

Safflower Production

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Utilization and Description

Safflower (*Carthamus tinctorius* L.) is an annual oilseed crop adapted primarily to the cereal grain areas of the western Great Plains. In North Dakota, safflower has been grown in experimental test plots since 1928 and on a commercial basis since 1957. Acreage has been concentrated in the western part of the state. Safflower is well-adapted to western North Dakota and South Dakota, as well as eastern Montana.

Safflower provides three principal products: oil, meal and birdseed. Safflower oil consists of two types: those high in monounsaturated fatty acid (oleic) and those high in polyunsaturated fatty acid (linoleic).

The predominant oil market is for those varieties that produce seed high in oleic acid and very low in saturated fatty acids. High-oleic safflower oil is lower in saturates and higher in monounsaturates than olive oil. High-oleic oil is a beneficial agent in the prevention of coronary artery disease.

Oil from this type of safflower is used as a heat-stable cooking oil to fry such food items as french fries, chips and other snack items. It also is used in cosmetics, food coatings and infant food formulations.

High-linoleic safflower oil also is used in human nutrition as a nutritional supplement to reduce body fat and inflammation, lower bad cholesterol, promote muscle health and

improve heart health. High-linoleic safflower oil also is used as an ingredient in soaps, sunscreens, lotions, moisturizers and cosmetics for hydrating the skin and to help reduce inflammation and speed healing.

High-linoleic oil is valued as a drying agent in paints and varnishes because of its nonyellowing characteristic, and as a source of conjugated linoleic acid. The meal, which is 24 to 36 percent protein, depending on the variety, is used as a protein supplement for livestock and poultry feed.

Supplementation of sheep diets with high-linoleic safflower oil (3 to 6 percent of the diet) has increased levels of unsaturated fatty acids and conjugated linoleic acid in the lean meat tissue without adversely affecting growth performance or carcass characteristics.

Supplementation of high-linoleic safflower in beef heifers also has improved body condition and animal performance. Supplementation of Nutrasaff safflower fed up to 3 percent of dietary dry matter helped improve the efficiency of nutrient utilization for milk production in lactating dairy cows and to improve milk fatty acid profile and milk quality.

Safflower seed also is marketed as birdseed. This industry predominately markets the white hull or normal hull type of safflower, even though striped and partial hull types are higher in oil and protein content. The birdseed market does not have a preference for a fatty acid type.

Safflower makes an acceptable livestock forage when cut at or just after the bloom stage in the event early frost kills the plants before seed ripening.

Agronomics

Safflower is a thistlelike plant with a strong central branch stem, a varying number of branches and a taproot system. Each branch usually will have from one to five flower heads containing 15 to 20 seeds per head.

The seed oil content ranges from 30 to 50 percent, depending on variety grown and environmental conditions. Flower color is usually yellow or orange, although some varieties have red or white flowers.

Plant height in North Dakota varies between 15 and 30 inches, depending on the variety and environmental conditions. The taproot of safflower can penetrate to depths of 8 to 10 feet in deep soils. Because of its deep taproot system, safflower is more tolerant to drought than small grains and other oilseed crops.

In western North Dakota, safflower typically is sown in April or early May. Seedlings generally emerge in one to three weeks.

A young plant spends two to three weeks in the "rosette" stage while producing leaves and its taproot system. Safflower tolerates temperatures as low as 20 F while in the rosette stage.

Safflower is very susceptible to fall frost injury during the flowering period and seed development. Safflower has potential as an alternative forage crop in the event an early killing fall frost occurs before crop maturity.

Relative forage value peaks at or just after the bloom stage and decreases in relative forage value as the safflower reaches maturity. In 1993, when safflower failed to mature due to unusually cool, wet

growing conditions and earlier than normal fall killing frosts, dry-matter yields ranged from 1 to 3 tons per acre and quality analyses showed that safflower hay had 8 to 10 percent crude protein with acceptable fiber levels.

Plants begin forming floral buds in late June and flower in mid to late July. The bloom stage usually lasts 14 to 21 days, depending on stand density, available moisture and variety.

The crop matures about four weeks after flowering ends. In North Dakota, safflower normally requires 110 to 120 days from seeding emergence to maturity.

Safflower grows best on deep, fertile, well-drained loam soils with good water-holding capacity. It also can thrive in coarser-textured soils of lower water-holding capacity when rainfall amount and moisture distribution are adequate.

Safflower is similar to barley in tolerance to saline soils. Safflower is an excellent crop to grow in recharge areas because its taproot system can access surplus water below the rooting depth of small grains and utilize the water during its full growing season.

