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FOREWORD

One more issue of the Sesame and Safflower Newsletter has been completed, the third since the FAO expert consultation recommended its publication. I apologize the small delay this year due in part to several articles which had been announced in advance and arrived late.

The level of participation in this issue has been even better than in the last one, with a total of 20 reports and articles of different length (15 in 1986) and 24 abstracts of published papers (22 in 1986). A very reduced number of received abstracts were not included because were published several years ago although exceptionally I included some relatively old material that I considered of interest. I have also included, for the same season, articles, with excessive length with only minor trimmings.

It has been maintained, in general, similar structure to that of the first two issues. However, I have included a complete list of experts and institutions which incorporates the lists of preliminar issues in order to facilitate the preparation of an updated list in the future.

There is an important new, in relation to the newsletter, appeared in the Oil Crops Newsletter № 4 published by IDRC. An agreement has been reached by FAO and IDRC to combine both newsletters in a new FAO/IDRC Oil Crops Newsletter which should enhance the standard of both publications and ensure that there is not duplications. Instructions for contributions in the future, given in the IDRC Newsletter, can be found in this Newsletter in Notices to readers.

As editor of the last two issues of the Sesame and Safflower Newsletter I wish to thank to all contributors and to many of the experts who sent letters of encouragement and suggestions to improve the Newsletter. Grateful acknowledgments are made to Dr. C. Pineda of the FAO who, as in previous issues coordinated the obtention of contributions, for his suggestions and interest to enhance the level of the Newsletter. Finally I wish to thank Miss Mª. José Bascón for the typing and preparation of the manuscript.

J. Fernández Martínez, Editor
NOTICES TO READERS

Future editions of the Newsletter

An agreement has been reached by FAO and IDRC (Oilcrops research) to combine efforts and publish a FAO/IDRC Oil Crops Newsletter in the future. This Newsletter will appear in 1988 combining the Sesame and Safflower Newsletter and Oilcrops Newsletter published by IDRC in only one publication. Contributions, of sesame and safflower specialists, to be published in the new Newsletter can be sent to either

1) Dr. C.R. Pineda
   Agricultural and Industrial Crops Officer
   FAO
   Via delle Terme di Caracalla
   00100 Rome, Italy

or 2) Dr. Abbas Omran
   Oilcrops Network Adviser
   Holetta Research Center
   P.O. Box 23464
   Addis Ababa Ethiopia

The contributions (Reports, news, letters, articles, abstracts etc.) should not exceed 5 pages typewritten, double-spaced.

Note on the second International Safflower Conference

In the second 'Sesame and Safflower Newsletter' we expressed the expectation of being able to hold the Second International Safflower Conference in 1988. This will not be possible. Several of you have contacted me about this. As plans develop, and once a venue has been finalized, we would like to contact all interested safflower workers. To facilitate this, please indicate your interest, including your subject matters of main involvement. Also, from the current lists, we cannot tell whether your are working on safflower or sesame. Please indicate which. If your name, research area (also: extension, processing and marketing), and address are submitted for the newsletter, you will receive updated information as it becomes available.

H. Henning Muendel
Plant Science and Research Station
P.O. Box 3000
Main Lethbridge, Alberta
Canada
Note on the Intercountry variety adaptation trials

AGPC/FAO inform in relation to the Intercountry sesame/safflower variety adaptation trials that the seed received last year will be multiplied by several institutions in 1988 in order to have enough quantities for trials. Seed will be distributed by these institutions in 1988 to all interested experts.

Registration of Lesaf 175 Safflower Germplasm Line (Crop Sci. 27:369-370), 1987.

