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Effect of Rainfed and Irrigated Conditions on the Yield of Indigenous and Exotic Varieties of Safflower (*Carthamus tinctorius* L.)

by

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Introduction: The yield of safflower (*Carthamus tinctorius* L.) in India is very low when compared to yields obtainable in other countries. It is largely due to these low yields that safflower has not played a more prominent role in helping overcome the oil-fat dietary deficiency of the Indian population as a whole. Safflower here is grown almost entirely under rainfed conditions. Irrigated safflower has not been generally experimented with in this country, nor has much emphasis been given by the commercial sector on higher oil-yielding varieties. The results of preliminary agronomic studies carried out in the Phaltan area of Maharashtra on rainfed and irrigated safflower, using standard indigenous and U. S. varieties, are presented in this paper, together with oil analyses covering a range of commercial varieties.

Review of literature: According to Chavan (1961) a pure crop of safflower in India under rainfed conditions may yield 400 to 600 pounds per acre. Using subirrigation or carefully controlled surface irrigation (Knowles, 1958) yields in California varied between 2500 and 4000 pounds per acre (Knowles and Miller, 1965). Chaudhari, *et al.* (1961) record that the standard and recommended variety for major safflower growing regions of Maharashtra, "Niphad 62–8", has an oil content of about 30%. Recent U. S. varieties have oil contents of over 40% (Knowles and Miller, 1965). However, introduced foreign strains were found to be unsuitable for economic cultivation in Maharashtra (Chaudhari, *et al.* 1961).

Materials and Methods: All the experiments were conducted in the "rabi" (winter) season of 1968–69 on black cotton soils of the Nimbkar Agricultural Research Institute at Phaltan. Since the above-ground portions of safflower are sensitive to moisture (Knowles, 1958), ridges and furrows were used for both the rainfed and irrigated experiments. Seeding was carried out by hand on top or slightly down one side of the ridges (2 to 3 cm into soil), to prevent the plants from ever being in standing water. Dhote and Bilal (1964) found that the uptake of N is likely to be more if it is combined with P or both P and K. Thus the complete fertilizer 18 : 18 : 10 was used at 100 kg N/ha (excepting the fertilizer experiments) in a single application. For the rainfed

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fertilizer experiment, the fertilizer was applied just prior to seeding and for all irrigated experiments three weeks after sowing, in both cases 15 cm to one side of the rows and 15 cm below soil level. For the rainfed spacing experiment, fertilizer was broadcast and worked into the soil by till ge prior to seeding.

The soil of the rainfed agronomic experiments and the irrigated varietal experiment presented in this paper had a pH of 8.2 to 8.3; organic carbon % of 0.80; available P_2O_5 of 16.13 kg/ha; and available K_2O of 957 kg/ha. The soil of the irrigated agronomic experiments had a pH of 8.0 to 8.2; organic carbon % of 0.76; available P_2O_5 of 29.57 kg/ha and available K_2O of 1041 kg/ha.

All experiments were irrigated immediately after seeding to ensure germination. The irrigated agronomic experiments each received four additional crop-irrigations and the varietal experiment (seeded later and hence having a reduced growing period) three. The last irrigation in each case was applied at about full bloom. The only rains received during the growing period were a total of 72 mm received on November 6 and 7.

Fertilizer Experiments: Three fertilizer treatments (0, 75 and 150 kg N/ha) were arranged in randomized blocks with four replications. Subtreatments were the Maharashtra standard variety "N 62-8" and the U.S. standard variety "Gila". Seeding of two seeds every 8 cm was carried out on October 11 for the rainfed and on October 4 for the irrigated experiment. At maturity, 2 rows, 12 m long, 45 cm apart were harvested of each 4 row plot, 15 m long. The rainfed experiment received one fortuitous irrigation on November 11.

Spacing Experiments: Four spacing treatments (30.0 cm × 7.5 cm; 60.0 cm × 7.5 cm; 45.0 cm × 30.0 cm and 75.0 cm × 30.0 cm) were arranged in randomized blocks with three replications. Sub-treatments were the varieties "N 62-8" and "US-10" (a standard U. S. variety with upright branching habit). Seeding of two seeds per locus was carried out on October 16 for the rainfed and on October 10 for the irrigated experiment. At maturity, 2 rows, 12 m long were harvested of each row plot, 15 m long.