In North Dakota, the crop is best adapted west of a north-south line through Minot and Bismarck. In this area, dry atmospheric conditions usually prevail during the blossoming and seed-filling stages. East of this line, higher humidity and morning dew increase leaf and head diseases and reduce seed set, both of which can reduce yields. However, the use of Quadris and Headline fungicide and varieties with improved *Alternaria* leaf spot resistance have extended the growing area farther east.

Rotation

Safflower most often is grown on recrop or in rotation with small grains or fallow and annual legumes. Volunteer grain from the previous crop may be a problem when safflower follows cereals. Volunteer grain is controlled easily with registered grassy weed herbicides such as Poast or Select Max.

Safflower should not follow safflower in rotation or be grown in close rotation with other crops susceptible to the disease *Sclerotinia* (white mold). These crops include dry bean, field pea, sunflower, mustard and canola. Reduced tillage and/or chemical fallow is advisable to preserve residue and reduce erosion when summer fallowing after safflower.

Planting Dates, Rates, Row Widths

Optimum planting dates for safflower in western North Dakota are between April 20 and May 10. Early planting allows the crop to take full advantage of the entire growing season. Earlier planting usually shows no advantage unless soil temperatures reach 40 F for seed germination.

Cruiser 5FS or another registered product is recommended as a seed treatment in fields when wireworms were a problem in previous crops. Planting after May 20 increases the risk of fall frost injury that reduces seed yield and quality. Delayed planting may delay the harvest to the point that mechanical drying of the seed is necessary. Late planting generally results in shorter plants, less rooting depth, decreased branching, and lower seed and oil yields.

Use high-quality seed that has good germination (above 80 percent) and is treated for prevention of seedling diseases. Safflower seedlings are not vigorous. Soil crusting can reduce stand establishment.

Planting depths of 1 to 1.5 inches are optimum. Recommended seeding rates are from 15 to 30 pounds per acre of pure live seed. The lower seeding rates result in more branches forming, a longer flowering period and later maturity of the crop. Higher seeding rates result in less branching and thicker stands with higher incidence of disease.

If possible, place seed into moisture; however, do not seed safflower deeper than 2 inches. Usually uniform emergence resulting in better stands is obtained with shallow seeding. Seeding into dry soil and allowing spring rains to recharge this germination zone is preferred to deep planting. Dryland safflower usually is planted in 6- to 10-inch row spacing.

Safflower seed size is similar to barley and weighs approximately 38 pounds per bushel. Drill settings for seeding safflower often correspond to settings for similar seeding rates of barley.

The following rule can help calibrate your drill prior to planting:

a 20-pound-per-acre seeding rate planting in 12-, 10-, 8- and 6-inch rows would require six, five, four and three seeds per linear foot of row, respectively.

If soil crusting occurs, running empty disk drills across the field or a light harrowing can improve seedling emergence.

Fertilizer Requirements

The amount of commercial fertilizer required for safflower production will depend on the yield potential, where safflower is placed in a rotation and other crops included in the rotation.

Safflower will root deeper than small grains. This allows the safflower plant to utilize deeper positioned nutrients, such as nitrogen (N), that are unavailable to small grains and other crops.

Nitrogen is most often the limiting nutrient on nonfallow land. Phosphorus can be limiting on fallow and nonfallow land, and safflower responds well to phosphorus.

Local climate, soil type and management (timeliness of planting, plant population, variety, weed control, etc.) influence yield. The NDSU soil test data and recommendations (Extension Publication SF882, "North Dakota Fertilizer Recommendation Tables and Equations") can be used.

Because safflower roots penetrate to depths of more than 4 feet, sampling to depths greater than 2 feet would increase the accuracy of fertilizer recommendations.

Yield potential targets should be realistic, based on longtime averages and the management ability of the grower. Yields have ranged from 500 pounds per acre when moisture was limiting or weed and/or disease pressures were high, to more than 2,500 pounds per acre under conditions relatively free of weeds, diseases and insects and when adequate moisture and fertility were available.

A general rule of thumb is that for every 100 pounds of seed produced, safflower plants will require 5 pounds of nitrogen applied and in the soil. A 1,500-pounds-per-acre yield potential requires 75 pounds of total N.

The method of nitrogen application will depend on the nitrogen source used. Anhydrous ammonia should be applied 4 to 6 inches beneath the soil surface. Broadcast-applied urea and other dry or liquid nitrogen fertilizer products should be worked into the soil shortly after application.

Drill row application never should exceed 15 pounds of actual nitrogen per acre because seedling injury may occur if this level is exceeded. Urea never should be applied with the seed.

Safflower grown on soils with low phosphorus tests depends heavily on applied fertilizer. Because of position

availability, banding or drill applying phosphorus is more efficient than broadcasting. Up to 35 pounds per acre of phosphate can be drill-applied safely. Safflower has not responded consistently to potassium application unless the soil tests in the low range.