This high oil, rust resistant, moderately early maturing, striped hull selection, originating from the cross PCA/Lesaf 34B (white), was developed at the Agriculture Canada Research Station at Lethbridge, Alberta in Canada, and released in April 1986. Small seed samples are available for research purposes upon written request, which should include an agreement to appropriately acknowledge the source in publications resulting from the use of this material. Seed requests should be addressed to the Plant Gene Resources of Canada, Building 75, Agriculture Canada Plant Research Center, Ottawa, ON K1A 0C6, Canada, indicating accession number PGR 17208. H.H. Muendel

Release of two new safflower lines bred at Griffith, New South Wales

Two new disease-resistant safflower varieties, Sironaria and Sirothora have been registered and will be available for commercial production during 1987-88.

The varieties originated from the breeding program at the Centre for Irrigation and Freshwater Research at Griffith, which set out to develop new varieties resistant to Alternaria and Phytophthora(1).

Sironaria will do well in areas of known Alternaria leaf blight infection. This is mainly in the northern areas where hot, humid weather is more frequent, but results from trials have shown that leaf blight is present in all states. Sironaria is also tolerant to Phytophthora root-rot(2).

Sirothora is recommended for irrigation areas and should be grown on raised bed systems. The heavy soil types should suit this variety. It is susceptible to Alternaria leaf blight and would be better suited for southern districts(3).
Both varieties have been assessed in trials in Queensland, New South Wales, South Australia and Victoria. Before this, the varieties were subjected to experimental flooding at Griffith under extremely hot conditions during irrigation to establish that they would survive under commercial production.

The origin of Sironaria is from a complex of crosses involving selections from Poland and Iran, with Gila, the most successful Australian variety(4).

It is similar to Gila in plant type, seed colour and size, hull percentage, seedling vigour, leaf and bract spininess and flower colour. On average it is three centimetres taller than Gila.

Sirothora is from crosses of selections from Ethiopia and Turkey with Gila. Its plant type, seed colour, seedling vigour, leaf and bract spininess and flower colour resemble Gila but at maturity it is, on average, six centimetres shorter. Sirothora matures slightly later than Gila.

Commercial certified seed production of these two varieties was made during 1986.

Basic seed distribution will be organised by a committee with representatives from the NSW Department of Agriculture, the certified seed producers, the private seed companies and CSIRO. The distribution of seed will be co-ordinated by John Sykes, NSW Department of Agriculture, Dubbo.

Sironaria and Siro Thora were bred by

Dr. K. Harrigan, CSIRO,
Griffith, NSW 2600

Sesame - F2 and Advanced generations seeds for distribution

I have seeds for distribution from many crosses between various introduced cultivars and the determinate mutant, and between the various cultivars themselves. The seeds are F2 and more advanced generations. Those interested can obtain seed sample upon request. Please specify main breeding objectives to help us choose suitable hybrid combinations.

Please write to me, as follows:

Prof. A. Ashri
The Hebrew University
Faculty of Agriculture
P.O. Box 12
Rehovot, 76100 Israel
Sesamum genetic resources

The IBPGR together with the FAO recently found a way to carry out the recommendations of the FAO Expert Consultations held in Rome (1980) and Viterbo, Italy (1984) to expand the germplasm collection of Sesamum. I was given a modest grant to assemble as complete a collection as possible of the cultivated and the wild species. The materials will be characterized and increased, and the seeds will be shared with all interested investigators and stored.

I am asking everyone working with sesame to send me small samples (ca. 200-300 seeds) of all the materials which they have, i.e. local land races, improved local cultivars, introduced materials and wild Sesamum species if available. Please send the seeds together with "passport data", other information if available and phytosanitary certificate. The seeds can be sent directly to me as follows:

Prof. Amram Ashri  
c/o Mr. M. Zur  
Plant Introduction Division  
Volcani Center  
P.O. Box 6  
Bet-Dagan, 50250  
Israel

or, via IBPGR, as follows:

Prof. A. Ashri  
c/o Ir. D.H. van Sloten  
IBPGR, FAO  
Via delle Terme di Caracalla  
00100 Rome  
Italy