Varietal Experiment: Nine Varieties, shown in Table 3, were arranged in randomized blocks with four replications. The varieties include the indigenous standard "N62-8" as well as an unselected local strain "Rajala local", aside from seven imported U. S. varieties. Seeds were dibbled on November 23. Later plants were thinned to about 5 cm between plants in the rows. At maturity, 2 rows, 12 m long, 50 cm apart were harvested of 2-row plots, 15 cm long. Seeding was delayed because of the late arrival of some of the U. S. seed. Seed samples were sent to the University of Illinois for oil-content determinations by Nuclear Magnetic Resonance (NMR).

Results: *Fertilizer Experiments:* In the Analysis of Variance of the rainfed experiment, the "F" test showed yield differences not to be significant. In the irrigated trial, only "Gila" at 150 kg/ha yielded significantly higher than "N62-8" at 0 kg N/ha. These data are presented in Table

TABLE 1. *Effect of increasing nitrogen on the seed yield of two safflower varieties under rainfed and irrigated conditions*

N Treatment (kg/ha)	Variety	Yield (quintals/ha)	
		Rainfed	Irrigated
0	N62-8	20.33	28.43 a*
	Gila	21.82	29.95 ab
75	N62-8	18.94	31.22 ab
	Gila	20.02	31.34 ab
150	N62-8	19.36	32.34 ab
	Gila	21.58	33.30 b

* Mean yields followed by the same letter do not differ significantly at the 5% level using Duncan's Multiple Range Test.

Spacing Experiments: The Analysis of Variance for the rainfed experiment gave significant "F" value only for spacings. The effects of varieties and spacing × variety interaction were non-significant. The pooled and ranged spacing means for the rainfed experiment are presented in Table 2b. It can be seen that the two widest spacings gave the highest yields. The irrigated trial was non-significant for "F". The yield data for both spacing experiments are presented in Table 2a.

TABLE 2a. *Effect of spacing on the seed yield (quintals/ha) of two safflower varieties under rainfed and irrigated conditions*

Condition	Variety	Spacing (cm)			
		30×7.5	60×7.5	45×30	75×30
Rainfed	N62-8	18.89	18.34	28.23	26.78
	US-10	21.92	15.24	22.88	23.36
Irrigated	N62-8	31.01	36.13	41.19	26.57
	US-10	33.87	26.57	31.78	27.77

TABLE 2b. *Effect of spacing on the seed yield of rainfed safflower*

Spacing	Yield (quintals/ha)
60× 7.5	16.79 a*
30× 7.5	20.41 ab
75×30.0	25.07 bc
40×30.0	25.56 c

* Mean yields followed by the same letter do not differ significantly at the 5% level using Duncan's Multiple Range Test.

Vaietal Experiment: As Table 3 indicates, the only two indigenous varieties used, "N62-8" and "Rajala local" ranked very poorly in this experiment. The highest yielding three varieties, "US-10", "UC-1" and "S-208" are all Californian varieties were devastatingly affected by a fungal attack. Many plants were killed outright. Beyond a few plants of "Gila", the U. S. varieties were not at all visibly affected by this fungal attack.

The U. S. varieties tested for oil percetage had an oil content from 1.5% to 8% higher than the two indigenous varieties included.

TABLE 3. *Seed and oil yield of two indigenous and seven exotic safflower varieties under irrigated conditions; planted November, 23, 1968*

Variety	Seed Yield (quintals/ha)	Oil %	Oil Yield (quintals/ha)
Leed	6.07 a*	—	—
Rajala local	6.90 a	29.3	2.02
N62-8	10.64 b	29.3	3.12
Gila	11.44 b	35.5	4.06
Frio	11.76 b	35.4	4.16
Rio	11.79 b	37.4	4.41
S-208	15.30 c	36.8	5.63
UC-1	17.27 cd	31.8	5.49
US-10	19.94 d	33.2	6.62

* Mean seed yields followed by the same letter do not differ significantly at the 5% level using Duncan's Multiple Range Test.

