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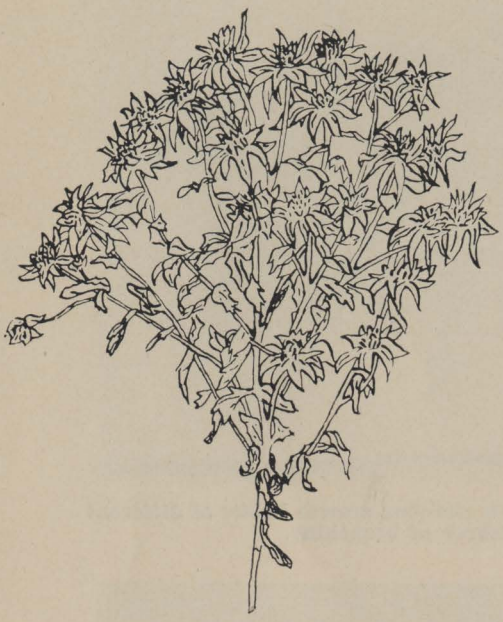
COLLEGE OF AGRICULTURE



Safflower Production

K. H. W. KLAGES

Department of Agronomy

IDAHO Agricultural Experiment Station

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Figure 1.—Individual safflower plants showing growth habits of different varieties with respect to height and degree of branching.

Figure 2.—A field planting of different varieties of safflower showing variations in habits of growth. Varieties in the foreground are medium in height and show a spreading, free-branching, habit of growth, those to the right and in the background are tall and erect. The cloth sacks over individual plants are to prevent cross-pollination and to insure the production of pure self-fertile seed.

Safflower Production

K. H. W. KLAGES[1]

SAFFLOWER is a new crop in the agriculture of Idaho. It has been grown on test plots at Moscow since 1940 and at various times at the Aberdeen and Twin Falls Branch Stations. Safflower has also been grown to a limited extent on a commercial basis in the Palouse area and on both dry and irrigated land in southern Idaho.

Safflower has been used successfully to provide nutritious winter feed for game birds. The plants are tall and stiff enough to extend beyond most snow covers and hold their seeds well into the winter.

Desirability of an Oil-Producing Crop in the Agriculture of the Pacific Northwest

To date no oil crop of commercial importance, at least none producing fatty oils, has become established in the Pacific Northwest. Peppermint and spearmint production falls into a special class in that these crops produce essential or volatile oils. They differ also from plants producing fatty oils in that they do not produce a high protein supplemental meal of value to the livestock feed industry. The value of a meal or cake left after the extraction of the oil from the seeds of such fatty oil-producing plants as cotton, flax, safflower, soybeans, and peanuts is high. The Pacific Northwest imports large amounts of these high-protein feeds. The production of such feeds in this area would result to a considerable saving to the livestock industry.

Soybean production has been tried in the Pacific Northwest. The crop was unable to compete with the standard crops of the area, largely due to the rather low yields obtained. Temperatures in most of the area are not sufficiently high to meet the requirements of this crop.

Seed flax production has possibilities. As a matter of fact, the merits of this crop should be given serious consideration. Practically no seed flax is produced in the Pacific Northwest at the present time.

Cotton and peanut production are out of the question because of temperature limitations.

Safflower has definite possibilities. The production of this crop as well as the production of seed flax would result in a needed diversification of the agriculture of the area in that it would add to the number of cash crops that can be grown. In addition, both of these crops would supply the area with a high value supplemental protein feed.

Safflower seed has been used in feeds; however, the amount of

[1] Agronomist of the Idaho Agricultural Experiment Station and Head of the Department of Agronomy, University of Idaho, Moscow.

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seed added to any feed must be limited on account of its high oil content, which may result in digestive disturbances. Safflower-seed meal or oil cake, produced after the extraction of the oil from the seed, has wider uses in feeds than the whole seeds. The protein content of such meal will vary with the methods of oil extraction used; it may range from 20 to 60 percent. Fed on an equal protein basis, the meal gives the same results as soybean meal or other protein concentrates. It is eaten readily by livestock without detectable change in quality or flavor of products.