If anyone can help by sending details of researchers, botanists etc., especially in Africa who may be able to assist in collecting seeds of wild Sesamum species, it would be much appreciated.
CYTOGENETIC STUDIES IN SESAME (Sesamum indicum L.)
I. KARYOTYPE ANALYSIS

Zhan Yingxian, Cheng Ming, Wu Aixhong
(Beijing Agricultural University)

Karyotype analysis is first one paper of a series of our cytogenetic research works in sesame (Sesamum indicum L.) with the purpose of identifying the morphological characteristics of each chromosome by modified squash technique using a local variety called Beijing Ba-Wang-Bian as material. The results may be concluded as follows:

1. The sesame karyotype (Fig. 1) is 2n = 2x = 26. Among 13 pairs of homologous chromosomes, one pair which carries satellites is listed at last in karyogram (Fig. 2) and idiogram (Fig. 3).

Fig. 1. Sesame karyotype (B reverse photo from A)

Fig. 2. Sesame karyogram
Table 1. The morphological indices of chromosome in sesame (*Sesamum indicum* L.)

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>Chromosome length = long arm (L) + short arm (s) (m)</th>
<th>Relative length (%)</th>
<th>Arm ratio (L/S)</th>
<th>Centromere position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0±0.04=(2.2±0.01)+(1.4±0.03)</td>
<td>10.97</td>
<td>1.8</td>
<td>sm</td>
</tr>
<tr>
<td>2</td>
<td>3.0±0.03=(2.0±0.02)+(1.0±0.01)</td>
<td>9.86</td>
<td>2.0</td>
<td>sm</td>
</tr>
<tr>
<td>3</td>
<td>2.4±0.05=(1.6±0.04)+(0.8±0.01)</td>
<td>7.74</td>
<td>2.0</td>
<td>m</td>
</tr>
<tr>
<td>4</td>
<td>2.4±0.04=(1.4±0.03)+(1.0±0.01)</td>
<td>7.74</td>
<td>1.4</td>
<td>m</td>
</tr>
<tr>
<td>5</td>
<td>2.4±0.04=(1.4±0.02)+(1.0±0.03)</td>
<td>7.74</td>
<td>1.4</td>
<td>m</td>
</tr>
<tr>
<td>6</td>
<td>2.4±0.04=(1.4±0.01)+(1.0±0.03)</td>
<td>7.74</td>
<td>1.4</td>
<td>m</td>
</tr>
<tr>
<td>7</td>
<td>2.4±0.03=(1.6±0.02)+(0.8±0.01)</td>
<td>7.74</td>
<td>2.0</td>
<td>sm</td>
</tr>
<tr>
<td>8</td>
<td>2.2±0.03=(1.6±0.01)+(0.6±0.02)</td>
<td>7.10</td>
<td>2.7</td>
<td>sm</td>
</tr>
<tr>
<td>9</td>
<td>2.0±0.09=(1.2±0.03)+(0.3±0.01)</td>
<td>6.45</td>
<td>1.5</td>
<td>m</td>
</tr>
<tr>
<td>10</td>
<td>1.8±0.03=(1.0±0.02)+(0.8±0.01)</td>
<td>5.81</td>
<td>1.3</td>
<td>m</td>
</tr>
<tr>
<td>11</td>
<td>1.6±0.02=(1.2±0.01)+(0.6±0.01)</td>
<td>5.64</td>
<td>2.0</td>
<td>sm</td>
</tr>
<tr>
<td>12</td>
<td>1.6±0.02=(1.2±0.01)+(1.2±0.01)</td>
<td>5.16</td>
<td>3.0</td>
<td>sm</td>
</tr>
<tr>
<td>13</td>
<td>3.2±0.09=(1.8±0.02)+(0.8±0.01)+(0.6±0.01)*</td>
<td>10.32</td>
<td>2.3</td>
<td>sm</td>
</tr>
</tbody>
</table>

*Satellite length*
Fig. 3. Sesame idiogram

2. The morphological indices of chromosome (Table 1) show that chromosome length, relative length and arm ratio varies from 1.6 m to 3.4 m, 5.16% to 10.97% and 1.3 to 3.0 respectively.

