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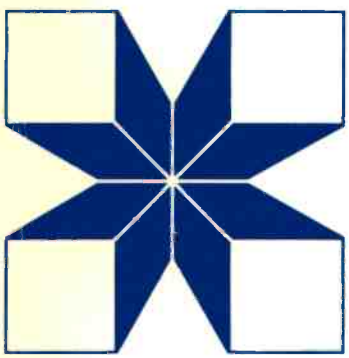

CANADA

OIL CROPS: SESAME AND SUNFLOWER SUBNETWORKS

PROCEEDINGS OF THE JOINT SECOND WORKSHOP HELD IN CAIRO, EGYPT, 9–12 SEPTEMBER 1989

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La présente série est réservée aux documents issus de colloques, aux rapports internes et aux documents techniques susceptibles d'être publiés plus tard dans une série de publications plus soignées. D'un tirage restreint, le rapport manuscrit est destiné à un public très spécialisé.

Esta serie incluye ponencias de reuniones, informes internos y documentos técnicos que pueden posteriormente conformar la base de una publicación formal. El informe recibe distribución limitada entre una audiencia altamente especializada.

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OIL CROPS:
SESAME AND SUNFLOWER SUBNETWORKS

Proceedings of the Joint Second Workshop held in Cairo, Egypt, 9–12 September 1989

Edited by
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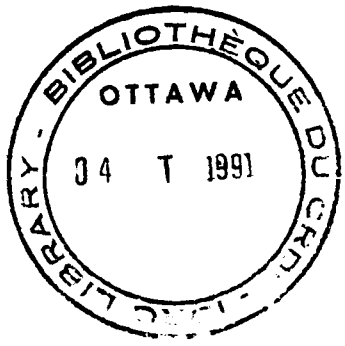

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FOREWORD

In September 1989, the Sunflower and Sesame subnetworks held their bi-annual meetings in Cairo, Egypt. The meetings were well attended and papers, presented in these proceedings, provide a very informative overview of some of the cropping systems, management practices, production constraints and research highlights for both crops in several countries.

Chronic edible oil deficit is a major problem facing many developing countries in Africa and Asia where most countries are forced to import large quantities to satisfy the requirements of their growing populations. With the present rates of population increase and the improvement of nutrition standards it is likely that the consumption of edible oil will rise over the years, increasingly drawing on scarce foreign exchange for the importation of this vital food staple. For this reason, several countries have opted to increase self-sufficiency in edible oil.

Production deficits are due to a number of factors, among which neglect in oilcrops research, in both developed and developing countries has been a major one. This is particularly true for minor crops such as sesame. In the context of the IDRC oilcrops network, initiated in 1981, the interchange of information and the sharing of results between scientists have proved to be very useful and beneficial for the generation of scientific knowledge and the stimulation of research in this important area. It is hoped that conclusions and recommendations of this meeting will stimulate further research and development in the future.

A second important reason for limited national production has been the exceptionally low levels of world prices for oils and fats in the 1980's and the comparative advantage of importation over production for developing countries. The description of a case study using a system's approach to analysis the Vegetable Oil/Protein System of Kenya has stirred much interest during the Cairo meetings and it is hoped that similar work can be carried out in other countries in the future.

The Cairo meetings will also unfortunately be remembered as the one which has witnessed the diagnosis of the fatal disease of late Dr. Hiruy Belayneh, Chairman of the Brassica Subnetwork. We will all regret his absence.

On behalf of IDRC and of all participants, I would like to thank the Government of Egypt for its hospitality, the organizers for the excellent arrangements and all those who contributed to the success of these meetings by their presentations and discussions.

Eglal Rached,
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IDRC, Cairo

CONTENTS

EFFECT OF MATURITY STAGES AND DESICCANT APPLICATION ON YIELD, OIL CONTENT AND OIL QUALITY OF SUNFLOWER

Masood A. Rana, Chaudhry A. Ozair, M. Ayub Khan and Shafiullah

Abstract

The effect of stages of maturity and desiccant applications on the sunflower (***Helianthus annuus*** L.) seed yield, oil content and oil quality were studied during 1988 and 1989. Stages of maturity were maintained by five dates of harvest with 5 days interval at 25, 30, 35, 40 and 45 days after flower completion (DFC). Four desiccant treatments (Paraquat at 0.50 kg ai/ha; Paraquat at 0.25 kg ai/ha + Agral-90 at 0.02 v/v) and one control treatment (without desiccant) were studied. The desiccants were applied seven days before each date of harvest.