Weed Control

Safflower is a poor competitor with weeds when in the rosette stage and before stem elongation, so weed competition is frequently a serious production problem. The rosette state lasts four to six weeks, allowing weeds to become established before the plants can shade the soil surface. Do not attempt to grow safflower without a good weed control program.

The following herbicides are labeled for weed control in safflower: Eptam (EPTC), trifluralin (various brand names), Sonalan (ethalfluralin), Dual/generic S/metolachlor, Harmony SG (thifensulfuron), Poast (sethoxydim), Select Max (clethodim) and Select/generic clethodim. Preharvest herbicides: Roundup/generic glyphosate, Valor+ MSO adjuvant (flumioxazin) and Drexel Defol (sodium chlorate). See NDSU Extension publication W253, "North Dakota Weed Control Guide," for specific recommendations. Read and follow the current pesticide labels prior to use.

Kochia, Russian thistle and wild mustard are the most difficult weeds to control. Perennials such as Canada thistle and perennial sowthistle can be serious problems. Safflower should not be grown on fields with heavy infestations of perennial weeds.

If weeds emerge before the safflower, harrowing with a light spike tooth or light coil spring harrow may control some weeds, but damage to the emerging safflower can occur. When irrigated safflower is planted in wide rows (22 to 24 inches), early cultivation between the rows before stem elongation will kill most small weeds.

After stem elongation, cultivation may be used to move soil into the row to cover small weeds in the row.

Disease Problems

Diseases have been a problem in years of above-normal rainfall with extended periods of high humidity. The most serious disease under these conditions is *Alternaria* leaf spot (*Alternaria carthami*).

Alternaria is characterized by the development of large, brown, somewhat

irregular spots on leaves and flower bracts. The resultant loss of photosynthetic tissue reduces yield. Growers should select varieties carefully because some are more susceptible to *Alternaria* leaf spot than others.

Quadris (Azoxystrobin) and Headline (Pyraclostrobin) are labeled for foliar application at first flower to control or suppress *Alternaria* leaf spot. Additional applications may be required under favorable disease conditions and under irrigated conditions.

Safflower rust (*Puccinia carthami*) is rarely a problem. The seed-borne spores of safflower rust are controlled readily by seed treatment.

Other diseases of safflower usually have not been a problem in North Dakota. Other diseases include: Sclerotinia root rot or head rot, Phytophthora root rot, Verticillium wilt, Fusarium wilt, Pythium root rot and Pseudomonas bacterial blight.

Control of these diseases is best obtained by planting disease-free seed, treating the seed with proper fungicides and crop rotation. Safflower never should follow safflower, sunflower, dry bean, soybean, mustard, canola or lentil in a rotation. A four-year rotation is recommended to separate these crops.

When possible, select varieties with disease tolerance. Most of the newer varieties have some tolerance to the *Alternaria* leaf spot.

Recommended seed treatments and foliar fungicides are listed in the most current NDSU Extension publication, PP622 (revised), "North Dakota Field Crop Fungicide Guide," available at your local Extension office.

Insect Problems

Safflower has relatively few insect pests that cause economic damage. Grasshoppers, cutworms and wireworms are a potential problem.

Insecticides are available and producers should consult the NDSU Extension publication E1143 (revised), "North Dakota Field Crop Insect Management Guide," available at local Extension offices, for latest recommendations. Check the label for the insects controlled. Cruiser 5FS (thiamethoxam), Dyna-Shield, Gaucho 600F and Senator 600FS (imidacloprid) are registered for wireworms in safflower. Mustang Max EC (zeta-cypermethrin) and Belt SC (flubendiamide) are registered for cutworms in safflower.

Other insects that could be a potential problem include western floral thrips, lygus bug and onion thrips. If significant populations of these insects occur, contact your local Extension office for recommended control measures.

Harvesting and Storage

Safflower is physiologically mature about 30 days after flowering and ready to harvest when most of the leaves have turned brown and only a tint of green remains on the bracts of the latest flowering heads. Seeds should rub freely from the heads.

Seed shattering is usually not a problem, although safflower should be harvested as soon as it is mature to minimize the danger of seed damage from excessive moisture. Excessive rain and high humidity after physiological maturity of the seed may cause sprouting in the head.

Bird damage to mature standing fields rarely has been a problem but may develop when fields adjoin a bird sanctuary.

Most safflower grown in North Dakota is ready to harvest in early to late September, depending on planting date and weather conditions during the growing season.

Safflower is directly harvested with a small-grain combine. To prevent cracking of the seed, the combine cylinder speed should not exceed a peripheral speed of 3,000 feet per minute. This will be about 500 rpm for a 22-inch cylinder.