3. Karyotype analysis indicates $2n = 2x = 5m + 8sm$ (ISAT). This karyotype is called symmetric one for having so many m and sm chromosome pairs in.

REFERENCES


**LODGING DUE TO WEAK STEM, A MAJOR PROBLEM IN SESAME IMPROVEMENT**

G.S.S. Murty and C.R. Bhatia
Nuclear Agriculture Division
Bhabha Atomic Research Centre
Trombay, Bombay-400 085, India

Nearly three decades back, Langham (1960) suggested that the existing genetic variability in sesame (*Sesamum indicum* L.) was adequate to meet the specific needs of agriculture and industry. Beech (1981) was also of similar opinion and attributed low sesame yields in many countries to poor crop management rather than the low genetic potential of the cultivars grown. However, except in a few isolated experiments, seed yields do not exceed 1 ton/ha. Moreover, the high yields are not realized at different locations. This is primarily because of extreme sensitivity of sesame crop to climatic factors and susceptibility to diseases and pests.

Optimum plant stand at harvest is the primary requisite for higher yields. After identifying the stress factors over a number of seasons, cultural practices were modified (Murty, 1986) to maintain required stand in the experimental plots. Improved cultural practices resulted in healthy and vigorous plant growth. Consequently, seed yields, in the range of 700 to 1000 kg/ha, were realized. However, several plants lodged which is an undesirable character. This problem was severe in the branched types and lodging was higher during heavy rains or following irrigation.

**Factors responsible for lodging:**

i) Being a herbaceous plant, stem is not woody and the pith is often hollow. Therefore, the stem is not able to sustain the load of capsule weight, resulting either in breakage or lodging. Plants having a poor bearing of capsules do not lodge indicating that the capsule weight makes the plant tops heavy.
ii) Shallow root system results in uprooting of plants.

iii) Excess nitrogen (75kg/ha) application was also found to cause lodging (Yermanos, 1980).

An induced "stiff stem" mutant was isolated from cultivar N-8, following the combined treatment of 60kR gamma rays and 1.0% E.M.S. The stem ridges of the mutant appear to have more mechanical tissue. However, the seed yield of the mutant was less than the parent N-8 (Table 1). Osman (1985) reported that weak, square stem tended to lodge at maturity while round, stout semi-solid stem prevented lodging.

Table 1. Comparative agronomical characters of 'Stiff stem' mutant and its parent

<table>
<thead>
<tr>
<th>Plant type</th>
<th>No. of branches</th>
<th>No. of capsules</th>
<th>Seed yield (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiff stem</td>
<td>71.9±1.7</td>
<td>5.7±0.2</td>
<td>39.3±3.5</td>
</tr>
<tr>
<td>(mutant)</td>
<td></td>
<td>5.3±0.5</td>
<td>3.2±0.4</td>
</tr>
<tr>
<td>N-8</td>
<td>90.9±1.9</td>
<td>4.1±0.2</td>
<td>56.5±4.5</td>
</tr>
<tr>
<td>(parent)</td>
<td></td>
<td>4.7±0.5</td>
<td>6.7±0.8</td>
</tr>
</tbody>
</table>

Shape of stem whether square or round, depends upon genetic factors as well as the climate. Generally, main stem in sesame is square shaped with heteromorphic leaves. The basal leaves are ovate, middle, tri-lobed and/or tri-fid and terminal leaves are narrow. In India, distinctly different varieties are grown in the rainy season (RS) and winter season (WS) (Richharia, 1957). The WS types show square stem in both WS and RS while RS types have square stem in RS and round during WS (Table 2).