By delaying harvest from 25 to 35 DFC the seed yield increased significantly from 1980 to 2391 kg/ha, and from 2629 to 3279 kg/ha in 1988 and 1989, respectively. No significant increase in seed yield was obtained after 35 DFC in both years. 100-seed weight increased significantly from 25 to 40 DFC in 1988, and from 25 to 30 DFC in 1989. Between 25 and 45 DFC the seed moisture reduction was 38. 1% (51.2 to 13.1%) in 1988, and 34.8% (43.1 to 8.3%) in 1989. The seed oil content significantly increased from 36.5% to 41.1% between 25 and 40 DFC in 1988, and from 43.8 to 49.0% between 25 to 45 DFC in 1989. Oleic acid contents reduced significantly from 56.9 to 49.1% in 1988 but no significant change was observed during the same period in 1989. In 1988, linoleic acid contents increased significantly from 35.0% to 43.3% between 25 and 35 DFC, and in 1989 from 41.2 to 45.0% between 30 and 45 DFC.

The effect of desiccant treatments on seed yield and other characters were not very pronounced. In 1988, Paraquat at 0.5 kg ai/ha with Surfactant increased the seed yield by 103 kg/ha over the control which was 2283 kg/ha. Fomesafen, in 1988, at 1.0 kg/ha increased 100-seed weight significantly and reduced the seed moisture content, but the reductions were not much. Paraquat at higher dose reduced the oil contents during both years over the control. In 1989, Paraquat at both concentrations reduced the oleic acid by 4.5-5.0% and increased the linoleic acid by 4.4-4.5%.

Key words: Sunflower, *Helianthus annuus*, maturity stages, date of harvest, desiccant application, oil quality, seed yield.

In irrigated regions, attempts are being made to realize high field efficiency for making more income per unit area per annum. In order to achieve this, growers are frequently dragged into a situation where harvesting of the existing crop and planting of the next crop overlap with each other. Consequently, it results in yield losses of the preceding crop due to early harvesting, and following crop due to the delayed planting. Manipulation of appropriate crop production technology and execution of high management skills are therefore, required to handle such situations. Planting of short duration varieties, use of desiccants, mechanized harvesting and planting strategies are imperative for receiving high returns from the crops involved in the intensive cultivation systems.

Use of desiccants is an established practice in some crops where mechanical harvesting and uniform ripening is a prime desire. In situation as stated above, it has become rather more important to harvest the crop at the earliest possible date, but without taxing the yield, to allow timely planting of following crop. Such decisions would be based on the knowledge of crop maturity time coupled with the use of appropriate desiccants. In USA, different doses of Dimethipin (1,2,3-dihydro-5, 6-dimethyl-1, 4-dithin-1, 1,4, 4-tetraoxide) were used as desiccant on sunflower and found that crop maturity was enhanced (1,2)

without the loss of yield, oil content and quality. Similar results were reported from France (9).

Diquat (6, 7-dihydrodiphyrido [1,2-a:2,1-c] pyrazinediium ion) has also been used successfully as harvest aid in sunflower (8). It has been reported that physiological maturity in sunflower was attained when seed moisture content ranged between 36-40% (3,7), and required 35 days after flower initiation (7) or 25 days after flower completion (6).

In Pakistan, such registered chemicals are not available in the market, except the "Bipyridinium", Paraquat, which is mainly used as non-selective herbicide in potatoes. Fomesafen is another post-emergence nonselective broad-leaf sensitive herbicide, which has a contact type mode of action and has more or less disiccation property. Fomesafen is an ICI product submitted to the Plant Protection Dept. for registration as post emergence herbicide. It is likely to be marketed some time in 1990. It was therefore, decided to initially include these two chemicals in our present study. Cost efficiency of the desiccants was also considered by reducing the rate of the chemical to half strength, and simultaneously increasing their uptake and subsequent activity by adding low cost non-ionic surfactant, Agral-90. Objectives of this study were to find out the earliest stage of maturity where sunflower could be harvested without considerable loss of yield, and to test the desiccants available in the local market for their effect to enhance the maturity, yield, oil content and quality.

Materials and Methods

The study was conducted at the National Agricultural Research Centre (NARC), Islamabad (33° 40N 73° 08E) Pakistan. The field trials were planted on February 7 and 10, in 1988 and 1989, respectively. The daily maximum and minimum temperatures and precipitation from May 1 to June 20, during 1988 and 1989 (as recorded by the Meteorology Department of NARC) along with the date of flower initiation (DFI), date of flower completion (DFC), date of first harvest (DFH) and date of last harvest (DLH) are given in Fig. 1.

The trials were maintained according to the local production recommendations. Fertilizer was applied at the rate of 120 kg N + 60 kg P_2O_5/ha at the time of seed bed preparation. The plots were irrigated twice, first at head initiation stage and later at the time of flower completion.

