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Growing Safflower in Nebraska

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This NebGuide provides information on the production and marketing of safflower in Nebraska.

Safflower (*Carthamus tinctorius* L.) is a broadleaf, annual oilseed crop *(Figure 1)*. Safflower production was promoted in the Nebraska Panhandle during the 1960s and production increased to several thousand acres before almost completely disappearing by 1970. The closing of the processing facility in Sidney, Neb., was a major reason for the decline in safflower production. However, it also was reported to decrease subsequent wheat yields, increase erosion potential, and suffer severe losses from diseases, weeds and insects.

Safflower oils are high in poly-unsaturated fatty acids, which are valued for their role in coronary health. Safflower oil also is used in paints and varnishes because of its non-yellowing characteristic. The high protein byproduct of oil extraction (called foots) is used for livestock feed, and whole seeds are used by the birdseed industry. Most safflower in Nebraska is grown for birdseed.

Rotations

Safflower has a taproot that can penetrate 8 to 10 feet. This extensive root system allows safflower to perform well when planted in rotation following winter wheat. The deep-rooted full-season nature of safflower often results in significant soil water depletion. During dry climate cycles, it may be necessary to provide six years between safflower crops in order for adequate replenishment of deep soil water. For example, a stacked rotation such as winter wheat-safflower-fallow-winter wheat-proso millet-fallow might be considered. In western Nebraska, it is necessary to summer fallow fields after safflower before planting wheat.

Safflower leaves very little crop residue, which leaves the land susceptible to wind and water erosion if fallowed. The potential for soil loss from wind erosion can be reduced significantly by growing safflower in strips with winter wheat and/or stubble with chemical fallow. Another option is to grow a shallow-rooted crop such as proso millet the year following safflower and then summer fallow after the millet. If soil water is sufficient, an early spring forage crop such as triticale or oats, with or without peas, could be grown after safflower as a partial summer fallow replacement crop.

Safflower is susceptible to several diseases that are common in other crops grown in the state. Crop rotations need to be designed to allow sufficient time between susceptible crops to minimize the impact of these diseases. See the *Pest Control: Disease* section below for more details.

Figure 1. Safflower is a broadleaf summer crop that performs well in rotation following winter wheat.

Fertilizer Management

Several factors influence fertilizer recommendations for safflower. Among these are: expected yield, previous crop, available soil moisture and, if available, how much irrigation water. Nitrogen often is the most limiting nutrient when safflower is grown on non-fallow land or under irrigation.

Safflower will root deeper than winter wheat and use nutrients that may be unavailable to winter wheat. Soils should be tested for nitrate-N to a depth of 4 feet. Dryland safflower usually does not require more than 30 to 60 pounds N per acre and irrigated safflower has not shown yield responses above 120 pounds N per acre. *Table I* shows suggested N rates based on residual nitrate for dryland and irrigated production. If safflower follows a legume crop, use standard N credits for that crop.

Drill row (direct seed) application of N should never exceed 10 pounds actual N per acre to avoid seedling injury. This 10-pound limit includes any potassium that is applied with the N. Urea or 12-0-0-26 should never be applied with the seed.

Table I. Nitrogen fertilizer rates for dryland and irrigated safflower.

Lbs Nitrate-N in 4 feet	*Dryland - Lbs N/acre*	*Irrigated - Lbs N/acre*
0-30	80	120
31-60	60	90
61-90	40	60
91-120	20	30
>120	0	0

Continuous N rate functions: Dryland N rate = 90 - 0.67*(lbs of nitrate-N in 4 feet).
Irrigated N rate = 135 - (lbs of nitrate-N in 4 feet).

Soil test to determine soil phosphorus levels. Medium to high levels of phosphorus are needed for high yields and early maturity. Soils testing very low in phosphorus will benefit from 20-30 pounds of P_2O_5 applied with the seed *(Table II)*.

Since most soils in the Great Plains have very high levels of potassium, follow guidelines for wheat if soil tests are lower than 125 ppm K. Safflower needs for sulfur are not well established, but should be similar or less than winter wheat needs.

Table II. Broadcast phosphorus recommendations.

Soil test method for phosphorus and ppm soil test level			*Lbs P_2O_5/acre recommended*
Olsen-P	*Bray P-1*	*Mehlich III*	
0-3	0-5	0-6	60
4-6	6-10	7-12	40
7-9	11-15	13-18	20
10-12	16-20	19-24	0

Varieties

The majority of safflower grown in Nebraska is grown for use in birdseed. This market prefers white hulled varieties such as "Finch" and "Montola 2000." Safflower varieties grown for the oil market are classified as either oleic or linoleic, based on the predominate oil type they produce *(Table III)*. Oleic and linoleic varieties grown for oil should not be mixed or grown within one mile of each other. These restrictions do not apply for safflower grown for the birdseed market.

