest	STP	Lino	v.good	med.	fair	tall	m.early	NA	NA
S-317	ST	STP	Oleic	v.good	med.	good	m.tall	med.	MS	MS
Mt.3697	MT, ND	STP	Oleic	good	high	good	med.	med.	MT	MT
Montola 2000	MT, ND	N	Oleic	good	med.	good	short	early	NA	NA

Source: *Safflower Production*, March 1991. A-870, Cooperative Extension, North Dakota State University, Fargo, ND.

¹ST = SeedTec International, MT = Montana, ND = North Dakota, Can. = Canada

²STP = purple or white stripes, N = normal or white

³Lino = high linoleic acid content, Oleic = high oleic acid content

⁴Yield = seed yield, TWT = seed test weight, Oil = oil content, v = very, m. and med. = medium

⁵S = susceptible, MS = moderately susceptible, MT = moderately tolerant, T = tolerant, NA = not available.

Relative performance of seed yield, test weight, and oil can vary with a severe disease infestation.



Uses

In the U.S., there are three major uses for safflower: oil, meal, and birdseed.

Commercial safflower varieties contain 32 to 52 percent oil, but the seed market demands seed with over 34 percent oil content. The crop is divided into two categories based on oil quality:

1. High linoleic (a polyunsaturated fatty acid) acid varieties. These contain 75 percent linoleic acid, a percentage much higher than that found in olive, soybean, cotton seed, corn, and peanut oils.
2. High oleic (monounsaturated fatty acid) acid varieties.

Do not mix the seeds of these two varieties at planting or harvesting.

See Table 1 for a description of several safflower varieties.

Oil from the crop is used in food products, e.g., salad oil, soft margarine, instant food formulations, and fried potato chips and French fries. It also is used as industrial oil to make paints and varnishes, because the light-colored oil does not yellow with age.

The meal that remains after oil extraction serves as a high protein (24 percent) and fiber supplement for livestock. The meal from dehulled seeds has an even higher protein content (40 percent) and lower fiber. Safflower can be used as forage for sheep and cattle and for flower arrangement. Birdseed producers also buy a small portion of the seed.

Conditions for growth

Climate

The climatic conditions in the lower rainfall wheat-growing areas of the PNW are ideal for growing safflower. Safflower is a sun-loving crop, and high temperatures and bright sunny days in July through early September speed development.

Seeds germinate when soil temperatures are above 40°F. Varieties adapted to the PNW tolerate temperatures as low as 20°F in the

seedling stage, but plants cannot withstand freezing temperatures after flowering.

Though moisture is important at planting, plants need dry atmospheric conditions during flowering and seed filling for proper head set. Thus, eastern Oregon is the ideal place. Research done in the U.S. showed that the crop required less than 2,200 growing degree days to mature. Work from Lethbridge, Alberta showed a similar level: 2,179 to 2,255 accumulated corn heat units. Seeding to maturity takes 120 to 150 days or longer.

Soil

Safflower is adaptable to a wide range of soils, but the best for production are deep, fertile, well-drained soils. Do not plant safflower in poorly drained or cool, wet soils. Cool, wet soil delays uniform emergence.

The plant is more tolerant of soil salinity than small grains because of its deep roots.

Cultural practices

Seedbed preparation

Safflower is a spring-planted crop. Seedbed preparation is no different from that of spring wheat or barley. A moist, firm, weed-free seedbed is required. Safflower doesn't do well when there is soil crusting. Light harrowing of the seedbed helps loosen the soil for seeding.

The crop is a poor competitor with weeds, especially in the early stages of growth, when it has not started branching. Presence of weeds at this time is detrimental. It is important to eliminate weeds before you plant the crop. Use any tillage operation that keeps down weed growth.

It is also important to kill all volunteer grain before planting safflower.

Planting date

In the Prosser, Washington area, growers plant safflower in late March to early April, or whenever soil temperatures are above 40°F. In

other safflower-growing areas, growers plant the crop from late April to early May.

