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Safflower Production in Northern Idaho — Varieties, Nitrogen Fertilization and Herbicides

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Safflower (*Carthamus tinctorius* L.) is an oilseed crop grown in Arizona, California, Montana and North Dakota. Safflower was first evaluated by the Idaho Agricultural Experiment Station from 1940 to 1954 and was found to be adapted to the dryland areas of northern Idaho and the irrigated valleys of southern Idaho. Trials in 1976 and 1977 indicated that new safflower varieties are well adapted to northern Idaho and probably could be raised commercially if suitable markets can be developed.

In 1978 and 1979, varietal performance, nitrogen responses and potential herbicides were examined. This publication provides growers with information on variety adaptation, nitrogen fertilizer response and herbicides for use on safflower. For information concerning other aspects of production and marketing, see University of Idaho Current Information Series 435, *Safflower — A Potential Crop for Northern Idaho.*

Variety Trials — 1978

These studies evaluated adaptation of safflower varieties to northern Idaho conditions. Treflan was applied at ¾ pound per acre (active ingredient) and incorporated before planting. Nitrogen rates were 60 pounds per acre at Moscow and 180 pounds per acre at Coeur d'Alene.

Moscow

Varieties UC 1, Gila, S 208 and S 541 had the highest yields and averaged 2,675 pounds of seed per acre (Table 1). Average seed yield for all varieties was 2,190 pounds per acre. Earlier maturing varieties usually had higher yields than later maturing varieties. Many varieties with thin hulls such as Partial Hull had poor seed yields.

Oil content ranged from 28.9 to 41.1 percent (Table 1). Average oil content was 34.6 percent, about 4 percent below the desired level. Excess precipitation in August (1.6 inches above normal) delayed maturity and probably contributed to reduced oil levels.

All the varieties tested showed some head rotting and leaf rust. Variety S 112 appeared to have the most resistance of all varieties to leaf rust.

Coeur d'Alene

Under irrigation at Coeur d'Alene, the best yielding varieties were S 112 and Ute (Table 1). Average seed yield of these two varieties was 820 pounds per acre; the average of all varieties tested was 500 pounds per acre.

Oil content ranged from 24.4 to 35.4 percent (Table 1). Average oil content was 29.8 percent, nearly 9 percent below the desired level.

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Variety Trials — 1979

Thirteen varieties of safflower were evaluated under dryland conditions at Moscow, Genesee and Grangeville. At all three test sites, an experimental rate of ⅜ pound per acre of Treflan (active ingredient) and ¼ pound per acre of Avadex (active ingredient) were incorporated as preplant herbicides. The nitrogen rate was 100 pounds per acre.

Seed yields of all varieties at Moscow ranged from 1,790 to 2,880 pounds per acre (Table 2). The highest yielding varieties — UC 1, Sidwell and S 208 — averaged 2,680 pounds of seed per acre. The oil contents of the varieties ranged from 37.1 to 51.4 percent. Sidwell had an unacceptable oil content of less than 41 percent oil. The Partial Hull variety had an extremely high oil content of 51.4 percent.

The seed yield of all the varieties tested at Genesee ranged from 971 to 1,460 pounds per acre (Table 2). The highest yielding varieties — UC 1, S 208, Carmex 353 and Partial Hull — averaged 1,420 pounds of seed per acre (Table 1). The oil contents ranged from 38.8 to 47.1 percent. Most varieties had acceptable or excellent oil levels.

Heavy rains that fell immediately after planting at Grangeville compacted the soil and caused differential emergence among the varieties (Table 2). Several varieties such as S 112, Partial Hull, Cal West 74, Carmex 353 and S 317 emerged well despite these conditions. Seed yield of all the varieties ranged from 842 to 2,060 pounds per acre. The highest yielding varieties — S 317, Cal West 74, S 208, Carmex 353 and Partial Hull — averaged 1,900 pounds of seed per acre.

