Safflower Production in Eastern Washington

Background History, Production Practices, Yields and Water Use

Hal Collins
USDA-ARS-VFCU
Prosser, WA

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Safflower (*Carthamus tinctorius*)

- Native to Asia, Middle East and Africa.
- Herbaceous annual member of the Asteraceae/Compositae family (sunflower).
- Safflower studies began in 1925, commercial production began in the 1950’s.
- Production is concentrated in the western U.S. and Canadian prairie provinces.
- California grows 63% of U.S. safflower, followed by ND and MT. SD, ID, CO, AZ, and NB produce the crop but on small acreage. Total: 140,000 ac.

- Grows well in dryland and irrigated areas, good fit in small grain rotations. High drought tolerance.
- Plant is thistle like, with a main stem and number of branches, each with 8-10 heads. Heads have 15-30 seeds, similar in size barley, glossy white, 35-42% oil.
- Grows to 1-4 ft in height, has deep tap root 8-10 ft.
Safflower Products: Oil, Meal, and Birdseed.

- Traditionally, safflower was grown for the flowers that were used in making red and yellow dyes for clothing and food preparation.
- Prior to the 1960s in the U.S. the oil was used mostly as a base for superior quality paints. Still used in paints and varnishes because of its non-yellowing characteristic.
- More recently it has also been used in infant formulas, cosmetics, and salad and cooking oils. High in olic and linolic fatty acids.
- Safflower meal is about 24 percent protein and high in fiber and is used as a protein supplement for livestock and poultry feed.
- Whole safflower seeds are used in the birdseed industry.
U.S. Safflower Production: 2011

- **Production**
  - 170 million pounds, down 23% from 2010, and is the lowest since 1991. Average yield 1,333 lbs/acre.

- **Price**
  - Average price of safflower in 2011 was $24.30 cwt, while the price in 2010 was a low $17.20 per cwt. (NASS, 2012).
  - Large variations in price can be attributed to the relatively few acres under production. Changes in planted acres and average yields affect the price.

- **Exports/Imports**
  - U.S. is a net importer of safflower oil valued at $42.5 million in 2011, up 44 percent from the previous year.
  - Japan largest market for U.S. safflower oil, valued at $15 million in 2011, down 22 percent from 2010.
  - Mexico is the source of 87 percent of the imported oil.
Safflower: Cultural practices

- Production practices and equipment are similar to small grains, except for pre-emergence herbicides.
- Safflower is a 120-150 d spring planted crop.
- **Seedbed Preparation:** A moist, firm seedbed should be prepared to help establish a good stand.

**Seeding**
- Plant in late March to May or when soil temps are above 40 °F.
- Drill safflower seed (15 to 30 lbs/acre) in 6 to 12” or 18-24” rows (dryland) to 1 to 1 ½” deep.
- Drill settings for safflower often correspond to settings for similar rates of barley. Takes 7-15 days to emerge.

- After emergence will stay in a rosette stage for 2-4 weeks.
- Flower buds form mid-late June and flowering mid to late July.
Fertilization:

- Dryland growers generally apply 50 lbs/acre depending on soil test. A general rule is add 5 lbs N/acre for every 100 lbs of seed yield expected.
- Safflower is an excellent scavenger of residual N.
- Maximum yields of safflowers can be obtained with 100 to 120 lbs N per acre under irrigation. Apply 40 to 60 lbs of phosphorus per acre when soils test low, is recommended.

- Safflower is generally ready to harvest 35-40 days after peak flowering.
- Harvest when leaves are brown, still may have some green. Be sure stems are dry.
- Direct combine harvest at 8% moisture, use low cylinder speed ~500 rpm to prevent seed cracking. Reel about 25% faster than ground speed. Shaker speed higher than small grain.
Safflower: Cultural practices, cont’

- **Dryland rotations:**
  - winter wheat/safflower/fallow
  - winter wheat/safflower/barley or millet/fallow
  - spring wheat/safflower/barley/fallow.

