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Evaluation of Different Safflower Varieties Under Rainfed Conditions

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Abstract
Significant differences were observed at 5 percent probability level in seed yield, oil content, number of capsule per plant, hundred Seed weight and plant height safflower the varieties. XJH-39 produced the highest seed yield of 854 kg ha^{-1} followed by Lesaf-244 and SPS-6912 with a yield of 792 and 750 kg ha^{-1} respectively. Thon-78 produced the highest oil content of 32.07 percent. A-300 produced the maximum number of capsule (35) per plant, Lesaf-246 produced the maximum (5.7 g) hundred seed weight while the Lesaf-247 was the short stature variety having a plant height of 106 centimeter.

Introduction
The yield of safflower (*Carthamus tinctorius* L.) is very low in Pakistan i.e., 679 kg ha (Anonymous, 1992). Zaman (1988) tested the performance of safflower under drought conditions and noted the grain yield of 1.10, 1.36 and 1.71 t ha^{-1} with the application of N at the rate of 0.60 and 120 kg ha^{-1}, respectively. Salvador *et al*. (1988) observed that the safflower variety Gila grown at 6-22 kg seed/ha and 15, 30 or 45 percent available soil moisture level, gave grain yield of 1.66, 2.31 and 2,34 t ha^{-1}, respectively. Katole and Meane (1988) reported that safflower cultivar JSF-5 grown in rows 30, 45 or 60 cm apart produced grain yield of 2.05, 2.13 and 1.71 t ha^{-1} and oil content percentage of 25.8, 28.1 and 25.7, respectively.

Kumar and Agrawal (1989) found that safflower variety HUS-305 gave an average yield of 1495 kg ha^{-1}. Bergman *et al*. (1989) found that safflower variety Girard and Finch had the plant height, oil content and grain yield of 54.6 and 51.3 cm, 42.2 and 41.3 percent and 1167 and 1164 kg ha respectively, under dryland conditions. Nikam *et al*. (1989) found that safflower cultivar Bhima at the seed rate of10, 15 or 20 kg ha^{-1} produced the average grain yield of 0,91, 0.95 and 0.92 t ha^{-1}, respectively. Sounda and De (1989) studied the 3 cultivars at 50, 100 or 150 hundred plants/ha in rows of 45 cm apart giving N at the rate of 0, 60 or 120 kg ha^{-1} and observed that increase in plant density, increase the plant height but decreased dry matter production. Zaman (1989) noted that safflower cultivars A100,116-4-5 and 340092 were applied N at the rate of 0-120 kg ha^{-1}, gave average grain yield of 1.40, 0.92 and 0.32 t ha^{-1}, respectively. compared with 0.56 t ha^{-1} under ranted conditions. Muralidharudu *et al*. (1989) found that (flower cultivars A-l and. BLY-652 gave average grain field of 1.05 and 0.92 t ha^{-1} and oil content percentage of 8.0 and 35.0, respectively. Salera and Megale (1989) and the safflower cultivars Saffiola gave average grain d and oil yield ranged 1,84-2.40 t ha^{-1} and 0.68-0.84 t ha^{-1}, respectively, out of the total 22 safflower cultivars. Mane *et al*. (1990) found that safflower were given $N + P_2O_5$ at 25 + 12.5, 50.75 + 37.5 or 100 + 50 kg ha^{-1}, increasing NP rate increased growth, number of capsule per plant, seeds per capsule, 1000-seed weight and seed yields. Musa and Munoz (1990) found that the safflower varieties Quiriego-88 and Sahuaripa-88 were intermediate in flowering & maturity, test weight average 521 and 538 g/liter, oil content percentage of 37.2 and 19.4 and grain yield 3020 and 2810 kg ha^{-1}, respectively. Abo-Shetaia (1990) found that maximum seed yield 2.9 vs. 2.3 and 2.6 t ha^{-1} for 15.5 and 31.0 kg P, respectively.

Materials and Methods
A field study consisted of 16 safflower varieties was conducted at National Agricultural Research Centre, Islamabad during November 12, 1992. The trial was laid down in randomized complete block design with 4 replications, accommodating 4 rows of 5 m length and 60 cm apart, from each other and spaced at 15 cm between plant to plant. 80 kg N and 30 kg P_2O_5 per hectare were applied in the form of urea and diamonium phosphate, respectively. The planting was done with hand drill on clay loam soil. To maintain the desired plant population, thinning was done manually, No irrigation applied to the crop throughout the growing season. One weeding and two spraying were done. The data were recorded from the two central rows in each plot. The produce of selected lines from each plot was kept separately and added up to obtain the average yield per plot. Data were regarding Seed yield (kg ha^{-1}), Oil content in percentage. Number of capsule per plant, Hundred seed weight in grams. Plant height in centimeters.