Late plantings may not mature before fall rains, or they may suffer injury from fall frost. Rain during flowering and seed-filling increases disease outbreak and prevents proper seed set, which can lead to reduction in seed yield and oil quality.

Method and rate of seeding

You can use both row and solid seedings to plant safflower. In both cases, you can use a regular grain drill. Seed at depths of 1 to 1.5 inches (2.5 to 3.5 cm). Do not seed deeper than 2 inches, as this prevents uniform emergence.

In some safflower-growing areas, it is recommended to plant the crop in rows 6 to 7 inches apart. However, other researchers recommend a 6- to 12-inch row spacing for "solid" seedings and an 18- to 24-inch row spacing for row seedings under dryland farming conditions.

Recommended seeding rates are 20 to 30 pounds of seed per acre. The following rule can help you calibrate the drill before planting: A seeding rate of 20 pounds per acre at 6-, 8-, 10-, or 12-inch rows would require 3, 4, 5, and 6 seeds per linear foot of row.

One advantage of safflower is that it compensates for poor emergence by producing extra branches, extra heads, and extra seeds per head.

Fertilizer

Safflower's nutrient needs generally depend on the following:

- Yield goal
- Soil test results
- The sequence of the crop in the rotation

Growers have applied nitrogen at rates of 20 to 50 pounds per acre under dryland conditions. A general practice in North Dakota is as follows: for every 100 pounds of seed produced, safflower plants require 5 pounds per acre of total N. Thus, for 1,000 pounds per acre of seed, 50 pounds per acre of N is required.

Safflower's deep taproot allows it to reach nutrients that may be unavailable to small grains. You may need more fertilizer if safflower follows deep-rooted crops in rotations. If the crop follows alfalfa, sweet clover, or fallow, you may not need to add nitrogen.

Consistent response to phosphorus or potassium (K_2O) is obtained only when a soil test is in the low range (low to very low).

Band or drill application of nutrients is better than broadcasting. Do not apply more than 20 pounds per acre of N or K fertilizer in the drill, as this may cause seedling injury. Do not apply urea with seed, either.

Weed control

Safflower competes poorly with weeds, especially from early growth through the rosette stage, when branching has not yet occurred. It is critical to have effective pre-plant weed control. Weeds have reduced safflower yields up to 75 percent, depending on the species and numbers. Wild oat (*Avena fatua*) was most troublesome in safflower planted in Idaho. Pigweeds (*Amaranthus* sp.), lambsquarters (*Chenopodium alba*), and chickweed (*Stellaria media*) can be a problem if not controlled early.

Control weeds emerging before or at the time of planting with cultivation. You can use a harrow, rotary hoe, or finger weeder.

Do not harrow after safflower is more than 8 inches tall, as it can cause severe damage to the crop. You can use herbicides at this stage to control summer annual broadleaf and grass species. Check with your local agrichemical dealer for labeled herbicides and **follow label directions explicitly**.

Diseases

In periods of higher than normal rainfall, fungal diseases such as Phytophthora root rot, Alternaria leaf spot (*Alternaria cartharimi*), Pseudomonas bacterial blight (*P. syringae*), and Sclerotinia rot can cause serious losses. Fusarium and Verticillium wilts and Botrytis head rot also have caused serious losses to



safflower production. To reduce disease severity, do these two things:

- Plant certified seed.
- Practice proper crop rotation.

Do not plant safflower before or after safflower, pulse crops, sunflower, mustards, or canola. These crops are susceptible to *Sclerotinia* head rot. Leave at least 4 years between susceptible crops.

Cereals are immune to the pathogen. Seed safflower after cereals or before cereals, grasses, or summer fallow.

Insects

There are few insect problems in safflower. Wireworms and cutworms can damage seedlings. Grasshoppers and lygus bugs also can damage the crop, but control them only if they reach levels that cause serious losses. Research into both cultural and chemical forms of control is needed in Oregon.

Harvest and storage

The crop is ready for harvest when most of its leaves have turned brown with only a tint of green remaining on the bracts. The stem must be dry. Seeds must be white and separate easily from the head.