- Safflower should not follow safflower in rotation or in close rotation with crops susceptible to Sclerotinia head rot, such as sunflower, mustard, canola or dry bean.

- A crop following safflower should be grown only if there has been a significant recharge of soil moisture.

- Very little crop residue remains after harvesting safflower.

- Reduced tillage or chemical fallow after safflower may help reduce wind and water erosion.
Safflower: Yields

<table>
<thead>
<tr>
<th>State</th>
<th>Yield (lbs/acre)</th>
<th>% Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montana (DL)</td>
<td>1300-1700</td>
<td>38-42</td>
</tr>
<tr>
<td>Idaho (DL)</td>
<td>1000-1400</td>
<td>35-39</td>
</tr>
<tr>
<td>Utah (IR)</td>
<td>1500-1800</td>
<td>38-41</td>
</tr>
<tr>
<td>California (IR)</td>
<td>2000-3000</td>
<td>38-42</td>
</tr>
<tr>
<td>Washington (IR)*</td>
<td>2000-2750</td>
<td>34-40</td>
</tr>
</tbody>
</table>


Grown under contract:
Contracts are usually made on an acre basis. The following market conditions are common:

• Seed bought on a clean basis - oil content 34%.
• One percent premium paid for every 1% oil content > 34%.
• One percent dock for every 1 percent oil content < 34%.
• Two percent dock for each 1 percent seed moisture > 8%.
Weed Control

- Weed control in safflower production is important. Safflower is not a highly competitive crop.
- 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.

Limited herbicides are available:
- *Trifluralin*: No mustard or sunflower control, wild buckwheat not adequate, kochia marginal.
- *Metolachlor*: Foxtail good, pigweed limited, other broadleaves not controlled.
- *Paraquat*: Not selective, contact product

Producers should consider the potential weed problems based on recent weed history.

The rotation interval between herbicide applications to previous crops and safflower can range from 9 months to 26 months.
Weed Control, cont’

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.
**Insect Pests of Safflower:**

- **Cutworms** will either cut the seedlings off below the ground or feed on developing foliage of young seedlings.
- Encouraged by previous crops of alfalfa, small grains and grassy weeds, most active early in the season.
- No insecticides are labeled on safflower that would be effective at controlling cutworms.

- **Wireworms** occasionally damage safflower plantings by destroying seeds as they germinate or by damaging roots of establishing seedlings.
- Damage is not likely to be severe, but a seed treatment containing **Lindane** may be effective in protecting seeds.

- **Lygus bugs** feed on buds, flowers and developing seeds.
- Yellowish brown or greenish in color; 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.
Diseases of Safflower

- **Pythium seedling blight/damping off** – (*Pythium ultimum*)
  - favored by rain directly after planting, cool, wet soils and crusting.

- **Sclerotinia head rot** – (*Sclerotinia sclerotiorum*)
  - can be severe, favored by prolonged periods of wet conditions during flowering and seed development
  - primarily affects the heads. Heads are bleached, limits seed development, causing empty shells.

- **Alternaria blight** – (*Alternaria carthami*)
  - cause damage throughout the growth cycle of plant
  - small brown spots about 1/2" dia. that may destroy entire leaves. Lesions often begin in the lower canopy and spread upward.
  - late-season development causes infection of leaves and flower bracts, cause areas of brown discoloration of the seed. Seed yield and oil content is reduced. Discolored seeds are discounted severely as bird seed.
Diseases of Safflower, cont’

- **Bacterial leaf blight** - (*Pseudomonas syringae p.v. syringae*)
  - occurs in cool, wet years.
  - not a problem in Columbia Basin