Description and Growth Habits of Safflower

Safflower is a coarse, mostly erect, annual plant varying from 2 to 5 feet in height. The height of the plants is determined by the climatic and soil conditions under which the crop is produced and by the variety selected. Some varieties are free branching and somewhat prostrate while others grow upright and branch less. The rather heavy, waxy leaves of most varieties develop sharp spines as the plants approach the bud stage. Certain varieties are spineless. In comparative yield tests the spineless varieties have been less productive than varieties with spines. The flowers vary in color from white through yellow to orange. The heads and also the seeds have the general appearance of small sunflowers. Each head produces from 20 to 100 seeds.

Variations in the growth habits of different varieties of safflower with respect to height of plants and degree of branching are shown in Figure 1. Figure 2 shows differences in the habits of growth in the field. The varieties in the foreground are medium in height and have a spreading habit of growth while those in the background are tall and very erect.

The seeds are enclosed by rather heavy hulls which make up for from 35 to 50 percent of the seed weight. The oil contents of the seeds of the better varieties vary from 26 to 35 percent. The protein contents of the seeds range from 15 to 22 percent. These percentages are based upon the entire seed weight, including the weights of the hulls. The percentage of protein in safflower meal, upon extraction of the oil, may vary from 20 to 60 percent, depending, for the most part, upon the percentage of hulls removed in processing. Under northern Idaho conditions, the greatest source of variation in the composition of the seeds are seasonal temperatures and possible damage from frost.

Seedlings will emerge in 8 to 10 days after seeding under favorable soil moisture and temperature conditions. Soil temperatures should be at least 40° F. at the time of seeding. The rate of growth of the plants is rather slow during the first month after emergence. During this period the plants develop a spreading type of growth, generally referred to as rosettes. After the first month the rate of upright growth is rapid and branches develop.

The young plants are relatively resistant to freezing temperatures. Late spring frosts were a yield-determining factor during only one of the eleven years that the crop was grown at Moscow. In 1951, the variety test was seeded on April 15. By the end of May the plants averaged four inches high. Average minimum

temperatures of 28° 28°, 31° and 29° F. occurring on May 29, 30, 31 and June 1 of that year injured all of the 15 varieties under test to varying degrees.

The plants start flowering early in August, under temperature conditions at Moscow. Flowering may continue over an extended period. The plants become ripe between the middle of September and the early part of October, depending on seasonal conditions.

Yields of Safflower

Table 1 gives the seed yields obtained in the variety tests at Moscow from 1940 to 1954 (with the exception of the years 1943 to 1946, when the crop was not grown), and the yields at the Twin Falls Branch Station for 1950 and 1952. The crop at Moscow was a failure in 1948. Due to heavy and frequent rains during April and May the crop could not be seeded until June 2. This was entirely too late; the plants were killed by a frost on September 24 when the seeds were in the early filling stages. Due to circumstances encountered in 1948, the crop for that year was not considered in calculating the average yield of 1893 pounds per acre obtained over the years safflower was tested at Moscow. The yields of varieties tested at Moscow from 1947 to 1954 are given in Table 5.

The yields reported show considerable variation within the same season and also between seasons.

The within seasonal variation can be accounted for by varietal differences, actual differences in the yielding capacities of the varieties included in the tests, and also in part by soil variations within the test area. The extremely wide variation in the yields of 1951 is due mostly to varietal response to the low temperatures prevailing from May 29 to June 1 of that year. Some varieties, mostly the low-yielding ones, were severely damaged by frost while others, the high-yielding ones, were only slightly damaged and recovered rapidly. The close relationship of spring frost damage to final yield is given in Table 2. Frost resistance was scored on a scale of 1 to 10. In this score 10 designates complete resistance, 9 slight injury, 6 severe injury and 3 very severe injury to the plants.

The seed-yield variations between seasons are accounted for by variations in climatic conditions, some seasons being more favorable than others, and by soil variations. It was not possible to locate the test plots on soils of the same level of fertility each year.

Temperature and moisture conditions have a direct influence on yields. This is evident from a comparison of Table 3, giving the climatic summary for Moscow, with the yield data presented in Table 1.