Stages of maturity were maintained by different dates of harvest, keeping DFC as reference point. Five dates of harvest treatments were super imposed with two desiccant applications each with two rates and one control treatment (without desiccant application) in a split plot design in which dates of harvest were arranged as main plots and desiccant application in subplots. The experiment was replicated four times. Desiccant treatments were applied in 5-days interval at 18, 23, 28, 33 and 38 days after DFC, Table 1.

Calibrated doses of the desiccants were thoroughly mixed into a known volume of water, used as diluent. The desiccants were sprayed on sunflower foliage using aluminum ladder for a uniform coverage. Solid-cone type brass nozzle was mounted on a knap-sack type manual sprayer to achieve complete wetting of the foliage. Harvesting was done seven days after each desiccant application, i.e. at 25, 30, 35, 40 and 45 DFC, Table 2. The DFC was standardized when about 95% of the floral buds/plot were opened to initiate anthesis.

Drying and burning effects of the desiccant treatments were recorded daily by visual observations after

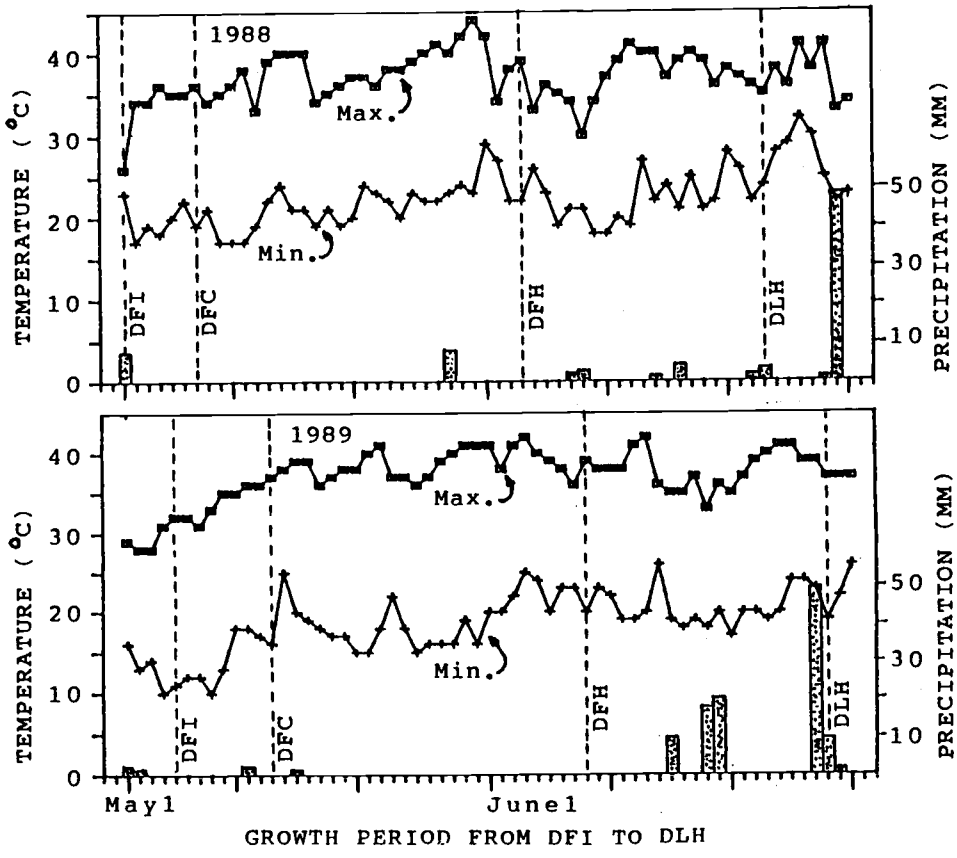

Fig. 1. Daily minimum and maximum temperature and precipitation from May1 to June30, showing date of flower initiation (DFI), date of flower completion (DFC), date of first harvest (DFH) and date of last harvest (DLH) during 1988 and 1989.

Table 1. Desiccation treatments, applicaton rates, common and chemical names of the desiccants followed by their formulated activity.

Treatment	Rate used (kg ai/ha)	Common name	Chemical name	Formulation (kg ai/ha)
Paraquat	0.50	Gramaxone	1:1-Dimethyl-4,4- Bipyridinium (cation) dichloride	20% AS
Paraquat + S*	0.25			
Fomesafen	1.00	Flex	5-[2-chloro-4-(trifluoromethyl) Phenoxy] -N- (methyl-sulfonyl) -2- nitrobenzamide	21% EC
Fomesafen + S*	0.50			
Control			No desiccant was applied	
Note: Adjuvant (surfactant)		Agral-90	[900 g/l alkyl phenol ethylene oxide condensate]	87% W/W 2% V/V

* Herbicides used as disicant, mixed with the non-ionic surfactant "Agral-90" to enhance the efficacy of the product.