Moisture content should be 8 percent or lower for proper storage. If the crop is cut at higher moisture content, dry it. It is recommended to combine a small sample and measure the moisture content.

Harvest the crop as soon as it matures to prevent problems with rain. Direct combining (as done for cereals) is better than swathing, because it reduces shattering losses, and birdseed quality is better. Use relatively low cylinder speeds—500 rpm for a 22-inch (56-cm) cylinder—to avoid cracking seed. Reel speed should be 25 percent faster than ground speed. Adjust shaker speeds to higher levels than you use for small grains to prevent

Table 2. Dryland fallow safflower—Sidney, Montana.

Cultivar	Test weight 1999 (lb/bu)	Yield (lb/a)		Oil (%)	
		1999	3-yr avg	1999	3-yr avg
Finch	46.8	2,200	1,640	34.4	37.3
Centennial	42.0	2,086	1,640	39.6	42.3
Morlin	41.3	1,911	1,498	37.5	39.0
Erlin	39.5	1,480	1,131	36.9	39.0
Montola 2000	41.3	2,235	1,583	39.3	38.3
Montola 2001	41.7	1,630	1,305	39.0	39.0
Montola 2003	43.3	1,957	1,684	37.4	38.5
S-518	40.2	2,239	1,900	38.6	39.0
95B7174	42.5	2,321	1,843	38.3	39.3
96B6170	45.3	2,076	1,623	37.7	38.1
96B6798	42.5	2,242	1,770	40.5	40.1
97B7185	42.7	2,238	—	39.1	—
97B1286	41.3	2,473	—	37.6	—
Exp GW9023	44.8	2,302	—	32.2	—
LSD 5%	1.1	322	—	0.6	—

1999 crop details—
Planted: 4/22/99
Harvested: 9/14/99
Avg. rainfall: 14 inches

plant residue from clogging the machine. Safflower seed heads have white fuzz that can clog combine radiators and create fire hazards, so check for blockage regularly.

Quality seed with solid white seed coat, large kernels, high test weight (38 pounds per bushel or higher), and oil content above 34 percent commands a premium price.

Yield potential

Test plots and commercial fields in dryland regions of the PNW have yielded from 500 to about 2,000 pounds per acre or more. Irrigated fields in California have yielded anywhere from 2,000 to 3,000 pounds per acre. New varieties may yield more.

Tables 2 and 3 give yield data for some safflower varieties grown over a 3-year period in Sidney, Montana. With the declining prices of small grains, the rising prices of oilseed crops, and the climatic conditions in this state, safflower appears to be a good crop to introduce into the cropping system.

Table 3. Dryland recrop safflower—Sidney, Montana.

Cultivar	Test weight 1999 (lb/bu)	Yield (lb/a)		Oil (%)	
		1999	3-yr avg	1999	3-yr avg
Finch	45.3	1,496	981	33.7	35.5
Centennial	42.2	1,628	1,020	38.9	40.2
Morlin	41.2	1,393	719	35.9	37.0
Erlin	40.7	1,574	901	35.8	37.0
Montola 2000	41.8	1,639	965	37.7	36.8
Montola 2001	42.2	1,366	820	36.9	37.6
Montola 2003	43.0	1,758	1,107	36.9	36.8
S-518	41.0	1,666	1,116	38.4	38.0
95B7174	42.7	1,924	—	37.4	—
96B6170	45.2	1,671	—	37.4	—
96B6798	43.2	1,747	—	38.9	—
97B7185	42.8	1,749	—	38.2	—
97B1286	41.2	1,787	—	36.8	—
Exp GW9023	44.8	1,878	—	32.0	—
LSD 5%	0.8	251	—	0.8	—

1999 crop details—

Planted: 4/19/99

Harvested: 9/20/99

Avg. rainfall: 14 inches

Source: MSU Eastern Agricultural Research Center, NDSU Williston Research Extension Center, 1999 *Agricultural Research Update*.



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