The high yields at Moscow in 1940 were due to the favorable moisture conditions during September and the exceptionally long-growing season of that year. The high yields in 1950 can be accounted for by the high availibility of moisture, high precipitation in June, and by the fact that frosts did not occur until late in September. Both 1952 and 1953 were favorable to the attainment

of high yields by virtue of good moisture conditions in September and the length of the growing season, during the first, and good moisture conditions in August during the second of these years. The quality of the 1953 crop, as indicated by the oil contents of the seed, especially of the late-maturing varieties, was reduced somewhat by a killing frost occurring on September 20, before the crop was completely mature.

The low yields obtained in 1942 were due to poor moisture conditions and especially to low moisture during August and September. The less-than-average yield of 1949 was due to the frost on September 12, which caught the crop before the seeds were fully mature. The season of 1951 was characterized by low moisture both in August and September. The relatively low yields in 1941, a high-moisture year, can be attributed to the decidedly low September temperatures, as may be observed from Table 3; this year had by far the lowest average September temperature recorded during the period the test covered. While moisture conditions during 1954

Table 1.—Yields of safflower seed, in pounds per acre, obtained on the University Farm at Moscow and at the Twin Falls Branch Station.

Year	No. of varieties tested	Yield per acre (pounds) Lowest yielding variety	Highest yielding variety	Average yield of all varieties
	AT MOSCOW			
1940	11	1728	3966	2581
1941	11	886	2077	1394
1942	11	496	1350	942
1947	14	1544	2058	1821
1949	12	1312	1633	1497
1950	9	2261	3197	2660
1951	15	739	3111	1657
1952	15	1654	2492	2064
1953	12	2007	3055	2545
1954	37	828	3080	1767
Average		1346	2602	1893
	AT TWIN FALLS			
1950	11	1900	2794	2386
1952	12	1797	2799	2435
Average		1849	2798	2411

Table 2.—Relative frost resistance of safflower varieties during the seedling stage and relationship of frost resistance to yield, University Farm, Moscow, 1951.

Variety	Source	Evaluation of resistance by replications* 1	2	3	4	Av. frost resistance	Av. yield in lbs. per acre
P. I. No. 182,165	Turkey	9	9	9	9	9.0	3111
C. I. No. 2377	U.S.D.A.	9	9	9	9	9.0	2602
P. I. No. 183,669	Turkey	9	9	9	9	9.0	2340
P. I. No. 175,624	Turkey	9	9	9	9	9.0	2028
P. I. No. 174,081	Turkey	9	9	9	9	9.0	1775
P. I. No. 177,302	Turkey	9	9	9	9	9.0	1752
P. I. No. 173,881	India	6	9	9	9	8.3	1705
P. I. No. 173,885	India	9	6	6	9	7.5	1193
Indian	Nebraska	9	6	6	6	6.8	1921
P. I. No. 173,883	India	6	6	6	6	6.0	1374
Nebr. No. 852	Nebraska	6	6	6	6	6.0	997
Nebr. No. 10	Nebraska	6	6	6	6	6.0	1545
Nebr. No. 6	Nebraska	3	3	3	6	3.8	908
Nebr. No. 9	Nebraska	3	3	3	3	3.0	739

* A score of 10 is taken as complete frost resistance, 9 slight injury, 6 severe injury, and 3 very severe frost injury.

were very favorable the yields of the varieties under test were depressed by the decidedly low July and August temperatures. Due to the cool season and abundance of moisture the 1954 crop did not mature until early in October. The harvesting of commercial fields that late in the season would have been extremely difficult.

Table 3.—Summary of temperature and precipitation for May to September, inclusive, for the years safflower was grown at Moscow.

Year	Monthly means					5-month average	Date of first killing frost in fall
	May	June	July	Aug.	Sept.		
			TEMPERATURES, °F				
1940	47.4	64.0	68.0	66.4	61.0	61.3	November 3
1941	53.2	59.6	71.0	66.8	53.0	60.7	September 21
1942	50.5	56.0	67.3	68.0	59.1	60.2	October 23
1947	58.7	59.1	67.0	65.0	60.3	62.0	September 14
1949	58.4	61.4	67.1	66.6	60.6	62.8	September 12
1950	51.5	60.5	66.5	66.6	59.4	60.9	September 27
1951	54.9	58.0	67.5	64.2	59.9	60.9	October 17
1952	55.9	59.7	67.7	65.7	61.6	62.1	October 16
1953	51.1	55.3	65.1	65.6	60.3	59.5	September 20
1954	54.8	57.5	64.8	61.9	58.3	59.5	September 30
			PRECIPITATION, inches			5-month total	
1940	0.72	0.36	1.46	Tr.	4.21	6.75	
1941	4.40	3.44	0.30	0.83	2.67	11.64	
1942	2.13	1.63	0.77	0.05	0 38	4.96	
1947	0.37	2.05	0.18	0.19	3.81	6.60	
1949	1.29	0.46	0.48	0.26	1.27	3.76	
1950	0.97	3.43	0.29	0.45	0.32	5.46	
1951	1.04	2.08	0.54	0.68	0.59	4.93	
1952	1.52	2.73	0.20	0.23	1.23	5.91	
1953	1.77	1.28	Tr.	1.27	0.29	4.61	
1954	1.63	1.63	1.04	2.51	1.22	8.03	