Source: 1. Thomson, W.T. 1984. Agric. Chemicals-Book II. Thompson Publications, Fresno, ca 93791.
2. Agral. 90, Tech. bulletin, ICI, Plant Protection Unit, Fernhurst tasemere survey, England.

Table 2. Average of two years effect of maturity stages on yield, seed test weight, moisture contents and oil quality of sunflower.

Days after flower Completion	Yield (kg/ha)	% gain	100seed weight (g)	% gain	Seed moisture (%)	% loss	Oil content (%)	% gain	Palmitic acid (%)	% gain(+) loss(-)	Oleic acid (%)	% gain loss	Linoleic acid (%)	% gain
25	2305		6.22		47.1		40.2		5.8		51.5		39.5	
30	2645	14.8	7.12	14.5	35.3	25.5	43.1	7.2	5.8	0.0	50.3	2.3	40.5	2.8
35	2838	23.1	7.67	23.3	24.1	48.8	43.7	8.7	5.6	-3.4	48.9	5.0	43.4	9.9
40	2813	22.0	7.90	27.0	16.2	65.6	44.2	10.0	6.1	+5.2	48.7	5.4	43.2	9.4
45	2850	23.2	7.91	27.2	10.7	77.3	44.8	11.4	5.7	-1.7	48.0	6.8	43.6	10.4
LSD (0.05)	81		0.21		0.8		0.6		0.3		0.9		0.9	
CV (%)	6.85		6.46		7.1		2.9		10.6		4.0		4.6	

each application upto the day of harvest of each treatment.

The size of the sub-plot was 3x5 m (4 rows, each 5 m long and 0.75 m apart). Sunflower hybrid NK-212 was planted, and the plants were spaced 25-30 cm apart within the rows. Two central rows were harvested to assess the seed yield. The plots were harvested and threshed manually and seeds were sun-dried for 12 days before the weights were recorded for yield measurements on plot basis. The seed yields were converted and reported in kg/ha and adjusted at 9% moisture content by using a moisture meter. The 100-seed weight was obtained as an average of three samples/plot from each of the four replications. Moisture content of the seed at the time of harvest was determined by the formula (A-B)/A where A = fresh weight of seed sample drawn from each plot at harvest, and B = dry seed weight obtained by drying the same sample in a forced air oven at 70° C for 120 hours.

The oil content was reported as an average of two seed samples per plot from each of the 4 replications. It was measured by a Nuclear Magnetic Resonance (4). A Newport NMR, model: Oxford 4000 was used and oil contents were reported at zero percent

moisture content. The fatty acid composition was measured by a Shimadzo Gas Liquid Chromatograph (GLC), Model GC-9A. A 2.1 m x 3.2 mm glass column packed with 3% SP 2310/2% SP 2300 coated chromosorb WAW on 100/120 mesh was used for the analyses. The column oven was operated at 230°C. Methylating solution of 4g metallic sodium prepared in 500 ml methanol was used for preparing methyl-esters of oil.

Results

Stages of maturity

The effect of stages of maturity on the seed yield was highly significant during both the years. Seed yield increased significantly from 25 to 35 DFC, Table 2 and Fig 2a. The increase of 417 kg/ha (from 1980 to 2397 kg/ha) in 1988, and 650 kg/ha (from 2629 to 3279 kg/ha) in 1989 were obtained within these 10 days. In 1988, seed yield steadily increased upto 45 DFC but the increase after 35 DFC was small and non-significant. On the contrary, during 1989, the seed yield slightly decreased after 35 DFC but it was non-significant. The mean seed yield of 3080 kg/ha for 1989 was significantly higher than the mean seed yield of 2300 kg/ha for 1988.

In 1988, the 100-seed weight increased significantly and rapidly from 6.37 to 8.53 g between 25 and 40 DFC but the increase in seed weight after 40 DFC was slow and non-significant. On the contrary, in 1989, seed development was rapid (from 6.08g to 6.96g) between 25 and 30 DFC, gradual (from 6.96 g to 7.20 g) between 30 and 35 DFC and plateaued thereafter, Fig. 2b. The 100-seed weight of 7.79g was significantly more in 1988 than that of 6.94 g in 1989.

Seed moisture reduced significantly, during both years and the moisture reduction was steady and continuous from 25 DFC to the last date of harvest (45 DFC), Fig 2c. In 1988, the moisture content of seed on 25 DFC was 51.2% which was reduced to 13.1% on 45 DFC, registering a 38.1% reduction during these 20 days. Similarly, in 1989, the moisture content of seed on 25 DFC was 43.1% which was reduced to 8.3% on 45 DFC, registering a 34.8% reduction in seed moisture was obtained during this period. On the average of both years, the seed moisture contents reduced by 23% during the first 10 days (25to 35 DFC), about 8% between 35 and 40 DFC and 6% between 40 and 45 DFC. Mean moisture content of 30.7% in 1988 was 8.0% higher than that of 22.6% in 1989.