The seed yield in kilogram per hectare was calculated by multiplying the yield of each plot with the net plot size. The oil content percentage was determined by Nuclear Magnetic Resonance Oxford 4000 method. The number of capsule per plant was recorded by counting the average of ten

plants selected randomly from each plot of the varieties. The hundred seed weight in grams was recorded by counting the average of ten plants selected randomly from each plot of the varieties. The plant height was recorded in centimeter from ground level to the top of plant by selecting ten plants at random, before harvesting. The data recorded were statistically analyzed by using analysis of variance technique and least significant differences at 5% probability level to find the difference in means for various agronomic characters (Steel and Torrie, 1960).

Results and Discussion

Significant variability was found in seed yield, oil content, number of capsule per plant, hundred seed weight and plant height among the varieties (Table 1, 2). Yield of different entries ranged from 406 to 854 kg ha^{-1}, Among 16 accessions, XJH-39 performed better giving an average yield of 854 kg ha^{-1} closely followed by Lesaf-244 and SPS-6912 kg ha^{-1}. Lesaf-7419 and NAO-5518 each produced the minimum seed yield of 458 kg ha showing the poor adaptability in the rainfed conditions. Other entries were in the range of 400 to 550 kg ha^{-1} which are moderate to lower yielding entries. In safflower, number of capsule per plant place an important role in the ultimate yield. The number of capsule per plant ranged from 35 to 27. L-221/5 and Lesaf-74/9 (30) ranked second and third in number of capsule per plant. The results are supported by the findings of Zaman (1988), Salvador *et al*. (1988), Katole and Mane (1988), Kumar and Agrawal (1989), Bergman *et al*. (1989), Nikam *et al*. (1989) Sounda and De (1989), Zaman (1989), Muralidharudu *et al*. (1989), Salera and Megale (1989), Mane *et al*. (1990), Musa and Munoz (1990) and Abo-Shetaia (1990). who reported similar results in their respective studies. As regards the oil content, its clusters around 30 percent in all the entries. Among different safflower entries, Thori-78 produced the highest oil content percentage of 32.07 closely followed by XJH-3 and SPS-6912. L-32 produced the minimum oil content of 27.94 percent. Hundred seed weight ranged from 5.7 to 4.7 grams. On an average of all the entries, maximum sees weight was recorded in Lesaf-246, followed by Lesaf-24 and XJH-39 each with 5.5 grams. The minimum hundred seed weight was observed in GL-19. The entries behaved differently for plant height. Plant height ranged from 106 cm to 132 cm (GL-19 and L-32). The varieties L-211/5 and L-247 each (107 cm) ranked second in plant height. Similar, results have been reported by Katole and Meane (1988), Bergman *et al*. (1989), Sounda and De (1989).

Table 1: Meteorological data at National Agricultural Research Centre, Islamabad, during Rabi, 1992-93

Month	Temperature °C		Humidity	Rainfall
	max	min	(%)	(mm)
November	22.9	8.3	72.5	35.0
December	19.1	6.1	72.5	8.0
January	15.2	2.9	72.5	28.3
February	21.2	7.0	63.0	46.9
March	21.1	8.3	68.5	144.7
April	29.7	14.2	56.0	27.8
May	36.4	20.3	36.0	23.6
June	37.7	23.1	44.5	83.2

Table 2: Performance of different safflower varieties under rainfed conditions, during Rabi, 1992-93

Entry	Seed yield (kg ha^{-1})	Oil content (%)	Number of capsule/plant	Hundred seed (g)	Plant height (cm)
A-300	625	29.68	35	5.0	111
GL-19	708	30.34	33	4.7	132
L-32	625	27.94	32	5.0	132
L-21 115	542	29.55	34	5.1	107
L-247	729	29.72	33	5.0	107
Lesaf-74/9	458	29.00	34	5.0	120
Lesaf-244	792	30.06	29	5.5	118
Lesaf-246	542	30.90	27	5.7	118
Lesaf-247	521	29.48	30	4.9	106
NA-132	625	28.97	31	5.0	117
NAO-5518	458	29.44	3.2	5.1	122
SAF-1	688	30.39	33	5.0	123
SPS-6912	750	31.03	31	4.8	121
Thori-78	625	32.07	32	4.9	109
XJH-39	854	31.50	29	5.5	123
CV (%)	018	7.3	15	9.2	007
$LSD_{(0.0b)}$	160	3.1	07	1.0	012

Muralidharudu *et al*. (1989) Salera and Megale (1989) and Musa and Munoz (1990). On the basis of performance in yield, capsule per plant and oil content during rabi 1992-93, XJH-39, is the entry best adapted to barani conditions. Lesaf-244, SPS-69/12, L-247, Gilla-19 and Thori-78 could also be considered good for dual purpose cultivation i.e., high seed cum oil production under rainfed conditions.

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