Crop Profile for Safflower Production in South Dakota

Prepared: December, 2001

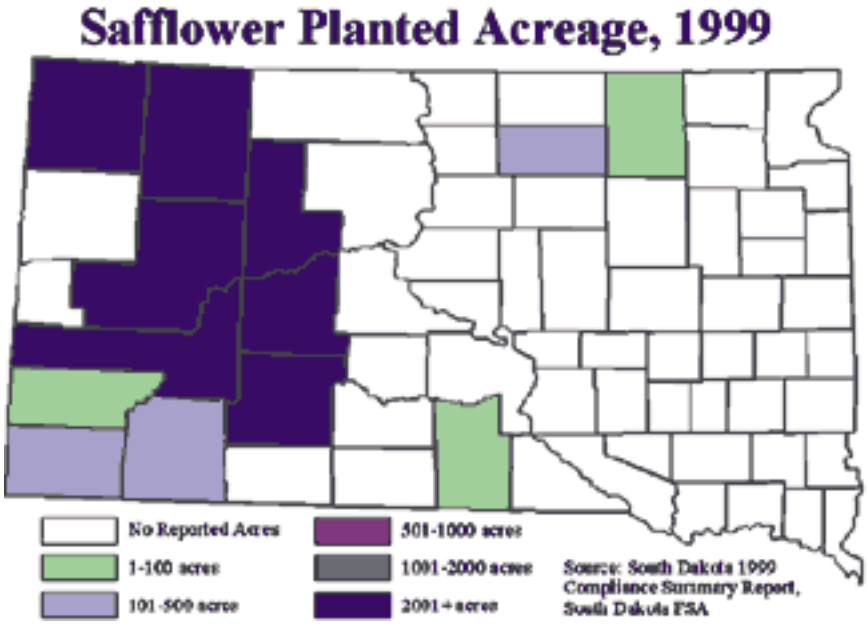
General production information

- South Dakota ranked as the fourth largest safflower-producing state in the United States during 1997, behind California, Montana and Utah. California is by far the largest safflower producer, with 134,920 planted acres in 1997.
- Planted acreage of safflower in South Dakota was estimated at 15,552 acres in 1999.
- Planted acreage of safflower nationally was estimated at approximately 313,000 acres in 1999, with an estimated 294,000 acres harvested.
- Average seed yield nationally was 1,446 pounds per acre, with total production of 412,085,000 pounds during 1998.
- Safflower is a spring annual crop planted in late April to early May and harvested in late summer or early fall, usually in late September in the state.
- Safflower is a thistle-like plant with seeds somewhat similar in appearance to small white sunflower seeds.
- Safflower is primarily raised for the birdseed market, although the edible oil crushing industry also provides a marketing opportunity.
- Safflower production in South Dakota is concentrated in the west central, northwest and southwest regions of the state, with minor production in the north central region.
- Leading production states, planted acres and production, in descending order of acres planted, from 1997 Census of Agriculture.

State	Acres Planted	Total production (Pounds)
California	134,920	296,716,365 pounds
Montana	19,609	19,716,365 pounds
Utah	11,014	10,345,590 pounds
South Dakota	10,656	6,084,510 pounds
North Dakota	10,428	9,991,872 pounds
Idaho	5,348	5,263,481 pounds
Arizona	1,348	3,168,000 pounds
Colorado	1,222	1,383,330 pounds