Oil Content of Seed

The percentage of oil in the seed varies with varieties and is also highly dependent on seasonal conditions. Oil determinations were not made during all seasons. In 1947, when 14 varieties were under test, the low oil percentage was 23.4, the high 33.6, and the average of all varieties 29.0. In 1949 the low, high and average oil percentages were 15.1, 29.9, and 24.5. In 1950 the oil percentages were high, namely 29.3 for the lowest variety, 38.5 for the highest; and the average of the nine varieties under test was 32.2. The relatively low oil percentages obtained in 1949 are accounted for by the occurrence of a low temperature of 28° F. on September 12. This temperature killed the plants before the seeds were fully ripe, thus accounting for both the relatively low yields and oil contents of the seed for that year.

Early fall frosts may cause both low yields and low oil contents. The season of 1953 was favorable to safflower in that more than normal precipitation was received during August, even though temperatures were below normal. Nevertheless, yields and oil percentages were held down by the occurrence of the first frost in fall on September 20. The oil percentages of 97 foreign introductions grown on the University Farm in 1953 averaged 28.64. It is interesting to note that the 22 early-maturing introductions showed an average of 29.30 percent of oil, 53 medium-maturing introductions 29.02, and the 22 late-maturing introductions only 27.08 percent of oil on the dry basis. The early introductions were practi-

cally mature at the time of the frost; consequently, their oil contents were but slightly below the potential. The percentages of oil of the medium-maturing varieties was depressed to some degree. The oil contents of the late introductions were decreased materially.

Areas of the State Adapted to Safflower

The main requirement for successful safflower production is a fairly long growing season. This has been brought out in the discussion of the yields and the oil contents of the seed produced at Moscow. Spring frosts may occasionally cause damage, as was the case at Moscow in 1951. However, the possibility of early fall frosts occurring before the crop is fully mature is the main hazard in the production of safflower in Idaho. For that reason the production of this crop should be limited to areas with either high summer temperatures or with relatively long growing seasons.

High temperatures and bright sunny days during July, August and early September speed up the development of the crop. Safflower is strictly a sun-loving crop. Cloudy days delay the opening of flowers. High temperatures, long days, and droughty conditions hasten flowering. Where such conditions prevail a growing season of 125 days will suffice to mature the crop. Where the average frost-free season is shorter than that the danger of loss from frost damage is high. This indicates that the crop can be grown with a good margin of safety in the lower and middle Snake River Valley of Idaho, but that its production becomes increasingly hazardous in the upper Snake River Valley and plains. Figure 3 shows a good growth of safflower produced under irrigation in the lower Snake River Valley. Yields of around 3000 pounds per acre can be expected on fertile irrigated land in the lower and middle Snake River Valley.

In areas such as northern Idaho, where summer temperatures are relatively low and where periods of cloudy weather are more common than in the southern part of the state, safflower demands a growing season of at least 145 days. The effects of variations in climatic conditions on the yields of safflower at Moscow were discussed under yields and oil contents. The average length of the growing season at Moscow over a period of 61 years, that is from 1894 to 1954, is 147.6 days. However, this average figure is subject to tremendous variations. The shortest frost-free season on record was in 1945, only 67 days; the longest growing season on record was the one for 1940; it totalled 201 days. The median length is 155 days.