During 1988, the oil content of seed significantly increased from 36.5% to 41.1% between 25 and 40 DFC, and thereafter reduced non-significantly. In 1989, the oil content increased rapidly and significantly from 43.8% to 47.4% between 25 and 30 DFC, and thereafter, almost no change was observed until 40 DFC. However, during the last 5 days (from 40 to 45 DFC), once again, a significant increase in oil content was obtained, Fig. 3a. Mean oil content of 39.4% in 1988 was significantly less than that of 46.9% in 1989.

Palmitic acid concentration changed significantly due to stages of maturity during both the years, Fig. 3b. However, the changes were minor and there existed no definite trend or direction in accordance to the stages of maturity from 25 to 45 DFC. Oleic acid contents reduced significantly from 56.9 to 49.1 between 25 and 45 DFC in 1988, whereas no significant change was observed in 1989 during the same period, Fig. 3c. In 1988, linoleic acid content increased significantly from 35.0 to 43.3% between 25 and 35 DFC, and reduced to 41.5% between 35 to 40 DFC and, once again, increased to 42.2% between 40 and 45 DFC. In 1989, linoleic acid reduced significantly between 25 and 30 DFC, and thereafter, it increased

continuously until 45 DFC but linoleic acid content of 45.0% at 45 DFC was not significantly different from that of 43.5% at 35 DFC, Fig. 3d.

Desiccant application

Paraquat at both concentrations burnt the sunflower leaves within 2-3 days after its application, whereas Fomesafen did not dry the leaves. However, yellow speckles, leaf chlorosis and leaf brittleness was evident and such desiccating effects were unique and different from the usual plant senescence.

Desiccant treatments did not dry the plant stem or capitulum and no obvious signs of induced drying (desiccation) appeared on them. These plant parts were identical in color and appearance to the untreated check. The effect of desiccant applications on the seed yield was not pronounced. The desiccant treatments did not significantly influence the seed yield in 1989. In 1988, Paraquat when applied with Surfactant (0.5 kg ai/ha + Agral-90 0.02 v/v) increased the seed yield significantly over the check, while the seed yields obtained from all other treatments, during the same year were not significantly different from that of the control, Table 3.

In 1988, Fomesafen applied at 1.0 kg ai/ha, significantly increased the 100-seed weight over the control. However, all other desiccant treatments during the same year were not significantly different from the check.

Desiccant applications remained non-significant to affect the 100-seed weight in 1989, Table 3.
In 1989, the desiccant treatments did not reduce the seed moisture contents significantly. On the contrary, during 1988, Fomesafen applied at 1.0 kg ai/ha reduced the seed moisture contents significantly over the control. The 1.3% reduction, however, was negligible, Table 3.

The desiccant treatments affected the oil contents and fatty acids very little though the changes in both years were significant, Table 4. In 1988, Fomesafen at the rate of 1.0 kg ai/ha increased the oil contents by 0.9% while Paraquat at the rate of 0.5 kg ai/ha reduced the oil contents by 0.9%. During 1989, Fomesafen did not afect the oil contents significantly but Paraquat at both concentrations, irrespective of the added Surfactant, reduced the oil contents. Paraquat at higher concentration reduced the oil content by 2.2% and at lower concentration by 0.9% as compared to the control.

Table 3. Effect of desiccant application on yield, 100-seed weight and moisture contents of sunflower.

Disccant	Yield (kg/ha)			100 seed wt.(g)			Seed moisture (%)		
treatment	1988	1989	Avg.	1988	1989	Avg.	1988	1989	Avg.
	--------(kg/ha)------			----------(g)---------			---------(%)---------		
Paraquat	2270	3019	2645	7.67	6.64	7.16	30.6	22.8	26.7
Paraquat + S*	2386	3185	2785	7.65	6.91	7.28	31.7	22.9	27.3
Fomesafen	2334	3125	2729	8.07	7.03	7.55	29.7	22.6	26.2
Fomesafen + S*	2226	2997	2611	7.75	7.13	7.44	30.5	22.5	26.5
Control	2283	3074	2678	7.81	6.99	7.40	31.0	22.4	26.7
LSD (0.05)	66	N.S	81	0.25	N.S	0.21	0.8	N.S	N.S
Year mean	2300	3080		7.79	6.94		30.7	22.6	
LSD (0.05) for year mean	88.7			0.32			0.8		

* Agral-90 was used as Surfactant.