Many of the varieties at Grangeville failed to produce the level of oil observed at the other locations. Most of the varieties produced in excess of 40 percent oil, but two varieties — Sidwell and 14-5 — had oil content of only 33.1 and 32.1 percent respectively. Varieties such as these should be avoided in commercial safflower production in northern Idaho.

Disease Trials — 1978

Safflower sustained severe damage from leaf rust and failed to produce economical seed yield at Bonners Ferry in 1976 and 1977. Research was initiated to determine if resistant varieties in combination with fungicide seed treatments would allow safflower to be produced in this area. Seed of Dcoy, a variety resistant to leaf rust, and Leed, a susceptible variety, were treated with Dithane M-45, a fungicide registered to control the seed-borne leaf rust. Treated and untreated seeds of these two varieties were planted April 27 in a seedbed that had ¾ pounds of Treflan (active ingredient) and 60 pounds of nitrogen incorporated before planting. Notes were taken on rust severity, and the plots were harvested Oct. 4, 1978.

Dithane M-45 did not reduce the severity of rust symptoms or increase seed yield of either variety (Table 3). Dcoy, the resistant variety, averaged 827 pounds of seed per acre while Leed, the susceptible variety, averaged only 252 pounds of seed per acre. Dcoy had less than 7 percent of its leaf area attacked by rust yet had very poor commercial yields. The oil content of the varieties ranged from 8.7 to 18.1 percent, indicating that even the resistant safflower variety did not completely mature at this location. Although a disease resistant variety gave a threefold increase in seed yield, existing varieties of safflower are not adapted to the climate at Bonners Ferry.

Nitrogen Requirements

These studies correlated nitrogen levels in northern Idaho soils with safflower seed yields and oil content. Soil tests were taken to rooting depth (Table 4). Nitrogen rates were based on soil tests and expected safflower seed yields. Phosphorous, sulfur or potassium were added to an entire plot area if soil tests showed these nutrients were needed.

Moscow, 1978

Nitrogen rates of 100 and 150 lb/acre significantly increased safflower yields over check plots (Table 5). Average seed yields of 2,062, 2,124, 2,269 and 2,476 pounds per acre were obtained with 0, 50, 100 and 150 pounds of nitrogen per acre respectively.

Moscow, 1979

Seed yields and oil content were not significantly increased as N level increased (Table 5). A trend toward increased seed yield appeared when 50 pounds N per acre was applied. Average seed yield was 3,625 pounds per acre.

Genesee, 1979

Seed yield and oil content were not significantly altered as N level increased from 0 to 150 pounds of N per acre (Table 5). A trend toward increased seed yield was noted when 100 pounds of N per acre was applied. Average seed yield was 3,379 pounds per acre.

Precipitation was below normal for the crop year, especially in June and July, and may have reduced expected N response.

Grangeville, 1979

Seed yield and oil content were not significantly increased by N (Table 5). One hundred pounds of N per acre appeared to produce the highest seed yields.

Table 1. Seed yield and percentage of oil of 13 varieties of safflower grown at Moscow and Coeur d'Alene, Idaho, 1978.

Variety	Moscow		Coeur d'Alene	
	Seed yield	Oil content	Seed yield	Oil content
	(lb/A)	(%)	(lb/A)	(%)
UC 1	2,870 a*	32.3 fgh*	600 bc*	29.0 def*
Gila	2,750 ab	33.6 efg	660 ab	29.0 def
S 541	2,530 abcd	38.9 ab	660 ab	33.4 ab
S 208	2,560 abc	34.8 def	570 bcd	27.9 efg
VF STP-1	2,370 bcde	31.2 gh	500 def	26.3 fgh
S 400	2,380 bcd	35.3 cdef	340 efg	27.3 fgh
Partial hull	1,190 i	38.3 abc	170 h	35.4 a
S 112	2,270 bcde	36.0 bcde	820 a	31.6 bcd
US 10	2,200 cdef	31.0 gh	420 def	24.4 h
Ute	2,090 efg	28.9 h	820 a	25.3 gh
287	1,780 gh	41.4 a	240 gh	34.7 ab
Hull 2	1,800 gh	28.9 h	440 cde	30.0 cde
290	1,670 h	39.2 ab	250 fgh	33.6 ab
Average	2,190	34.6	500	29.8

*Means within a column not followed by the same letter differ at the 0.05 level of probability by Duncan's new multiple range test.