Climatic conditions at Moscow are fairly representative of the Palouse area of northern Idaho. In view of the performance of safflower on the University Farm it appears that the crop may well be considered in this area — with proper recognition of the climatic hazards involved. The crop is also fairly safe on the Rathdrum Prairie of northern Idaho, where the growing season is slightly longer than at Moscow and the summer temperatures somewhat higher. The crop can be grown with a higher margin of safety in the ridge areas of northern Idaho—the bean-producing sections—than in the Palouse proper. Due to the low tempera-

tures and the shortness of the growing season, the production of safflower on the upper prairie of Lewis and Idaho Counties cannot be recommended until earlier maturing varieties than we now have become available.

Since summer temperatures are of such great importance to successful safflower production, it is well to take this into consideration in the selection of land for the crop. Avoid flat areas and the bottoms of valleys where poor air drainage often results in lower temperatures and more damage from early fall frosts than on adjoining sloping land. Fields seeded on sloping land, with good air drainage, frequently escape frost damage during the early and the middle parts of September so that the plants can take full advantage of the longer frost-free period and thus produce higher yields and better quality seed. Seeding on low areas invites frost damage before the plants have reached maturity.

The relative temperature and length of growing season requirements of two potential oil producing crops for the Palouse area, flax and safflower, are shown in Figure 4. The flax in the foreground was seeded on the same date as the safflower in the background, April 24, 1954. The flax was fully mature on August 8 or at the time the safflower was coming into full bloom. The picture was taken on September 2 after the yield rows of the flax, every third row, were removed from the field. The safflower did not mature until October 2. The extreme lateness of the crop in 1954 is accounted for by the abnormally low July and August temperatures and the great abundance of moisture during that period.

Another factor to be considered in safflower production is the possibility that the late date of maturity of the crop may, in some seasons, be expected to coincide with the beginning of fall rains. This eventuality is most likely in the northern part of the state. It complicates the harvesting of the crop and getting the seed sufficiently dry for safe storage. For safe storage the moisture content of the seed must be less than 9 percent.

Safflower is a rather drought-resistant crop. Availability of moisture during the summer months is correlated with yielding ability. This has been discussed under yields. The crop has been grown under dryland conditions in the middle Snake River Valley. Under those conditions yields of from 400 to 600 pounds per acre have been reported. Moisture conditions in northern Idaho are sufficient for the production of good yields. This is evident from the yields reported at Moscow, Table 1.

Selection of Land and Sequence of Cropping

The advisability of not seeding safflower on low areas subject to late spring and especially early fall frosts already has been discussed.

Safflower in its early stages of growth is only a fair competitor against weeds. This means that fairly clean land should be se-

Figure 3.—A good growth of safflower grown under irrigation in the lower Snake River Valley.

lected for the crop. The most effective means of providing relatively weed-free land for the crop is to grow it in a rotation system in which alfalfa-grass or sweet clover-grass mixtures are used every four to six years depending on the fertility level of the soil. Safflower may take the place as a cereal crop in the rotation system.

That the growing of oil-producing crops such as safflower and flax has no detrimental effects on the yields of crops following them in the rotation is shown in Table 4, giving the yields of spring wheat following the crops designated. The area used for this trial had a sweet clover-grass green manure crop turned under in 1948, produced an average yield of 72.4 bushels of winter wheat in 1949 and was seeded to the crops designated in Table 4 in 1950. One triplicated set of plots was fallowed in 1950. The yields of the peas, flax, safflower and oats obtained in 1950 are given in the table. In 1951 the entire area, including the summer-fallowed plots, was seeded to spring wheat thus giving the yields of this crop after fallow and each of the designated crops. As is to be

Table 4.—The 1950 seed yields of peas, flax, safflower, and oats following a heavy crop of winter wheat, and the 1951 spring wheat yields after fallow and the 1950 designated crops, University Farm, Moscow.

Fallow and designated crop grown in 1950	1950 yields of designated crops, in lbs. per acre	1951 yields of spring wheat after fallow and the 1950 designated crops, in bushels per acre
Fallow	.....	43.4
Peas	1418	35.4
Safflower	1309	25.4
Flax	783	24.3
Oats	2153	21.2

Figure 4.—Two potential oil producing crops, flax in the foreground and safflower in the background. The picture was taken on September 2, 1954. The yield rows of the flax variety test, every third row, were harvested on August 8. The safflower was not ready for harvest until October 2. Low growing season temperatures during 1954 account for the late date of maturity.

expected the highest spring wheat yields were obtained after fallow and peas. The wheat yields following both the safflower and the flax were somewhat higher than those after oats.