**Disease Management**

- No foliar-applied fungicides are labeled for safflower.
- Seed treatment effectively manages or controls many soil-borne diseases of safflower.
- Allow a minimum of two years between safflower crops.
Questions?
Quincy Sand Soil Series
- 4% organic C and 0.37% N
- 92%+ sand content
- Surface soil BD - 1.33 kg m$^{-3}$
- pH of 6.7
Oilseed Irrigation Trials: Water Use

• Safflower Variety Trials (Paterson)
  Varieties – CW99OL, S345, S334
  Seeding rate – 25 lbs/acre
  Row spacing – 9 inches (Tye drill)
  Seeding depth – 1 inch
  Date of seeding – early April to May
  Fertilizer rates – 100 and 150 lbs/acre
  Irrigation water - Full (24 in); Deficit (17 in)
  30% reduction in irrigation

Figure 1. Irrigation and N fertilizer rate applications delivered through center pivot irrigation.
### Performance Comparison:

<table>
<thead>
<tr>
<th></th>
<th>Full Irrigation</th>
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<th>Deficit Irrigation</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>100</td>
<td>150</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>N rate (lb/ac)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Yield</td>
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<tr>
<td></td>
<td>kg/ha/cm Water</td>
<td>kg/ha Water</td>
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<td>kg/ha/cm Water</td>
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<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cw99OL</td>
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<tr>
<td>08’</td>
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<td>43</td>
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<tr>
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<td>11’</td>
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<tr>
<td>Average</td>
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<td>S345</td>
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<td>11’</td>
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<tr>
<td>Average</td>
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<td>3090</td>
<td>43</td>
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<td>S 334</td>
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<td>08’</td>
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<td>2936</td>
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<td>33</td>
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<tr>
<td>Average</td>
<td>2242</td>
<td>31</td>
<td>2256</td>
<td>32</td>
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</tbody>
</table>

- Full irrigation = 24 in/acre; Deficit irrigation = 17 in/acre
- Irrigation water savings: 7 in/acre.
- No statistical difference in yield between irrigation levels.
- Yield per water used is based on soil storage, precipitation and irrigation applied
- Greater yield per inch of water applied under deficit irrigation.
Table 2. Average available soil water and water use by safflower at the USDA-ARS Field Station near Paterson, Benton County, WA.

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Start Season Soil Water</th>
<th>End Season Soil Water</th>
<th>Soil Water Depletion</th>
<th>Precip. Crop Season</th>
<th>Applied Irrigation Water</th>
<th>Total Water Use</th>
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</thead>
<tbody>
<tr>
<td>Full</td>
<td>11.6</td>
<td>8.1</td>
<td>3.5</td>
<td>2.5</td>
<td>23.5</td>
<td>29.5</td>
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<tr>
<td>Deficit</td>
<td>12.5</td>
<td>6.8</td>
<td>5.7</td>
<td>2.5</td>
<td>16.7</td>
<td>24.9</td>
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<tr>
<td>Difference</td>
<td>+0.9</td>
<td>+1.3</td>
<td>+2.2</td>
<td>0</td>
<td>-6.8</td>
<td>-4.6</td>
</tr>
</tbody>
</table>

- Stored soil water contributed 5.7 inches to the safflower crop under deficit irrigation.
- Actual water savings was 4.6 inches/acre.
- We did not measure total crop biomass, only seed yield.
General Irrigation Guidelines: Oilseeds

✓ Soil type, seasonal temperatures, previous cropping, irrigation, soil water storage, etc. affect oilseed yield.

✓ Soil moisture should be maintained above 50% available moisture in the active root zone (4 ft).

✓ After planting avoid soil crusting with light frequent applications until the crop has fully emerged.

✓ Once the crop reaches the vegetative state irrigate to replace ET losses. Safflower uses up to 17 in of water a season and over 0.3 in/day during peak periods.

✓ Most critical times for irrigation are during vegetative, bud formation and through the flowering period. Keep irrigating until flowering stops.

✓ Irrigation should end by seed-fill or when leaves turn brown, typically a month before harvest.