Planting Dates, Rates and Row Widths

Safflower grows best when planted on deep, fertile, well-drained soils with high water holding capacity and moist soil to a depth of at least 4 feet. Optimal planting dates for safflower in western Nebraska are from April 20 to May 10. Safflower should not be planted before the soil temperature reaches 40°F. As a seedling, safflower can tolerate temperatures as low as 20°F. Safflower usually takes eight to 15 days to emerge. Early planting results in larger plants that are more tolerant of insects and diseases. Late planting generally results in smaller plants and lower seed and oil yields.

Soil crusting can be a problem in stand establishment. Planting depths of 1 to 1.5 inches are recommended in fine textured soils such as silt loams or loams. Safflower does not have a vigorous seedling and should never be planted deeper than 2 inches in fine textured soils. A moist, firm seedbed will increase the chances of an adequate stand. Recommended seeding rates are from 20 to 25 pounds of pure live seed per acre.

Safflower is usually planted with small-grain drills in row spacings up to 14 inches. It can also be planted in 30-inch rows and cultivated. Wider rows can reduce the incidence of disease and benefit yields in dry seasons, but they also may increase competition from weeds, delay maturity and decrease branching and seed oil content. Safflower seed is about the same size as barley seed and has a test weight of 42 pounds per bushel. Drill settings for safflower are often about the same as for barley. The following rule can help calibrate your drill before planting: a 20 pound per acre seeding rate planted in 12, 10, 8 and 6-inch rows would require 6, 5, 4 and 3 seeds per linear foot of row, respectively.

Harvesting

Safflower is ready to harvest when most of the leaves have turned brown and the flower bracts show only a green tint. Stems should be dry but not brittle and seeds should rub free of the least mature heads. The seed should have a moisture content of 8 percent or less for safe storage.

Safflower is harvested with a small-grain combine. To prevent cracking of the seed, the combine cylinder should not exceed a peripheral speed of 3,000 feet per minute. This will be about 500 rpm for a 22-inch cylinder. The suggested concave clearance is 5/8 inch at the front and 1/2 inch at the back. Shaker speeds greater than those used for small grains are required to keep the machine from clogging.

Shattering is not usually a problem, but safflower should be harvested when it is mature to minimize sprouting in the heads if a fall rain occurs. Bird damage to mature standing fields has not been a problem.

Pest Control

Weeds

Weeds can cause yield loss and harvesting difficulties. Safflower seedlings grow slowly and compete poorly with weeds for the first three to four weeks. The herbicides labeled for use in safflower are primarily active against grass weeds, although they also have some activity on small-seeded broadleaf weeds that germinate at shallow soil depths. Broadleaf weeds such as kochia and Russian thistle are troublesome in safflower and need to be controlled in other phases of the crop rotation in order to minimize their impact in safflower. These weeds cannot be allowed to grow and produce seed after winter wheat harvest.

The following herbicides are currently labeled for use in safflower: EPTC (Eptak 7E, Eptam), ethalfluralin (Sonalan),

Table III. Safflower variety descriptions.

Variety	*Origin*	*PVP*[†]	*Hull type*	*Oil type*	*TWT*[‡]	*Oil*
Centennial	Montana/North Dakota	yes	striped	linoleic	medium	very good
Finch	Montana/North Dakota	no	white	linoleic	very high	fair
Morlin	Montana/North Dakota	yes	striped	high linoleic	medium	good
Nutrasaff	Montana/North Dakota	yes	reduced	linoleic	medium	high
S-541	SeedTec	no	striped	linoleic	medium high	very good
Montola 2000	Montana/North Dakota	yes	white	high oleic	medium	good
Montola 2001	Montana/North Dakota	yes	striped	high oleic	medium	good
Montola 2003	Montana/North Dakota	yes	white	high oleic	medium high	good
Montola 2004	Montana/North Dakota	yes	white	high oleic	medium high	good

[†]PVP = protected by plant variety protection laws.
[‡]TWT = grain test weight.

metolachlor (Me-Too-Lachlor, Parallel, Stalwart C) *s*-metolachlor (Cinch, Dual Magnum, Dual II Magnum), trifluralin (Bayonet, Treflan, Triflurex HFP). EPTC, ethalfluralin, and trifluralin all require soil incorporation. Metolachlor and *s*-metolachlor may be preplant incorporated or applied preemergence.