South Dakota production regions

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

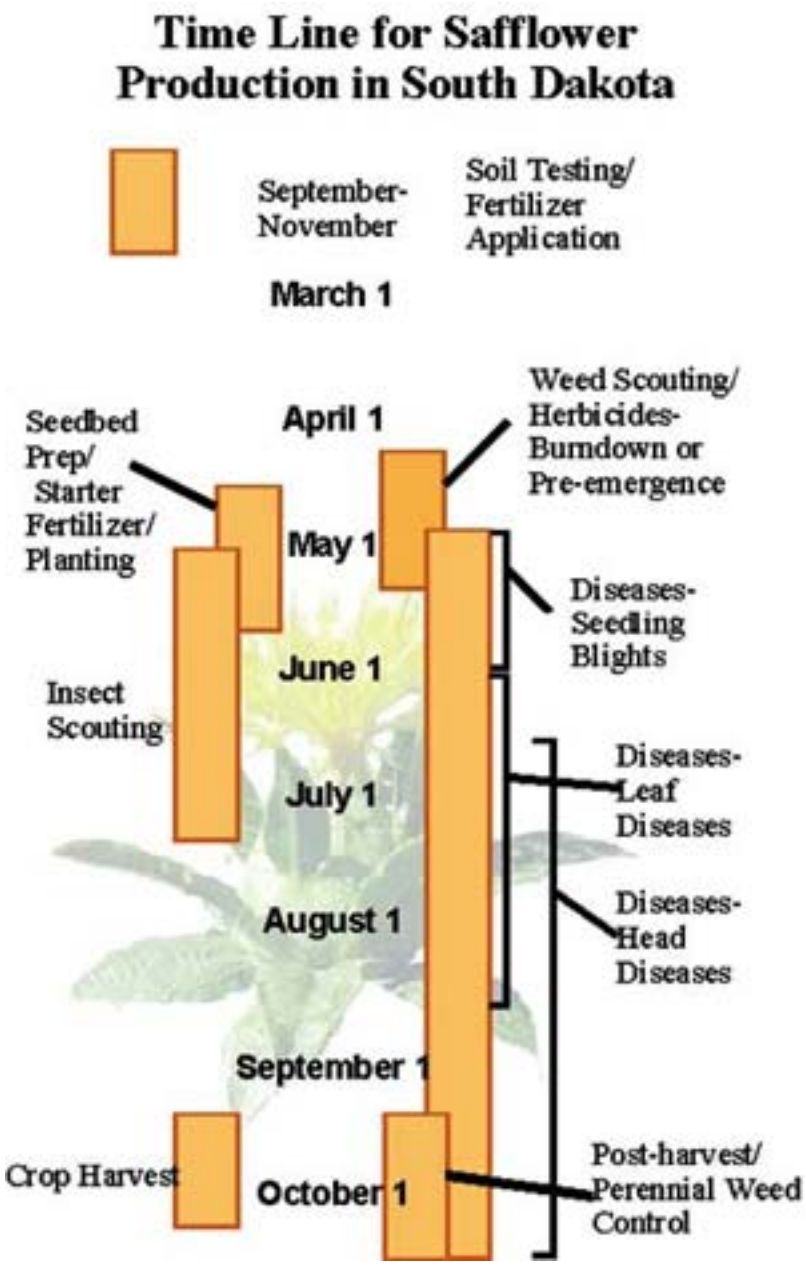


Cultural Practices

Description

Safflower is a thistle-like plant well adapted to dryland production in areas such as South Dakota. The plant grows upright with a strong central stem and numerous branching stems. One to five flower heads are produced per branch. The plant has a very deep taproot, often penetrating the ground to depths of eight to ten feet. This deep taproot gives the plant significant drought tolerance and possibly the ability to tap fertilizer resources deeper in the soil profile than other spring crops such as wheat. The plant usually grows from 15 to 30 inches high (Fig. 1). The seed of the plant is white in color with 15 to 20 seeds per head.

Figure 1. Healthy safflower plants grow to 15-30 inches in height.
Photo: Duane Berglund



Cultural practices

Safflower is planted in South Dakota as a spring crop, usually in late April or very early May. Delayed planting will not allow the crop to mature properly before the danger of killing frosts in the fall. Seed is usually planted with a small grain drill with a six- to eight-inch row spacing. Approximately 20 to 30 pounds of pure, live seed per acre is usually planted, with higher rates being used if diseases such as damping off are a threat. Safflower does not have strong seedlings and is slow to develop in early growth (Fig. 2). Safflower grows best in deep, fertile, well-drained soils with good water-holding capacity, but it will tolerate coarser soils if adequate moisture is present.

Figure 2. Soil crusting can severely affect stand establishment.
Conditions favoring soil crusting also favor Pythium and Rhizoctonia seedling blights.
Photo: Duane Berglund

In South Dakota, the best locations for growing safflower are in the western half of the state. This is primarily due to the generally lower humidity in that area of the state during sensitive stages of plant growth. High humidity and long dew periods, such as those commonly present in the eastern tier of counties in South Dakota, favors significant infection by leaf diseases. Wider rows will allow greater air movement between plants as the plants grow, which may reduce humidity in the plant canopy and reduce the potential problems with disease. Safflower, however, is a poor competitor with weeds, and close rows generally create a more competitive stand of the established crop. Postemergence herbicides are not currently available for this crop, so there is a heavy reliance on preemergence products and crop competition to reduce weed pressure.