Variety Tests

During the early years of safflower testing the varieties included in the tests were largely of Russian origin. While high yields were obtained from some of these varieties, it became evident that they contained from 5 to 10 percent less oil than varieties originating from India, Turkey and Turkestan. This is the reason that variety test results obtained prior to 1947 are not given.

Table 5 gives the results of variety tests conducted at Moscow and Twin Falls. Only the results of two years are available from Twin Falls. The newer varieties were tested at Moscow since 1947. The crop failure in 1948 was explained under the heading, yields of safflower.

The standard varieties are Nebraska 852, 10 and 6. It will be observed from Table 5 that these varieties yielded slightly less than Indian. The percentage of oil in the seed of Nebraska 852, 10 and 6 were 32.8 and 33.3 and 30.7, respectively, at Moscow in 1950 as compared to 30.0 percent for the Indian variety. C.I. No. 2,377 produced excellent yields at Moscow. The seed of this variety contained 31.2 percent of oil in 1950. In California, Nebraska 852

and 10 have given best results on dry areas, while Nebraska 6 has been the better variety on moist areas and on irrigated land. No significant differences were found in the yielding capacities of these standard varieties at Moscow. Nebraska 852 has given good results at Twin Falls.

For the sake of interest, the yield data of two foreign introductions are included in Table 5. These two varieties showed not only high yields but also high oil contents. In 1953, 110, and in 1954, 122 such foreign introductions were grown on the University Farm at Moscow in an effort to find high-yielding, high-quality varieties adapted to Idaho conditions. These tests however have not gone far enough at this time to justify the distribution of new varieties.

Table 5.—Yields of safflower varieties, in pounds per acre, at Moscow and Twin Falls for the years indicated.

Variety	Yields in pounds per acre by years							Average yields		
	1947	1949	1950	1951	1952	1953	1954	7 yrs. 1947-1954	5 yrs. 1950-1954	4 yrs. 1951-1954
AT MOSCOW										
Indian	1681	1609	2483	1921	1925	2757	2200	2032	2257	2201
Nebr. 852	1980	1458	2723	997	2140	2715	1908	1989	2097	1940
Nebr. 6		1633	2738	908	1821	2911	1952		2066	1898
Nebr. 9		1610	2794	739	2019	2346	1592		1898	1674
C. I. 2,377			2734	2602	2251	2484	1892		2393	2307
Nebr. 10			3197	1545	1734	2014	1920		2082	1803
P. I. 182,165				3111	2261	2486	2300			2539
P. I. 183,669				2340	2492	2851	2328			2503
AT TWIN FALLS								2 yr. Av. 1950 & 1952		
Nebr. 852			2757		2636			2697		
Indian			2794		2450			2622		
Nebr. 9			1900		2985			2443		
Nebr. 6			2459		1819			2139		
P. I. 183,669					2799					
P. I. 182,165					2539					
C. I. 2,377					2413					
Nebr. 10					2265					

Diseases and Insect Pests

Safflower produced in Idaho so far has been relatively free from diseases and insect pests.

Leaf rust has as yet not been reported in the State.

A few instances of root rot were observed during the early work on safflower at the Aberdeen Branch Station when varieties of Russian origin were grown under irrigation. Since the new varieties are resistant, this disease will probably not become serious.

A trace of Botritus head blight was observed at Moscow in 1954. This disease causes the rotting of the upper portion of the stems supporting the heads. When the disease progresses far enough, it causes the breaking off of infected heads.

Slight to moderate infections of leaf spot caused by a species of *Altenaria* have been observed. Leaf spot is likely to be more common on irrigated than on dry land plantings. Frequent showers or heavy dews during July and August favor its development. Since the organism causing this disease is both soil and seed-borne, seed treatment will give only partial protection. Leaf spot is characterized by the appearance of large irregular brown spots on

the lower leaves of infected plants. As the disease progresses the lower leaves turn brown and irregular spots develop on the upper leaves. Not all killing of the lower leaves should be attributed to leaf spot. Lack of moisture also causes the lower leaves to turn brown.