If safflower is planted in wide rows, a rotary hoe may be used at speeds of 8-10 mph to kill weeds between the rows. A harrow may be used to control weeds that emerge before the safflower plants. Some damage to the safflower seedlings may occur if the soil is ridged and seedlings are buried too deep. Glyphosate may be used to control emerged weeds prior to safflower emergence.

Disease

A number of diseases have been reported for safflower in various production systems throughout the world. Fortunately, diseases in the High Plains are not generally a problem except in those years with above normal rainfall, or extended periods of high humidity. The most serious diseases seen under these conditions are Alternaria leaf spot, caused by *Alternaria carthami*, and bacterial blight caused by *Pseudomonas syringae*. Both diseases are characterized by irregular spots on leaves and bracts of plants, which if severe enough will reduce yields by loss of green, photosynthetic tissues. Both diseases also can be managed with measures that ensure use of disease-free seed, and with genetic resistance. Varieties developed during the past 20 years are resistant to Alternaria leaf spot and bacterial blight, which has greatly improved stability of safflower yield.

The most serious disease in many areas of the Great Plains is Sclerotinia head rot, caused by *Sclerotinia sclerotiorum*. With timely rainfall and/or irrigations allowing soil surfaces to remain moist around the time of flowering, Sclerotinia head rot can result in greatly reduced yields. Severe outbreaks from this disease may also occur under prolonged periods of high humidity between flowering and seed developmental stages, as with Alternaria leaf spot and bacterial blight. Resistant varieties have been developed for Sclerotinia head rot. The large host range for *S. sclerotiorum* increases the probability for Sclerotinia head rot occurring in safflower; thus susceptible crops, such as potatoes, sunflowers, dry beans, canola or mustards should be avoided within four years of safflower production.

Safflower rust, caused by *Puccinia carthami*, is distributed worldwide, but is rarely a problem in the Great Plains because it occurs late enough in the season that yields are not affected. However, the disease still can occur on most varieties as a result of seedborne or airborne inoculum if conditions for disease development are favorable. Additionally, severely contaminated seeds will not germinate well if saved for future plantings.

Safflower is susceptible to a Cercospora leaf spot disease caused by *C. carthami*, but recent observations in Montana have demonstrated that safflower is an additional host for the sugar beet pathogen, *C. beticola*. This creates new potential disease problems for both crops if grown within four years of each other. Other examples of pathogens capable of causing disease in both safflower and other crops potentially grown in rotation include seedling damping-off and root rot diseases caused by *Rhizoctonia solani*, and *Pythium* spp. The lack of registered fungicides in safflower necessitates the use of cultural practices for disease control.

Genetic resistance is the most effective method of disease management, but this is not available for all diseases. In general, best management of disease is obtained by planting disease-free seed, treating seeds with proper seed protectants, and crop rotations of at least four years between susceptible crops.

Insects

Several insects can be found present and feeding on safflower through the growing season. But, the majority of these insects are not pests and may even be beneficial. Under certain circumstances there are several insects that can cause significant damage; however, there are few insecticide options for insect control in safflower.

The most serious crop damage usually results from insects that reduce plant stand early in the season. Wireworms and cutworms are most likely to cause stand loss early in the season by attacking germinating seed and young seedlings. Rotations that include cereal crops are most likely to develop wireworm problems. Stand reduction from wireworms is usually irregular with spots of severe reduction. Seed treatment with Cruiser will control wireworms, but at a substantially added cost. Planting into warm soils to allow rapid germination and emergence will minimize wireworm potential.

Cutworms will either cut the seedlings off below the ground (pale western cutworm) or feed on the developing foliage of young seedlings (army cutworm). These cutworms are most likely to occur where winter cereals have been planted in the fall, in areas that were tilled early the previous fall, or where volunteer cereals were present in the previous fall. These cutworms are most active early in the season so early plantings (April) are most vulnerable. No insecticides are labeled on safflower that would be effective at controlling cutworms.

Thrips are tiny (1 to 2 millimeters in length) cigar-shaped insects that congregate and feed under the bracts of the buds and in the flowers. Their feeding results in blotchy streaks on the bracts and leaves. The buds may turn bronze-colored and resulting heads may be somewhat deformed. High populations of thrips would be necessary for severe damage.