The crop usually begins to form flower buds in late June and heads in mid July (Fig. 3). North Dakota data reports that, in general, safflower takes from 110 to 140 days from seeding to maturity. Safflower is usually harvested in late September and early October in South Dakota (Fig. 4).

Figure 3. Safflower plants in bloom.
Photo: Duane Berglund

Figure 4. Mature safflower in research plots.
Photo: Duane Berglund

Rotation

Safflower fits best into a crop rotation with small grains, such as wheat and barley. Volunteer grain from a previous small grain crop can present a control problem in the safflower crop. Tillage or use of a burndown prior to planting safflower will reduce this concern. Safflower should not be planted in immediate rotation with other crops with similar growth type that serve as hosts for the pathogen Sclerotinia (white mold). In South Dakota, these crops include soybeans, sunflower, canola and dry beans. This disease will infect the safflower plants if present. A three- to four-year rotation is needed to break this disease cycle.

Fertilizer requirement

Fertilizing for optimal safflower production depends on yield goal, rotational crops, and rotational order. Recommendations from the Soil Testing Laboratory at South Dakota State University show that for a 2000 lb/acre yield goal, 100 pounds of soil nitrogen plus fertilizer nitrogen is required. For soils with a moderate phosphorous soil test (Bray-1 of 11-15) and a moderate potassium test, 22 pounds of P_2O_5 fertilizer equivalent and 36 pounds of K_2O potassium equivalent is recommended for a 2000-pound-yield goal. Increase nitrogen application by 30 pounds per acre if the safflower is being grown in a no-till situation.

Use

Most safflower grown in South Dakota is marketed as bird seed (Fig. 5). However, safflower produces three marketable commodities‹oil, meal and whole seed as birdseed. The market for safflower oil include uses for human consumption and industrial uses. Varieties producing either oleic or linoleic fatty acids are available to producers. After crushing the seed for oil, the remaining meal can be used as an animal feed supplement, with a protein content of about 24%. The birdseed market prefers white, blemish-free seed with a test weight of 38 pounds per bushel or greater. Diseases such as Alternaria as well as environmental conditions can cause the seed to be discolored and/or low test weight. As a result, the seed may be unmarketable in the bird seed industry. The safflower crop also can make an acceptable, palatable forage if it is harvested shortly after the bloom stage. The spiny nature of the plant does not seem to cause injury to the animals or reduce the palatability.

Figure 5. Safflower seed.
Photo: Duane Berglund

Insect pests

Several insect pests can occasionally become significant in safflower production in South Dakota. Among the insects attacking safflower in the state are grasshoppers, cutworm, wireworms and armyworms. Occasionally, lygus bug and thrips may also be a concern, although the grasshopper is by far the greatest concern.

Grasshoppers

Grasshoppers are a potential pest of safflower production in South Dakota in nearly every production year. The severity of a grasshopper infestation depends on the weather conditions during the growing season, as cool, wet conditions tend to reduce grasshopper infestations due to natural fungal infections in the pest. Dry, warm weather conditions and proximity to adequate hatching beds such as grass borders and fence rows, ditch banks, and rangeland favor abundant grasshopper populations. No-till fields may create a favorable hatching bed as egg-laying areas remain relatively undisturbed (Fig. 6). The most damaging species of grasshopper is the redlegged grasshopper (*Melanoplus femurrubrum*), which hatches from the end of June through August in South Dakota. In addition, two other species also can cause damage to agricultural crops in the state. These grasshoppers are the two-striped grasshopper (*Melanoplus bivittatus*) and the differential grasshopper (*Melanoplus differentialis*). Safflower is not a preferred host, but movement into safflower fields after other crops such as winter wheat mature is possible.

Pesticides labeled for insect control: There are no pesticides labeled that are effective against grasshoppers.

Figure 6. Grasshoppers may be a concern in South Dakota in any year if environmental conditions are favorable.

Army cutworm and pale western cutworm

These two cutworms are frequently present at some level, primarily in western South Dakota in small grain fields. Pale western cutworms (*Agrotis orthogonia*) are primarily subterranean feeders, while army cutworms (*Euxoa auxiliaris*) tend to be surface feeders. Pale western cutworms overwinter in South Dakota as eggs that hatch in the spring, whereas the Army cutworm overwinters as a larvae. Monitoring for army cutworms must take place early in the season, as army cutworms can be active at 40 degrees Fahrenheit.