Table 2. Agronomic performance of 13 cultivars of safflower grown at Moscow, Genesee and Grangeville, Idaho in 1979.

Variety	Moscow			Genesee			Grangeville		
	Bloom 8/6	Seed yield	Oil content	Bloom 7/25	Seed yield	Oil content	Emergence	Seed yield	Oil content
	(%)	(lb/A)	(%)	(%)	(lb/A)	(%)	(%)	(lb/A)	(%)
UC-1	65 abc*	2,880 a*	42.2 g	68 a*	1,460 a*	43.1 abc	55 cd*	1,490 cde*	37.6 f
Sidwell	53 abcde	2,610 ab	37.1 j	31 bc	970 b	41.1 bc	50 cd	1,310 ef	33.1 g
S 208	66 abc	2,550 abc	44.6 e	39 bc	1,460 a	44.8 ab	81 ab	1,910 abc	40.9 de
14-5	70 ab	2,440 abcd	37.4 i	55 ab	1,220 ab	38.8 c	33 de	1,020 fg	32.1 g
Gila	71 ab	2,410 bcd	41.3 h	26 c	1,320 ab	42.7 abc	56 c	1,570 cde	37.5 f
Carmex 353	49 bcde	2,410 bcd	43.2 f	38 bc	1,390 ab	44.1 abc	84 ab	1,590 bcde	40.5 e
S 541	60 abc	2,370 bcd	46.8 b	26 c	1,260 ab	47.1 a	68 bc	1,770 abcd	42.4 bcd
S 112	79 a	2,300 bcd	44.6 e	71 a	1,220 ab	44.3 ab	94 a	1,580 cde	40.0 e
S 742	54 abcde	2,280 bcd	47.0 b	30 bc	1,300 ab	46.6 ab	74 abc	1,350 def	43.7 b
S 317	41 cde	2,180 bcde	46.2 c	18 c	1,250 ab	46.1 ab	83 ab	2,060 a	42.6 bc
Cal West 74	59 abcd	2,080 cde	45.3 d	21 c	1,130 ab	46.3 ab	88 ab	2,030 a	42.0 cd
S 400	34 de	1,980 de	45.4 d	24 c	1,210 ab	45.6 ab	13 d	840 g	42.4 bcd
Partial hull	31 e	1,790 e	51.4 a	41 bc	1,380 ab	46.6 ab	94 a	1,720 abcde	47.3 a
Average	56	2,340	44.0	38	1,275	44.4	67	1,560	40.2

*Means within a column not followed by the same letter differ at the 0.05 level of probability by Duncan's new multiple range test. Oil content determined by the nuclear magnetic resonance method at the Montana Eastern Agriculture Research Center, Sidney, Montana, on oven-dried seed samples.

Table 3. Seed yield, oil content and disease severity of two varieties of safflower with fungicide treated and untreated seed lots grown at Bonners Ferry, Idaho, in 1978.

Variety	Treatment	Rust score**	Seed yield	Oil content
		(%)	(lb/A)	(%)
Dcoy	Dithane M-45	6.0 a*	840 a*	8.7 a*
Dcoy	—	7.3 a	810 a	11.1 b
Leed	Dithane M-45	91.0 b	260 b	15.8 a
Leed	—	96.0 b	240 b	18.1 a

*Means within a column not followed by the same letter differ at the 0.05 level of probability of Duncan's new multiple range test.