Table 2. Seasonal variation for stem and leaf shape in rainy and winter season types

<table>
<thead>
<tr>
<th>Plant type</th>
<th>Rainy season</th>
<th>Winter season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>shape of stem</td>
<td>shape of stem</td>
</tr>
<tr>
<td></td>
<td>leaf</td>
<td>leaf</td>
</tr>
<tr>
<td>Rainy</td>
<td>square</td>
<td>round</td>
</tr>
<tr>
<td>winter</td>
<td>square</td>
<td>ovate</td>
</tr>
<tr>
<td></td>
<td>heteromorphic</td>
<td>heteromorphic</td>
</tr>
<tr>
<td></td>
<td>square</td>
<td>square</td>
</tr>
</tbody>
</table>
Besides, WS types produce heteromorphic leaves in both the seasons, while RS types grown during WS produce basal ovate and terminal narrow leaves. Tri-lobed or tri-fid leaves are completely absent (Fig. 1)

![Figure 1](image)

**Fig. 1.** Heteromorphic nature of leaves as seen in winter varieties in both the seasons and rainy season types only during rainy season.

**Bottom:** Altered nature of shape of leaves in rainy season types during winter.

(Note: Shape of leaves from left to right in the Figure roughly corresponds to leaf shape seen at basal, middle and terminal portions on main stem).

**Inheritance of stem cross section and leaf shape:**

Crosses were made between WS (cv N-8) and RS types (cv TC-25) and TTL-3 mutant) to study the inheritance pattern of stem shape and leaf characters. The $F_1$ plants grown during RS (June to October) showed square main stem and heteromorphic leaves as expected. When the $F_1$ plants were grown during WS (November to March), they showed round stems and ovate leaves, indicating that these traits were dominant over square stem and heteromorphic leaves respectively, an expression seen only during WS. $F_2$ generation grown during WS showed wide segregation for lobing of leaves which was found difficult to classify. In one of the crosses an attempt was made to classify plants
broadly into five groups (Table 3) based on the stem shape and nature of leaves on main stem and primary branches. Plants in classes i, ii and iii (Table 3) were pooled together into RS type and classes iv and v into WS types. The winter types appear to be controlled by three pairs of recessive genes \(707 \text{ rainy, } 14 \text{ winter, } \chi^2 (63:1) = 0.6742, P = 30-50\%\). RS and WS types are known to respond differently to photoperiod, as sesame cultivars grown during WS behave like typical short day plants and varieties grown in India during RS are day neutral (Joshi, 1960).

Table 3. Classes showing segregation for shape of stem and leaves in the F2 generation of N-8 X TC-25 grown during winter 1986-87

<table>
<thead>
<tr>
<th>Class</th>
<th>Shape of stem</th>
<th>Shape of leaves on main stem</th>
<th>Shape of leaves on branches</th>
<th>No. of plants segregating</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>round</td>
<td>ovate</td>
<td>ovate</td>
<td>324</td>
</tr>
<tr>
<td>ii)</td>
<td>round</td>
<td>ovate</td>
<td>slight lobing</td>
<td>166</td>
</tr>
<tr>
<td>iii)</td>
<td>round</td>
<td>slight lobing</td>
<td>slight lobing</td>
<td>217</td>
</tr>
<tr>
<td>iv)</td>
<td>square</td>
<td>deep lobing</td>
<td>slight or deep lobing</td>
<td>11</td>
</tr>
<tr>
<td>v)</td>
<td>square</td>
<td>tri-lobed</td>
<td>tri-lobed or deep lobing</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Total = 721</strong></td>
</tr>
</tbody>
</table>

The results suggest that it may be desirable to concentrate sesame improvement on the following lines:

i) establishing cultural practices for maintaining optimal plant stand to tap the genetic potential of the cultivars

ii) combining the characters of stiff, solid, semi-woody stem with high number of capsules

iii) grouping sesame germplasm into classes, similar to 'Maturity Groups' of soybeans.