Wireworms

Wireworms (*Limonius* spp.) can occasionally damage safflower plantings by destroying some of the seeds as they germinate or by damaging the roots of establishing seedlings. Damage is not likely to be severe, but a seed treatment containing Lindane may be effective in protecting seeds. Combination seed treatments with a fungicide and insecticide are available.

Lygus bugs

Lygus bugs (*Lygus hesperus* Knight) have the potential to become an insect of concern, although current research has not reported significant damage from this insect in South Dakota (Fig. 7). The period of concern for safflower is during bud development. If large numbers of lygus bugs are present and feeding on the safflower buds, blasting of the heads may occur. Lygus bugs have been a concern for producers of alfalfa when the crop is grown for seed, so the potential for infestation of safflower fields does exist,

although data from several sources shows that very large numbers of lygus bugs are needed to cause economic damage.

Pesticides labeled:

Foliar Herbicides	Brand Names	Class	Rate	REI	PHI
bacillus thuringiensis	Dipel DF	biological	0.5-1.0 lb product/ acre (14.5 billion IU/ lb)	4 hrs.	None

Figure 7. Lygus bugs can cause blasting of heads if feeding is severe.

Thrips

Flower thrips (Eastern or Western) or onion thrips have been reported as an occasional pest in safflower production areas in California, North Dakota, and Montana, but damaging levels have not been reported in South Dakota. Field observation in Montana shows that thrip damage tends to be more severe if the crop is drought stressed.

MOST COMMONLY APPLIED INSECTICIDES/NEEDED PRODUCTS

The most commonly applied insecticides nationally, according to total pounds active ingredient applied,

as reported in the U.S. Geological Survey National Water Quality Assessment Pesticide National Synthesis Project, dated 7/7/97 were dimethoate (40,492 pounds on 62,199 acres), methidathion (35,403 pounds on 60,518 acres), malathion (13,314 pounds on 10,086 acres), carbaryl (8,937 pounds on 6,724 acres) and lindane (3,110 pounds on 1,681 acres). There are significant concerns annually for grasshopper control in safflower. Many pesticide alternatives are available for grasshopper control in soybean production in South Dakota, including: Asana XL (esfenvalerate), Furadan 4F (carbofuran), Karate or Warrior T (lambda-cyhalothrin), Lorsban 4E (chlorpyrifos), Scout X-Tra (tralomethrin), Sevin XLR Plus (carbaryl) and Capture (bifenthrin). Currently, these products are not available for safflower. Additional registration of any of these products on safflower would significantly enhance effective insect control in this crop.

Diseases

Safflower production in South Dakota can be affected by many diseases caused by various fungi, bacteria, and viruses as well as by disorders from environmental conditions. Disease infection occurs most commonly when above normal rainfall and extended periods of high humidity exist. The most serious of the diseases are caused by fungal pathogens and include blight and leaf spotting caused by Alternaria fungi and Pseudomonas bacteria, Sclerotinia head rot caused by *Sclerotinia sclerotiorum*, and various diseases that may cause seedling mortality. Safflower rust also has the potential to affect production. Effective disease management depends on cultural disease management strategies. Fungicides are not available for most diseases. Some effective options for disease management are included in the following table:

General disease control strategies

- Plant only well-adapted disease-resistant cultivars. To the greatest extent possible, look to sources such as university trials for disease ratings on varieties adapted to the area. Resistance to certain diseases may not be available, but certain varieties may be noted for tolerance to common diseases.
- Choose only sound, pathogen-free seed. Seed that is free of disease-causing organisms and has germination above 80% will allow for rapid stand establishment and reduce chances of infesting a field with disease-causing organisms. Certified seed ensures high-quality seed with a reduced risk of seed-borne diseases.
- Plant shallow in warm, moist, well-prepared seedbed to promote rapid emergence and vigorous, young plants.
- To reduce disease concerns such as Sclerotinia diseases, leaf spot, rust, seedling blights, and root rots, do not plant safflower after safflower, sunflower, pulse crops, mustard, canola
- Fertilize adequately to insure that proper nutrients are available for adequate growth. This will reduce stress on the plants and may help in disease resistance and tolerance.
- Residue of infected crops should be buried if possible. Tillage may help reduce the population of overwintering inoculum that may cause infection in successive years.