Suggested concave clearance is $\frac{5}{8}$ inch at the front and $\frac{1}{2}$ inch at the back. Shaker speeds greater than those used for small grains are required to prevent plant residue from plugging the machine.

Air should be adjusted to remove most of the empty or unfilled seeds. During the harvest operation, a white fuzz from the seed heads is abundant in the air and may clog combine radiators and air intakes, causing the combine to overheat. Small-meshed screen enclosures over these cooling mechanisms should minimize this problem, and blowing out radiators with air once or twice daily may be necessary. Accumulations of this fuzz can be a fire hazard.

For safe, long-term storage, threshed seed should not exceed 8 percent moisture. Drying the seed can be accomplished following the same precautions and procedures as for sunflower. Drying temperatures should not exceed 110 F to ensure highest seed quality and no seed damage.

Marketing

Historically, nearly all safflower produced in North Dakota, Montana and South Dakota is grown and sold under contract.

Contracts should be negotiated prior to spring planting.

Basically, the contract will promise to buy, at a set price, the total production from a specific number of acres agreed to by the grower. Price per ton may vary depending on seed oil content and/or test weight.

Contracts should include price per unit, payment provision, acreage to be grown, storage payments and provisions, premiums and discounts for oil content or test weight, as well as moisture content and dockage, final delivery point and freight allowances, and an “act of God” clause in case of crop disaster. Contracts are recommended as a safe way to market safflower seed.

Varieties

Almost all commercially available safflower varieties have been tested at western North Dakota Research Extension Centers. See NDSU Extension publication A1105, “North Dakota Alternative Crop Variety Trial Results and Selection Guide,” for agronomic performance information. Agronomists at the respective centers or county agents can be consulted for variety recommendations.

A description of the most popular commercial safflower varieties and agronomic traits are shown in **Tables 1 and 2**. Often, the grower will be limited to growing varieties that are contracted by the buyer and contractor.

Finch, Montola 2003, Hybrid 9049, Cardinal and MonDak are the preferred varieties for the white birdseed market because they have a pure white seed (normal hull). Oleic and linoleic safflower oil varieties should not be mixed or grown within one mile of each other.

Table 2. Agronomic Performance of Varieties – 2012* (average of six site locations).

Variety	Seed Yield (lbs/A)	Plant Height (inches)	Test Weight (lb/bu)	Oil (%)
Oleic types				
Hybrid 1601	2,341	23	39.0	36.5
Hybrid 9049	1,939	22	40.4	31.5
MonDak	1,927	22	39.5	35.4
Montola 2003	1,803	20	39.8	37.7
Linoleic types				
Cardinal	2,091	23	42.2	36.2
Finch	1,557	23	40.4	36.8
Nutrasaff	1,372	24	36.3	46.6

Quadris fungicide applied at first flower.

* Data provided by:

NDSU Research Extension Centers at Hettinger, Minot, Carrington and Williston, N.D., and MSU Research Center at Sidney, Mont.

Table 1. Safflower Variety Descriptions.

Variety	Origin ¹	PVP ⁶	Hull Type ²	Oil Type ³	Irrig. Yield ⁴	Dryland Yield ⁴	TWT ⁴	Oil ⁴	Maturity	– Tolerance ⁵ –	
										Alt.	BB
Centennial	MT/ND	yes	STP	lino	m good	good	med	v good	m late	MT	MT
Finch	MT/ND	no	N	lino	good	v good	v high	fair	med	MS	T
Hybrid 1601	STI	yes	STP	oleic	v good	v good	m high	good	m late	MT	MT
Hybrid 9049	STI	yes	N	oleic	v good	v good	m high	fair	m late	MT	MT
Morlin	MT/ND	yes	STP	lino	v good	good	med	good	m late	T	T
Nutrasaff	MT/ND	yes	RED	lino	good	good	med	high	med	T	MT
Montola 2003	MT/ND	yes	N	oleic	v good	v good	m high	good	m early	MT	MT
MonDak	MT/ND	yes	N	oleic	good	v good	high	fair	m early	T	MT
Cardinal	MT/ND	yes	N	lino	v good	v good	v high	fair	med	T	MT

¹ STI = Safflower Technologies Inc., MT = Montana, ND = North Dakota

² STP = striped, N = normal, RED = reduced

³ Lino = linoleic

⁴ Relative ratings of yield, test weight and oil will vary under conditions of moderate-severe disease infestation

⁵ Alt = Alternaria leaf spot disease, BB = bacterial blight, MS = moderately susceptible, MT = moderately tolerant, T = tolerant

⁶ “yes” indicates the variety is protected and the seed may be sold for planting purposes only as a class of certified seed.

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Photo by Hans Kandel.

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