**Plants scored on percentage of foliage covered with rust pustules from 0 to 100 percent.

Table 4. Soil test data for sites selected for safflower evaluation trials in northern Idaho in 1978 and 1979[1].

Location	Soil depth	NO_3-N	SO_4	P	K	Acidity
(Date)	(inches)		(ppm)			(pH)
Moscow	0- 6	10.9	18	8.0	225	5.8
4-14-78	0-12	1.7				
	12-24	1.3				
Moscow	0-12	4.4	8.0	10.8	234	6.0
4-20-79	12-24	2.0	6.0			
	24-36	2.0	3.0			
Genesee	0- 6			8.9		6.0
5-5-79	0-12	4.4	10			
	12-24	2.8	8			
	24-36	1.6	6			
Grangeville	0- 6					6.4
5-3-79	0-12	8.8	5	6.5	130	
	12-24	12.9	6			

[1]Analyzed by the University of Idaho Soil Testing Laboratory.

Table 5. Effect of N fertilizer on seed yield and oil content of safflower in trials conducted in northern Idaho in 1978 and 1979.

Trial	N rate	Seed yield	Oil content
	(lb/acre)	(lb/acre)	(%)
Moscow, 1978[1]	0	2,062 a*	39.9 a*
	50	2,124 ab	38.4 ab
	100	2,269 b	37.1 b
	150	2,476 b	37.2 b
Moscow, 1979[2]	0	3,508 a	45.5 a
	50	3,916 a	45.4 a
	100	3,796 a	45.3 a
	150	3,768 a	45.3 a
Genesee, 1979[3]	0	3,167 a	40.0 a
	50	3,182 a	40.8 a
	100	3,639 a	40.4 a
	150	3,527 a	40.8 a
Grangeville, 1979[4]	0	1,882 a	44.4 a
	50	2,167 a	44.6 a
	100	2,369 a	44.4 a
	150	2,322 a	44.7 a

* Means within the same column for a particular trial followed by the same letter are not significantly different at the 0.05 level according to Duncan's Multiple Range Test.

[1] Planted 4/19/79 at 25 pounds per acre with rows 7 inches apart. Ammonium nitrate broadcast was on soil surface after planting. Plot size: 4 rows + 20 feet. Harvested September 22, 1978.

[2] Planted 4/20/79 at 49 pounds per acre with rows 7 inches apart. Ammonium nitrate broadcast on soil surface after planting. Plot size: 4 rows + 20 feet. Harvested with Hege combine September 21, 1979.

[3] Planted 4/30/79 at 49 pounds per acre with 7 inches between rows. Ammonium nitrate was broadcast on soil surface after planting. Plot size: 4 rows + 20 feet. Harvested with Hege combine September 24, 1979.

[4] Planted 5/3/80 at 49 pounds per acre with rows 7 inches apart. Ammonium nitrate was broadcast on the soil surface after planting. Plot size: 4 rows + 20 feet. Harvested September 27, 1980.

Table 6. Herbicides labeled for weed control in safflower grown in Idaho.