Discussion: The yields of "N 62-8" and "Gila" were comparable in both fertilizer experiments; with "Gila" tending to yield consistently slightly higher than "N 62-8" (Table 1). One possible explanation for the general lack of response to N applied may be the relatively high initial fertility level of the particular fields (which on the average received fertilizer in one to two seasons yearly).

In the spacing experiments, the yields of "N 62-8" and "US-10" were comparable. At the closest spacing of both the rainfed and irrigated experiments "US-10" yielded somewhat higher than "N 62-8.". This can be explained by the former's more upright branching habit.

While in the rainfed experiment the adjusted yields (to compensate for gaps) indicated the 30 cm in-row spacing as yielding higher than the 7.5 cm spacing, the former may not be a useful spacing to use. Poor germination, insect or disease attack to individual plants would result in large gaps which could not adequately be compensated for by adjacent plants. The 75 cm between-row spacing resulted in poorer germination than the narrower

ones. The most promising between-row spacing tested under rainfed conditions therefore seems to be 45 cm.

Under irrigated conditions the exact spacings may be less critical, as indicated by the fact that yield differences were not significant for this experiment. This would point to a greater compensatory ablity of safflower, to adjust to different spacings, under irrigated conditions.

Considering all four agronomic experiments, the yields of the irrigated experiments were considerably higher than those of the rainfed experiments. Furthermore, the yield of the exotic variety tested in each case was quite comparable to that of the indigenous "N 62-8".

The abnormally late planting date of the varietal experiment, with its concomittant fungal attack, biases the yields in favour of the exotic varieties. Bearing this in mind, even with comparable seed yields, with varieties of higher oil content the hectare yields of oil could be appreciably increased (Table 3).

In the irrigated experiments conducted, the indigenous varieties included lodged from moderately to severely. All the exotic varieties tested showed essentially no lodging. The lodging-resistance of these exotic varieties may be an important factor in their favour for irrigated safflower. Harvesting speed and ease may be greatly enhanced.

Summary and Conclusions: Indigenous "N 62-8" and exotic "Gila" and "US-10" were studied severally under rainfed and irrigated conditions in fertilization and spacing experiments. A varietal trial including two indigenous and seven exotic varieties was conducted under irrigation and the oil content of the seed was determined by NMR.

High initial fertility of the soil partly masked the effect of fertilizer applied. A 45 cm between-row spacing may be most useful for rainfed conditions. Under irrigation, the exact spacing may not be as critical.

The exotic varieties tested yielded comparable to "N 6 -8". Irrigation raises the upper limit of safflower yields considerably in this low-rainfall area. Lodging-resistance under irrigated conditions and higher oil contents of some of the commercial U.S. varieties are important points to consider in their favour.

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Relative Efficacy of Simazine and Select Dithiolcarbamates in the Control of Weeds in Hybrid Sorghum

by

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Sorghum is grown on comparatively heavier soils on which control of weeds is one of the most difficult tasks as these soils and climatic conditions give rise to a host of weed problem. Past experiments at Udaipur showed that application of 2, 4-D sodium salt best controls weeds when applied at the rate of 1.0 to 1.5 kg/ha (Singh and Faroda, 1964). Yet, some weeds like *Trianthema portulacustrum* and *Physalis minima* remained unhurt and hand weeding was the best to control many of the weeds including *Trianthema portulacustrum* (Singh and Porwal, 1967). Use of simazine which has given remarkable control of weeds in maize and also other herbicides as EPTC and PEBC which hold great promise are worth trying. Since time and rates of application of these herbicides are different for different crop weed situation it will be of practical importance to try these new herbicides and work out proper time and rate of application and to see how the new practices compare with the traditional methods of controlling weeds by the use of 2, 4-D.

Materials and Methods : The experiment consisted of three herbicides *viz.*, simazine, EPTC and PEBC with seven concentrations *viz.*, 1.0, 1.5, 2 0, 2.5 3.0, 3.5 and 4.0 kg (*a.i.*) per hectare, applied as pre-planting and pre-emergence treatments making thereby 21 treatments in pre-planting and 21 in pre-emergence series. To these treatment combinations one control in pre-planting

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