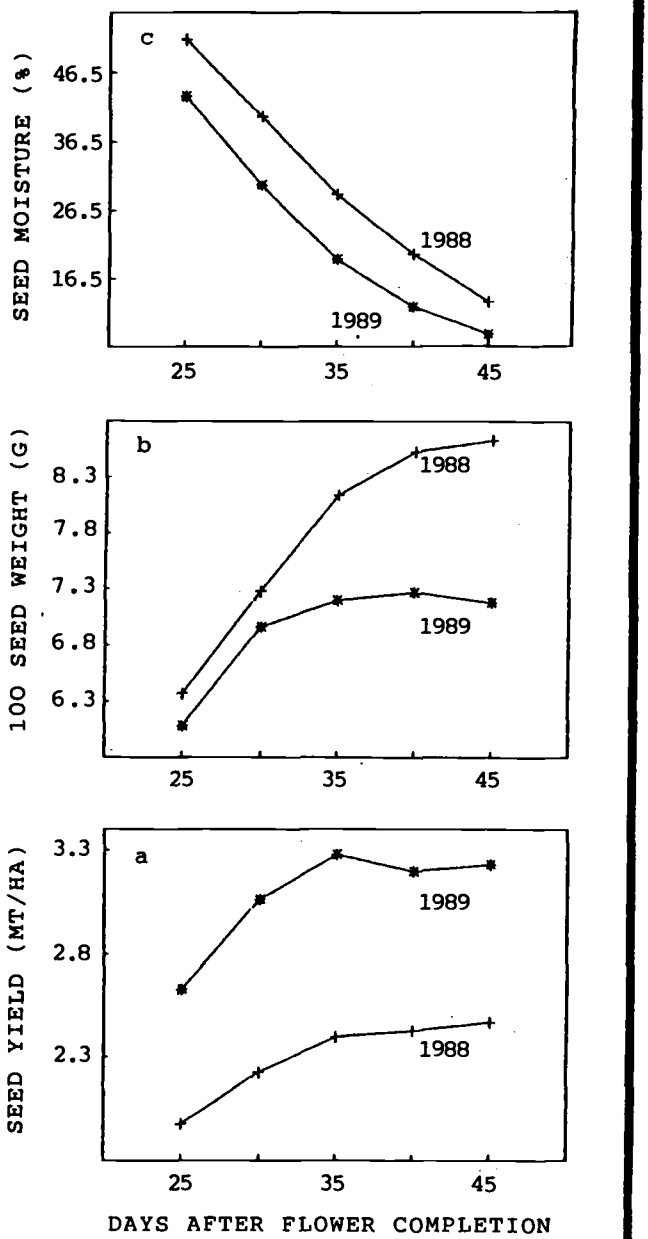

Fig. 2. Effect of stages of maturity on seed yield, 100 seed weight and seed moisture content of sunflower during 1988 and 1989.