Aphids caused some damage to the crop in the moist season of 1954 In most seasons the infestations have not been severe enough to justify application of control measures.

Lygus bugs if present in sufficiently large enough numbers attacking young safflower buds cause the blasting of the entire head. On developing heads these insects may cause the blasting of the outer row of seeds. When this insect is abundant, control measures should be applied.

Grasshoppers, if abundant, may be expected to damage safflower severely and especially in locations where this crop is grown adjacent to dry grassland areas or early maturing cereals.

Production Practices

Preparation of Seed

Before seeding clean seed to remove any weed seeds and to facilitate the uniform delivery of seed from the drill Treat seed with New Improved Ceresan at the rate of one ounce per bushel. Safflower is subject to a leaf rust. So far no trouble has been experienced from this rust in Idaho. Seed treatment is a precautionary measure. The leaf rust is transmitted on the seed.

Seedbed Preparation

Prepare the same type of seedbed as for spring wheat. Fall plowing is best. When this is not possible, plow as early in the spring as soil conditions permit. Early working of the soil favors the production of the desired firm seedbed. Frequent working of the soil prior to seeding encourages the sprouting of weed seeds so that they may be destroyed. The seedbed should be prepared so that soil moisture will be near the surface.

Date of Seeding

Since safflower is a long-season crop, early seeding is essential. At Moscow good results have been obtained by seeding from April 15 to May 1. The crop should by all means be in by the first week in May. Early seeding is also desirable in the Snake River Valley.

Method and Rate of Seeding

Both row and solid seedings have been used at Moscow and Aberdeen with equal success. Row seedings and cultivation, while offering an effective means of combating weeds, have generally not resulted in sufficient increases in yields to cover the extra expense.

The most satisfactory method of seeding on irrigated land is in rows 20 to 24 inches apart. This allows for the corrugations down the rows. Seeding the crop in rows enables cultivations for weed control during the early stages of growth.

Under relatively high moisture conditions prevailing in the Palouse area of northern Idaho, 35-40 pounds of seed per acre has

given good stands. As low as 10 pounds per acre has been used to obtain maximum increase of seed and good stands resulted. However, the plants combat weeds more favorably when the higher rate is used. Where the crop is grown under irrigation in 20 to 24-inch rows the use of 25 pounds of seed is sufficient.

This seed may be planted with grain drills where the crop is to be grown in solid stands, or with bean and beet planters where row culture is desired.

The seed should be placed deep enough to come in contact with soil moisture but avoid planting deeper than three inches. Depths from one to two inches are ideal under favorable moisture conditions.

Harrowing for Weed Control

Safflower is rather slow in emerging. Usually 8 to 14 days elapse between seeding and emergence of the plants. Harrowing the field with an ordinary harrow diagonally or crosswise to the direction of the seeded rows a few days before the safflower plants come up will eliminate small weeds without damaging the safflower stand. Such harrowing can even be done after a few plants are beginning to push through the soil. Safflower plants at the time of emergence have strong tap roots which keep the plants well anchored during harrowing.

Harrowing of fields soon after the plants are up may result in covering some of the plants and reduce stands. If necessary for weed control, safflower fields can be harrowed a second time when the plants are three to six inches high. Harrowing at this time is less effective for weed control than just prior to emergence.

Safflower plants are susceptible to and severely damaged by 2,4-D compounds. These compounds have no place in weed control in safflower fields.

Fertilization

The same methods employed in fertilizing spring-sown cereal crops in northern Idaho can be used to advantage on safflower. Like cereals, the crop will respond to nitrogen The most economical amounts to apply will depend on the cropping history of the field, and especially on the amounts of straw returned to the soil from the previous crop. Where safflower follows alfalfa, sweet clover or fallow no additions of nitrogen are necessary. Where the crop follows cereals or peas, applications of nitrogen will pay. Where the previous crop contributed 1 to 1½ tons of straw use 40 pounds of nitrogen per acre. If the amount of straw returned is greater, use as high as 50 pounds. The application of more than 50 pounds of nitrogen may delay the maturing of the crop and for that reason should be avoided.

In the southern part of the state, safflower producers should be guided by the practices used in fertilizing cereals. Where the land has been out of alfalfa for a number of years applications of nitrogen and phosphate carrying fertilizers will pay.