Seed treatment

Many of the diseases of safflower are effectively managed or controlled by seed treatment. Seed treatments are effective against fungal pathogens and can help assure a better stand after planting. Diseases that can be addressed by seed treatment include seedling blight and damping off diseases caused by Alternaria, Pythium, and Rhizoctonia fungi. Seed treatments available to producers are listed in the following table:

Fungicide Active Ingredient	**Brand Name**	**Class**	**Rate**
Carboxin	Vitavax-34	Carboximide	2 fl oz/cwt
Mancozeb	Dithane DF	EBDC	2.1 oz/cwt
	Dithane DF Rainshield NT		2.1 oz/cwt
	Dithane F-45		3.2 fl oz/ cwt
	Dithane M-45		2.0 oz/cwt
	Dithane WSP		2 oz/cwt
	Grain Guard		3 oz/cwt
	Manzate 75 DF		2 oz/cwt
Thiram	42-S Thiram	Dithiocarbamate	2 fl oz/bu
	Thiram 50 WP Dyed		4 oz/cwt

Adapted from: 2000 Field Crop Fungicide Guide, Publication # PP-622, NDSU

Specific diseases

Pythium seedling blight and damping off

Pythium damping off and seedling blight (caused by *Pythium ultimum* and others) is favored by rain directly after planting. Cool, wet soils favor the disease. Crusting or conditions that favor crusting may increase the risk of Pythium diseases.

Cultural management: Practice good crop rotation‹allow a minimum of two years

between safflower crops. Plant in well drained soils.
Fungicides: No foliar-applied fungicides are labeled for use on safflower.

Bacterial leaf blight

Bacterial leaf blight caused by *Pseudomonas syringae p.v. syringae* is a common disease in cool, wet years, following heavy rain events. Typically, the disease is severe only in the spring when temperatures remain cooler. The bacteria that cause this disease are spread by rain splash and as such require heavy rain for epidemics to develop. Infections occur largely on lower leaves, appearing initially as dark, water-soaked spots drying to a tan color.

Cultural management: Practice good crop rotation or bury residue‹allow a minimum of two years between safflower crops.
Fungicides: No foliar-applied fungicides are labeled for use on safflower.

Sclerotinia head rot

Commonly called white mold. This disease, caused by *Sclerotinia sclerotiorum*, can be severe and is favored by prolonged periods of wet conditions during flowering and seed development. This disease primarily affects the heads, causing a head rot. Infection occurs through wilting petals or wounds on the heads. This disease may also infect field peas, sunflowers, soybeans, canola, and many other broadleaf crops. The pathogen survives as sclerotia in the soil from a previous white mold infection on some susceptible crop or weed. Sclerotia are hard, black, seed-like resting structures of the fungus. The sclerotia germinate and produce small, funnel-shaped mushrooms from residue or buried sclerotia. Spores from these mushrooms then infect declining parts of the safflower plant. Sclerotinia rot causes heads to appear bleached and limits seed development, causing empty shells.

As the disease progresses, a black, cone-shaped sclerotium of matted fungal mycelium forms in the receptacle (pith below the head). This sclerotium may be present in harvested seed, reducing value of the harvested crop. It may also fall to the soil, creating the potential for reinfestation of the following crop. Photos of a diseased head and sclerotia are shown in Figure 8.

Cultural management: Plant seed free of sclerotia. Practice good crop rotation‹allow three or more years between plantings of susceptible crops.
Fungicides: No foliar-applied fungicides are labeled for use on safflower.

Figure 8. Safflower heads showing severe damage from Sclerotinia.
Photo: Henning Mundel

Alternaria blight

Alternaria blight, caused by *Alternaria carthami*, may cause damage to safflower throughout the growth cycle of the plant. The disease is the most commonly reported disease damaging safflower in South Dakota, resulting in losses of 15-30% in 1998. If infected seed is planted, seedling blight and damping off may occur. Leaf infection is characterized by small brown spots about 1/2" in diameter, that may later coalesce to destroy entire leaves (Fig. 9). Lesions may have a characteristic pattern of concentric rings. Lesions often begin in the lower canopy and spread upward. Late-season development of the disease causes infection of leaves and flower bracts. Head (tube flower) infections may also occur and may cause areas of brown discoloration at one end of the seed. Infected seed is shriveled and seeds may be empty. Seed yield and oil content is reduced if infection occurs. Discolored seeds are also discounted severely in the bird seed trade, and significant infection may cause the entire seed lot to be rejected for bird seed or oil, meaning the crop must be sold as feed at a severely reduced price (Fig. 10).

Cultural management: Use pathogen-free seed at planting to reduce infection. Seed produced in areas of low rainfall more likely will be free of Alternaria. Use seed treatment fungicides to eliminate seed-borne inoculum. Practice good crop rotation-allow a minimum of two years between safflower crops. Increasing airflow around the plants will reduce humidity in the plant canopy and reduce the severity of infection.
Fungicides: No foliar-applied fungicides are labeled for use on safflower.