Lygus bugs feed on the buds, flowers and the developing seeds. Lygus bugs include several species of true bugs that are yellowish brown or greenish in color and are about 1/4 inch long as adults. Feeding on unopened flowers or buds can result in deformed or blasted heads. Later feeding in the flowers and seeds can result in unfilled heads and shriveled seeds. The economic significance of this damage is not well understood and no treatment guidelines have been developed.

Safflower is not a highly preferred host for grasshoppers, but they will move into safflower if other feeding options are sparse. No insecticides are labeled on safflower; therefore, grasshoppers should be controlled in surrounding areas before the grasshoppers move into safflower.

Perhaps the most important insects associated with safflower are bees. Bees, both honey bees and wild bees, are attracted to safflower, and their presence can increase seed set. Safflower also is attractive to several beneficial insects, including lady beetles and lacewings, that may provide insect control in surrounding fields. The impact of insecticide treatments on bees and other beneficials, especially those treatments applied during the safflower flowering period, need to be considered when making management decisions.

Safflower Economics

Planted acres of safflower in the U.S. have ranged from a high of 303,000 in 1998 to a low of 165,000 in 2005. This crop is grown primarily in California and Montana with small acreages in several other states. The market is similar to sunflower, with both oil and birdseed uses. Typically, safflower production in the High Plains region is contracted in the spring with a birdseed or oil company for fall delivery.

Table IV. Production costs for dryland safflower in western Nebraska.

	Cost per Acre					
	Labor	*Fuel and Lube*	*Repairs*	*Materials and Custom*	*Total*	*Your Cost*
Variable Costs						
Spray (Preplant)	0.49	0.27	0.18	18.91	19.85	
	Dual II Magnum 20 oz/acre @ $121.00/gal					
Harrow	0.59	0.27	0.16		1.02	
Plant 0.68	1.17	1.22	24.80	27.87		
	Safflower Seed 20 lb/ac @ $0.50/lb					
	10-34-0 Fertilizer 8 gal/acre @ $1.85/gal					
Spray (Pre-emergence)	0.49	0.27	0.18	3.60	4.54	
	Roundup Ultra 20 oz/acre @ $23.50/gal					
Swath	1.15	0.87	0.26		2.28	
Combine	1.52	3.65	1.62		6.79	
Haul Custom			2.60	2.60		
	Custom Haul 10 cwt/acre @ $0.26/cwt					
Operating Interest @ 8.5% for 8 months				3.68		
General Overhead				3.25		
Total Variable Costs	**4.92**	**6.50**	**3.62**	**49.91**	**71.88**	
Fixed Costs						
Machinery						
Depreciation				10.81		
Interest				8.94		
Land Rent	*$25.00 per acre*		25.00			
Operator Management	*10% of variable costs*		6.49			
Total Fixed Costs				**51.24**		
Total of All Costs				**123.12**		

Production contracts are necessary for many of the alternative crops to reduce risk.

The typical contract terms are for 34 percent oil seed with discounts and premiums adjusting price from this base level. Prices for safflower have ranged from just under $8.00/cwt to nearly $15.00/cwt on an annual basis. Large variation in price can be attributed to the relatively few acres of production annually. These swings from high to low pricing are common in many of the alternative crop markets where acreage stability has not been achieved. Changes in planted acres and average yields can have dramatic impacts on the price from year to year.

The 2002 Farm Bill included safflower in the "minor oilseed" category, making the crop eligible for the marketing loan program, allowing producers to collect a loan deficiency payment when price drops below $9.30/cwt. Recently, farmers also have been able to insure safflower under written agreement for many of the counties in the region.

Typical production costs for safflower are shown in *Table IV.* These costs reflect a typical dryland scenario for the region. Your costs may differ from these, and appropriate adjustments should be made when evaluating this crop in comparison to other alternatives on the farm.

Table V shows the potential for safflower profitability at different price levels and yields. In most cases, yields in excess of 1,000 pounds per acre and prices in excess of $10.00/cwt will be at or above the break-even point.

There is potential for safflower to fit into area rotations for growers who have the proper equipment and need an additional crop to fit into a rotation. Contracting production is encouraged and marketing may be the biggest challenge associated with growing this crop, or any other alternative crop.

Table V. Estimated net returns ($/acre) for dryland safflower in western Nebraska for a range of yields and prices.

Price ($/cwt)	*Safflower Yield (lbs/acre)*				
	600	*1000*	*1400*	*1800*	*2200*
$8.00	-74.08	-43.12	-12.16	18.80	49.76
$10.00	-62.08	-23.12	15.84	54.80	93.76
$12.00	-50.08	-3.12	43.84	90.80	137.76
$14.00	-38.08	16.88	71.84	126.80	181.76

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