Produce	Rate per acre	Remarks
Wild oat		
barban (Carbyne)	⅜ lb/A (3 pt)	Spray when wild oat is in 2-leaf stage or less. Spray within 30 days after crop emerges.
propham (Chem Hoe FL4)	3 to 4 lb/A (3 to 4 qt)	Apply preplant or preemergence incorporated. Spray preplant treatment within 3 days of planting. Use shallow incorporation. Need rainfall for good results.
chloropropham (Furloe 4EC)	3 to 4 lb/A (3 to 4 qt)	Apply as preplant incorporated treatment within 3 days of planting. Need rainfall for good results
Other annual grasses (Volunteer grain; downy brome)		
propham (Chem Hoe FL4)	3 to 4 lb/A	Apply preplant or preemergence incorporated. Spray preplant treatment within 3 days of planting. Use shallow incorporation. Need rainfall for good results.
chloropropham (Furloe 4 EC)	3 to 4 lb/A (3 to 4 qt)	Apply as preplant incorporated treatment within 3 days of planting. Use shallow incorporation. Need rainfall for good results.
EPTC (Eptam)	3 lb/A (3½ pt 7E) (30 lb 10 G)	Apply as preplant incorporated treatment. Thoroughly incorporate 2 to 2½ inches with disk or recommended implement immediately after application. Spray applied to damp or wet soils will result in rapid loss of herbicide unless incorporated within a few minutes.
profluralin (Tolban)	½ to 1 lb/A (1 to 2 pt)	Apply as a preplant incorporated treatment. Best results with disk or other approved implement.
trifluralin (Treflan)	½ to 1½ lb/A (1 to 3 pt 4EC) (10 to 30 lb 5G)	Apply as preplant incorporated treatment. Incorporate within 8 hours after application. Thorough incorporation with disk gives best results.
Annual broadleaf weeds		
propham (Chem Hoe FL4)	3 to 4 lb/A (3 to 4 qt)	Apply preplant or preemergence incorporated. Spray preplant treatment within 3 days of planting. Use shallow incorporation. Need rainfall for good results.
EPTC (Eptam)	3 lb/A (3½ pt 7E)	Controls nightshade, pigweed, lambsquarter and certain other broadleaf species (consult label for specific species). Apply as preplant incorporated treatment. Thoroughly incorporate 2 to 2½ inches with disk or recommended implement immediately after application Spray applied to damp or wet soils will result in rapid loss of herbicide unless incorporated within a few minutes.
chlorpropham (Furloe 4EC)	3 to 4 lb/A (3 to 4 qt)	Apply as preplant incorporated treatment within 3 days of planting. Use shallow incorporation. Needs rainfall for good results.
profluralin (Tolban 4E)	½ to 1 lb/A (1 to 2 pt 4E)	Controls pigweed and lambsquarter. Weak on mustard species. Apply as a preplant incorporated treatment. Best results with disk or other approved implement.
trifluralin (Treflan)	½ to 1½ lb/A (1 to 3 pt 4EC) (10 to 30 lb 5G)	Controls pigweed, lambsquarter, chickweed, purslane and other broadleaf annuals (consult label for specific species). Apply as preplant incorporated treatment. Incorporate within 8 hours after application. Thorough incorporation with disk gives best results.

Average seed yield was 2,185 pounds per acre. Precipitation was 3.19 inches below normal for the crop year and 2.10 and 0.58 inches below normal in June and July. Nitrogen responses were probably limited by reduced precipitation.

Weed Control

Weeds can be a major production problem in safflower fields and can reduce potential crop yields. Protection of the crop from weed competition during the early portion of the growing season is most important. As the safflower plant grows, a dense canopy of vegetation forms, allowing the crop to compete effectively with late emerging weeds.

Cultivation has been an effective means of eliminating established winter annual broadleaf and grass weeds before planting the crop. If the seedbed is prepared early in the spring and proper weather conditions exist, some weed species such as field pennycress (*Thlaspi arvense*), shepherd's purse (*Capsella bursa-pastoris*), tumble mustard (*Sisymbrium altissimum*) and prickly lettuce (China lettuce) (*Lactuca serriola*) may be a problem. Timely and thorough cultivation is, however, a management practice that can provide initial weed-free conditions for the emerging crop.

Herbicides may be necessary for the control of summer annual broadleaf and grass weed species that emerge after the safflower crop is planted. If dense stands of weeds are allowed to compete with seedling safflower plants, severe yield loss may result. Crops must be protected until plants are well established. Available short-lived, soil-applied herbicides are effective against most of the common weeds that occur in northern Idaho.