Figure 9. Leaves damaged after infection by Alternaria.
Note the concentric rings shown on the lower leaf.
Photo: Henning Mundel

Figure 10. Safflower seeds discolored by Alternaria (left) and undamaged seed (right).
Photo: Henning Mundel

Safflower rust

While reported to be very common in other parts of the country, safflower rust caused by Puccinia carthami, has not been a serious disease in South Dakota. As safflower acreage increases in South Dakota, the potential for developing safflower rust will increase. Safflower rust may attack young safflower seedlings, infecting cotyledons, leaves, and stems. Although not a severe problem, this disease can cause yellow discoloration and wilting of the plant. The disease is more noticeable from flowering to seed development, when typical orange-brown rust pustules form on leaves and flower bracts from urediospores of the disease. As the disease progresses, black teliospores of the disease are produced.

Severely infected leaves may die prematurely. This disease is favored by extended periods of high humidity and dew in the plant canopy.

Cultural management: The pathogen causing this disease overwinters as teliospores in crop residue. Use seed treatment fungicides to eliminate seed borne inoculum. Burying crop residue will reduce inoculum. Rotating to other crops will also break the disease cycle.
Fungicides: No foliar-applied fungicides are labeled for use on safflower.

Weeds

Weed control in safflower production in South Dakota historically has presented concerns for producers of this oil seed crop. Additional weed management by producers for successful crop production is required. Safflower is not a highly competitive crop, further increasing control difficulties. Limited herbicides are available for use in this commodity. Producers should consider the potential weed problems based on recent weed history and consider control problems that may arise given the limited herbicides available. Early-season control of annual weeds such as kochia (*Kochia scoparia*), Russian thistle (*Salsola kali*), and foxtail species, including green foxtail (*Setaria viridis*) and yellow foxtail (*S. lutescens*) is important (Fig. 11).

Figure 11. Young safflower plants are not highly competitive with weeds.
Photo: Duane Beglund

An additional concern for safflower producers is the rotation interval between herbicide applications and safflower planting. Application to planting intervals for previous herbicides range from 9 months to 26 months or greater. Refer to product label or SDSU Fact Sheet FS 525-OS for information.

Safflower is sensitive to many previous herbicide applications and residue tolerances for other products have not been set for the following safflower crop. Refer to the product label for listed tolerances.

Herbicides Available		**AI, lb.**	**REI**	**PHI**
Trifluralin[1]	Treflan, Trific,	0.5-1.25	12 hours	Spring PPI/ Fall incorporated only

Metolachlor[2]	Dual II/	1.5-3.0 Dual II	24 hours	PRI/Pre-emerge only
	Dual II Magnum	1.0-2.0 Magnum		
Paraquat[3]	Gramoxone Extra/	0.6-0.9	12 hours	Preemergence/
	Cyclone CF			preplant burndown

[1] No mustard or sunflower control, wild buckwheat not adequate, kochia marginal.
[2] Foxtail good, pigweed limited, other broadleaves not controlled.
[3] Not selective, contact product.

Critical need

Products registered for this crop are very limited. Any loss of a registered product would create a gap in the already minimal arsenal of products available. Trifluralin provides the only consistent, registered control of broadleaf weeds that have not germinated by planting time, and the control by this product is limited to certain broadleaf species. Postemerge grass and broadleaf weed control products are needed to allow production of this crop to expand.

Future pesticide registrations/ IR-4 program proposals

Several herbicides are currently included in the IR-4 Minor Crop Project. Data for establishing a tolerance for ethafluralin and sethoxydim have been developed. Currently, Section 18 Emergency Exemptions requests may be submitted based on residue data available. Labeling is anticipated for these herbicides. Thifensulfuron has been identified as a Priority "A" project for the current year. Labeling for these herbicides will provide much needed postemergence options for annual grasses and certain annual broadleaf weeds (Fig. 12).

Non-herbicide management practices

- Use weed-free seed at planting.
- Seed into fields that are free of weeds and have had consistent effective weed control.
- Clean tillage and harvest equipment to prevent spread of weeds.
- Manage manure application to assure minimal presence of weed seed.
- Tillage may be used, where appropriate.

- Plant a highly competitive crop the previous year to minimize "seed bank" of weed seeds in the soil.

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