Commercial fertilizers should be applied and worked into the seedbed prior to seeding.

Irrigation

As the discussion on yields has indicated, safflower responds to favorable moisture conditions. Under irrigation, the crop is best grown in rows 20 to 24 inches apart. The corrugations down the rows should be deep enough to avoid flooding. The field must be corrugated before the plants spread too much to avoid damage. Three to four irrigations per season will suffice in most of southern Idaho. Applications of water before flowering starts may be fairly heavy. Those made after flowering has begun should be medium to light. Safflower demands good soil aeration, over-irrigation or poor drainage will damage the crop.

The most critical time, as far as moisture needs of the plant are concerned, is soon after the flower buds start to form. Keeping the plants well supplied with moisture at that time will increase yields, but do not over-irrigate and especially not after flowering.

Applications of water late in the season, after August 20, will delay the maturity of the crop and may therefore subject it to frost damage.

Harvesting

Safflower is well adapted to direct combining. The plants stand up well, and, except where the field is over-ripe, little loss from shattering will be experienced.

The time to start harvest is when most of the leaves have turned brown. There may be a tinge of green on some of the upper leaves and at the base of the heads.

Avoid premature combining. Seed that is completely mature will have around 8 percent moisture. Safflower seed with more than 9 percent moisture is likely to heat in storage.

With some adjustments of the combine, the crop can be harvested as easily as wheat. Tooth and bar type of cylinders work well. A slower cylinder speed than that used for wheat is necessary to avoid cracking of the seed. In general, cylinder speeds between 400 to 800 RPM have given best results. With tooth cylinders, either two or four rows of concaves are used, depending on the ease of threshing. Drop the concave teeth so that they just begin to mesh with the cylinder teeth. In the case of rub bar cylinders, use a clearance of around ½ inch between the concave and the cylinder bars. It is important to keep a proper speed on shaker screens. Best results are obtained when the shakers are run slightly faster than the speed commonly used with grain.

All safflower varieties have a certain amount of fuzz in the heads. This creates considerable dust during harvest. Since this tends to accumulate in the radiator grill of combine engines it should be blown out periodically to avoid heating of the engine.

Summary

Safflower has been grown for many years in India and Egypt as a source of oil and red dye. It is a relatively new crop in American agriculture and in Idaho.

Idaho farmers are interested in the production of safflower in

that it may serve to diversify the cropping program and provide an additional source of income in those parts of the state to which the crop is adapted. Safflower will yield an income not only from the oil contained in the seed, but will also provide the livestock industry with a valuable supplemental high protein feed in the form of safflower meal and cake. The plant also has value in providing a good winter feed for game birds.

The relatively high temperature requirements of the crop will limit its successful production to the warmer portions of the state and to areas with fairly long growing seasons.

Safflower can be grown to good advantage in the middle and lower Snake River Valleys and in the Palouse area. However, in the latter area certain hazards in its production largely associated with occasional cool seasons and the occurrence of early fall frosts must be considered in the evaluation of the crop.

The average yield of 1893 pounds of seed per acre obtained during the years that the crop was tested on the University Farm at Moscow is quite satisfactory. In some of the 11 years over which the tests extended both the yields and the quality of the crop were reduced by the occurrence of early fall frosts before the crop was mature. The occurrence of late spring frosts interfered with the attainment of maximum yields in only one of the eleven years of the tests.

The crop matures in late August and early September in the middle and lower Snake River Valleys. This is sufficiently early for favorable harvesting. Due to the moderate temperatures encountered in northern Idaho, the crop does not mature in this part of the state until late in September. In occasional years this late date of maturity will coincide with the beginnings of fall rains which will interfere with harvesting operations.

Since safflower is only a fair competitor against weeds in its early stages of growth, relatively weed-free land should be selected for the crop. Safflower plants are susceptible and severely damaged by 2,4-D compounds. These compounds have no place in weed control in safflower fields. Pre-emergence harrowing will aid in weed control.

Safflower is not difficult to grow. It may be grown either in rows or in solid stands. When the crop is grown under irrigation, it is best to seed in rows 20-24 inches apart. This allows for corrugations down the rows. Safflower will take the place of the cereals in the rotation. It responds to the application of commercial fertilizers as the grain crops. Safflower lends itself well to combine harvesting.

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