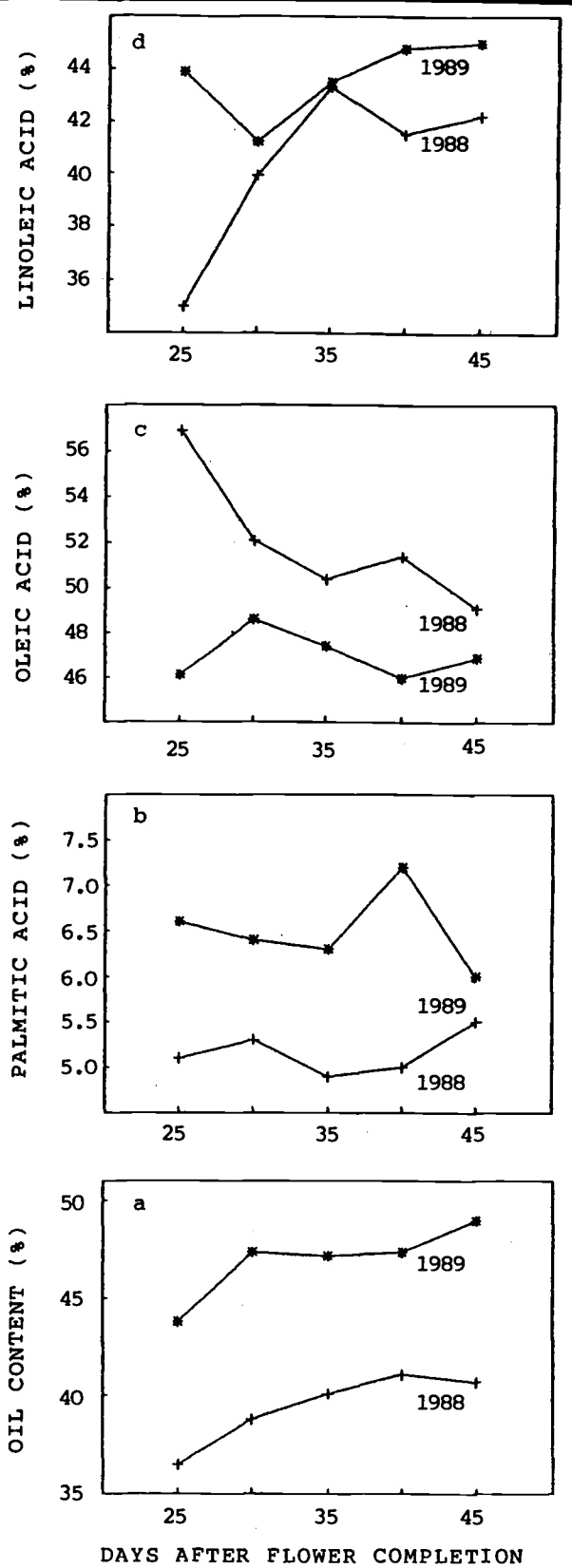

Fig. 3. Effect of stages of maturity on oil content and fatty acid composition (palmitic, oleic and linoleic) of sunflower during 1988 and 1989.

Fomesafen at the rate of 1.0 kg ai/ha reduced the palmitic acid significantly over the check and the remaining treatments reflected similar palmitic acid contents as expressed in the check, Table 4. Both the treatments of Paraquat significantly reduced the oleic acid contents during both years as compared to the check (1.3-1.0% in 1988, and 4.5-5.0% in 1989). On the contrary, both treatments of Fomesafen significantly increased the oleic acid contents (0.9 and 1.3%) over the check in 1988 while no significant increase was obtained in 1989, Table 4. Paraquat treatments increased linoleic acid contents

Table 4. Effect of desiccant application on oil contents and quality of sunflower during 1988-1989.

Disccant	Oil content			Palmitic acid			Oleic acid			Linoleic acid		
treatment	1988	1989	Avg.	1988	1989	Avg.	1988	1989	Avg.	1988	1989	Avg.
	----------					-%						
Paraquat	38.5	45.4	41.9	5.3	6.7	6.0	50.7	43.8	47.2	41.8	46.2	44.0
Paraquat + S*	39.6	46.7	43.2	5.2	6.6	5.9	51.0	44.3	47.6	41.4	46.3	43.9
Fomesafen	40.3	47.5	43.9	4.9	6.2	5.6	52.9	48.5	50.7	39.4	42.5	41.1
Fomesafen + S*	39.4	47.4	43.4	5.1	6.4	5.7	53.3	49.7	51.5	39.1	41.7	40.4
Control	39.4	47.6	43.5	5.2	6.5	5.9	52.0	48.8	50.4	40.0	41.8	40.9
LSD (0.05)	0.7	0.9	0.6	0.2	N.S	0.3	0.8	1.5	0.9	0.7	1.5	0.9
Year mean	39.4	46.9		5.2	6.5		52.0	47.0		40.4	43.7	
LSD (0.05) for year mean	0.8			0.3			0.9			1.1		

* Agral-90 was used as Surfactant.

significantly over the check during both years (1.4-1.8% in 1988, and 4.4-4.5% in 1889). Fomesafen at 0.5 kg ai/ha with Agral-90 reduced the linoleic acid contents (0.9%) over the check during 1988 but no evident effect of both treatments of fomesafen was observed during 1989, Table 4.

Discussion

Delaying the harvest for 10 days from 25 to 35 DFC has significantly increased the seed yield. The seed yield gains during this period were 21.1 and 24.7% in 1988 and 1989, respectively. However, no significant increase in seed yield was obtained after 35 DFC during both years, indicating the stage of physiological maturity as defined by Anderson (3). Whereas physiological maturity was reported (6) just at 25 DFC. The seed moisture contents on 35 DFC were 28.9% in 1988 and 19.4% in 1989. Suggestively, seed moisture content range of 30 to 20% can be used as a good indicator of the physiological maturity of sunflower. Contrary to our results, physiological maturity was reported (7) at 35 days after flower initiation when moisture contents of the seed was about 36%.

The 100-seed weight increased significantly upto 40 DFC. Our results are in contrary to those of (3) who obtained highest dry seed weight at 35 days after flower initiation.