Wild oat (*Avena fatua*) is a common and troublesome weed in safflower. Cultivation will eliminate the early emerging plants, but a herbicide treatment is necessary for the control of late-emerging seedlings. Propham (Chem Hoe F14) can be applied before planting or immediately after planting and shallowly incorporated into the soil (Table 6). Chloropropham (Furloe 4EC) must be applied before planting and soil incorporated. Both propham and chloropropham must have rainfall in order to be effective herbicides against wild oat.

If the wild oat seedlings emerge, barban (Carbyne) can be used as a postemergent application. Barban must be applied when the wild oat plants are in the 1- to 2-leaf stage to get effective control.

If volunteer grain, downy brome (*Bromus tectorum*), barnyardgrass (*Echinochloa crus-galli*) or green foxtail (*Setaria viridis*) are a problem, several herbicides can be applied as preplant treatments for effective control. Propham and chloropropham are effective against these weed species as well as wild oat. EPTC (Eptam), profluralin (Tolban) and trifluralin (Treflan) applied as a preplant incorporated treatment will kill the grassy weed seedlings that germinate in the soil zone where the herbicide is placed.

Large seeded grasses which germinate below the herbicide-treated zone will likely be unaffected. EPTC will provide 6 to 8 weeks of weed control. Profluralin and trifluralin remain active in the soil throughout the growing season and will effectively control late-emerging grassy weeds.

Summer annual broadleaf weeds such as pigweeds (*Amaranthus* sp.), lambsquarter (*Chenopodium album*), the nightshades (*Solanum* sp.), chickweed (*Stellaria media*) and others can be a problem if not controlled early in the growing season. Propham, EPTC and chloropropham will provide weed control until midgrowing season (Table 6). These herbicides may be desirable if winter wheat is to be planted after the safflower crop is harvested.

If nightshade species are a problem, EPTC will provide the best control compared to the other available herbicides. Profluralin and trifluralin are active herbicides for the control of pigweed and lambsquarter but are weak against mustard species.

Consult herbicide labels to determine the weed species that can be controlled before making the final selection. Each field may have a weed problem that will require a different herbicide treatment. Careful selection of weed control materials will insure best results and greater safflower yield potential.

Field trials are being conducted by the University of Idaho to develop new herbicides for use in safflower production. These herbicides will be available when EPA registration and labels are secured.

Summary

Safflower varieties UC-1, S 208 and Carmex 353 were the best adapted varieties for dryland conditions of northern Idaho. Yield and oil content were best when warm and dry conditions prevailed after flowering. Hot, dry weather and reduced soil moisture during flowering were detrimental to yield and oil content. For these reasons, early maturing varieties are essential for production in areas with growing seasons similar to northern Idaho.

Safflower is not recommended for either Bonners Ferry or the irrigated areas of northern Idaho. Leaf rust and moist conditions after flowering were economic problems at Bonners Ferry. Regulation of irrigation rates and timing so that moist conditions do not prevail immediately after flowering could

improve the feasibility of safflower production under irrigation.

Optimum N rate for safflower production was between 50 and 100 pounds per acre. Excess N can delay maturity and cause late harvest. In drier areas, excess N can cause rapid early use of moisture and limit yields. Oil levels can also be reduced if maturity is delayed by high N rates.

Wild oats in safflower can be controlled with preplant incorporated applications of Chem Hoe FL4 or Furloe 4 EC. Postemergence wild oat control with Carbyne when oats are in the two-leaf stage is also possible.

Volunteer grain, downy brome and other annual grasses along with broadleaf weeds can be controlled with preplant incorporated herbicides. These include Chem Hoe FL4, Furloe 4 EC, Eptam, Tolban and Treflan.

Consult herbicide labels for use and the weeds that they control before application.

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Trade Names

Trade names are used in this publication to simplify the information presented. Such use does not imply an endorsement of any product nor criticism of similar products that are not mentioned.

Chemical Recommendations

The chemical recommendations are based on the best information available at the time of printing. Before using any pesticide, read the instructions on the label. Follow all precautions and restrictions for safe product use.

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