Increase in seed yield, in general, corresponded to the trends of increase in 100-seed weight during both years. However, 100-seed weight in 1988 was higher than that of 1989 which was a reverse situation for seed yield. Lower seed yield, in 1988, having bigger seed size can be explained by the lower seed set per capitulum. As such, it resulted in lower competition for the allocation of photosynthates per seed per capitulum. In turn, the seeds gained larger size. For the same reason, during 1988, the seed growth was more steep and it continued to gain weight

till the last date of harvest. However, it failed to influence the seed yield with the same magnitude and steepness because of lower total number of seeds per head. It was also reported (5) a negative correlations between 1000-seed weight and seed yield in two different seasons.

The lower seed set, in 1988, was expected due to the high temperature during the anthesis period. The maximum temperature on the day of flower initiation was 26°C which immediately rose to 34°C on the following day and it went upto 35 and 36°C, and prevailed up until flower completion. The minimum temperatures were also higher in 1988 and varied from 17 to 23 °C during anthesis period, Whereas in 1989, the maximum temperature was 32 °C on the day of flower initiation, and it gradually increased to 35 °C during the flower completion period, Fig. 1. During the same period the minimum temperatures were between 11 °C and 18 °C which were considerably lower than those of the previous year. Growing degree days (GDD) received within the experimental years also seemed to influence the seed yield. GDD is calculated as: [(Max.-Min. temp)/2]-3.1 °C] Total GDD received from planting to flower initiation and onwards to last harvest were more in 1988 than in 1989, Table 5.

Table 5. Dates of desiccant application and harvesting, growing degree days (GDD) from flower initiation (FI) to date of last harvest (DLH) and precipitation received from date of planting (DP) to last harvest.

Year	Date of desiccant application	Date of harvest	Growing Degree Days DP to FI	FI to DLH	Total	Precipitation PD to LDH (mm)
1988	May 27	June 3	1189	1529	2718	236
	June 1	June 8				
	June 6	June 13				
	June 11	June 18				
	June 16	June 23				
1989	June 1	June 8	1112	1382	2494	187
	June 6	June 13				
	June 11	June 18				
	June 16	June 23				
	June 27	June 28				

Most of the oil-filling (upto 40%) took place by 25 DFC, and the remaining 3-4% of oil was filled between 25-30 DFC and thereafter the increase in oil content was negligible. Our results are in agreement to (7) who obtained about 50% oil in 28 days after flower initiation (DAF) and 53% oil at 35 DAF.

Among the fatty acids, oleic acid contents changed appreciably at different stages of maturity in 1988, and did not change much during 1989. Oleic acid contents reduced by enhanced maturity whereas the linoleic acid contents changed in the reverse order of oleic acid, i.e., it increased with the enhanced maturity. Similar results were reported, (7).

Drying of the leaves due to Paraquat application is considered as an aid for the mechanical harvesting of sunflower. But, green stem and head pith at 35 DFC could still offer a considerable problem for proper threshing and cleaning of the crop during combine harvesting. Desiccant treatments did not considerably reduce the seed moisture contents either. These results are contrary to those of (2) who reported about 7% reduction in seed moisture contents as compared to the untreated check

even after 10 days of desiccation with Harvade 5F.

Although the effect of desiccation on seed yield, 100-seed weight and oil contents at some treatments were significant, but they were small and unpronounced. Increase in yield due to desiccant application as compared to the control ranged from 51 to 117 kg/ha. Decrease in oil content ranged from 0.9 to 2.2% and decrease in 100-seed weight ranged from 0.08 to 0.35 g. These results are in agreement with (2) who reported that desiccant application at higher doses reduced the oil content from 0.9 to 1.2% without any effect on seed weight.

The effect of desiccant on oil content seems to be influenced by the moisture content of seed during its development and maturity process. In 1988, when seed moisture content was 6-9% higher than that of 1989, the desiccant treatments either slightly increased the oil content or when reduced, the reduction was not much. On the contrary, in 1989, when the seed moisture content was relatively lower, all the desiccant treatments reduced the oil content and the significant reduction values were more than those of 1988.

Conclusion

There was no significant increase in seed yield after 35 DFC. And since desiccant application did not reduce the seed yield, the induced maturity before 35 DFC rather than after, may help early harvest without yield loss. Harvesting at 35 DFC may reduce the oil contents by about 1.0% which could otherwise be gained by delaying the harvesting upto 45 DFC. But vacating the fields 10 days earlier is of greater interest and is desirable than harvesting the last 1.0% of the oil. No loss of oil quality was found beyond 35 DFC.

Paraqquat is a better desiccant than Fomesafen as it helped drying and burning of the leaves at both concentrations within 2-3 days of its application. Fomesafen did not induce drying or burning of the leaves. Both the desiccants failed to reduce the seed moisture contents, even when they were applied at later stages of maturity within seven days of their application. It is therefore, suggested that desiccants should be applied more than seven days before the crop is harvested.

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