REFERENCES


A trial including twenty one varieties from Greece, Mexico and Burkina Faso, distributed by FAO, together with a local variety Yuzhi No 1 was conducted in Zhengzhou in the summer of 1986. The trial was under randomized blocks design with three replications. All the varieties were sown on May 23, and harvested from August 24 to September 21. The yield performance of these varieties are presented in Table 1. The highest yield 1,775 kg/ha was produced by Yuzhi No 1. Varieties Teras 77, No 456 Sindos 64, No 449 Koastantsa and No 247 Dodekaniso/A produced more than 1,450 kg/ha, and were not significantly different from Yuzhi No 1 according to Duncan's New Multiple Range Test. Varieties like 38-1-7 and Instituto 81 did not ripen normally under local environment and produced very low yield, i.e., 125 kg/ha and 437.5 kg/ha respectively. Other pertinent data of these varieties are given in Table 2.

A precise evaluation for these varieties can not be obtained through one year's experiment. But, it may be interesting to see generally how these varieties from Mediterranean, Latin America and West Africa were growing in the central part of China. Besides, some characters should be emphasized as the following:
Table 1. Yield of twenty two varieties of sesame tested in Zhengzhou, 1986.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Origin</th>
<th>Yield, Kilograms per hectare&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yuzhi No. 1</td>
<td>China</td>
<td>1,775.0 a&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Teras 77</td>
<td>Mexico</td>
<td>1,500.0 ab</td>
</tr>
<tr>
<td>No.456 Sindos 64</td>
<td>Greece</td>
<td>1,475.0 abc</td>
</tr>
<tr>
<td>No.449 Kostantsa</td>
<td>&quot;</td>
<td>1,462.5 abc</td>
</tr>
<tr>
<td>No.247 Dodekaniso/A</td>
<td>&quot;</td>
<td>1,462.5 abc</td>
</tr>
<tr>
<td>No.455 S. Sindos</td>
<td>&quot;</td>
<td>1,425.0 bcd</td>
</tr>
<tr>
<td>Ciano 16</td>
<td>Mexico</td>
<td>1,312.5 bcde</td>
</tr>
<tr>
<td>No.454 Ald. Sindos</td>
<td>Greece</td>
<td>1,312.5 bcde</td>
</tr>
<tr>
<td>No.37 Rodos</td>
<td>&quot;</td>
<td>1,312.5 bcde</td>
</tr>
<tr>
<td>No.463 Tetrahori</td>
<td>&quot;</td>
<td>1,275.0 bcde</td>
</tr>
<tr>
<td>No.458 Makrokapso</td>
<td>&quot;</td>
<td>1,162.5 bcdef</td>
</tr>
<tr>
<td>No.471 Proimo</td>
<td>&quot;</td>
<td>1,150.0 cdef</td>
</tr>
<tr>
<td>No.464 J-4 Sindos</td>
<td>&quot;</td>
<td>1,112.5 def</td>
</tr>
<tr>
<td>No. 381 white Sindos</td>
<td>&quot;</td>
<td>1,075.0 ef</td>
</tr>
<tr>
<td>No.450 Katy</td>
<td>&quot;</td>
<td>1,037.5 efg</td>
</tr>
<tr>
<td>Ciano 27</td>
<td>Mexico</td>
<td>1,037.5 efg</td>
</tr>
<tr>
<td>No.451 Salmi</td>
<td>Greece</td>
<td>1,025.0 efg</td>
</tr>
<tr>
<td>Yori 77</td>
<td>Mexico</td>
<td>975.0 efg</td>
</tr>
<tr>
<td>Pachequeno</td>
<td>&quot;</td>
<td>662.5 fg</td>
</tr>
<tr>
<td>No.452 Aspa</td>
<td>Greece</td>
<td>737.5 g</td>
</tr>
<tr>
<td>Instituto 81</td>
<td>Mexico</td>
<td>437.5 h</td>
</tr>
<tr>
<td>J8-1-7</td>
<td>Burkina Faso</td>
<td>125.0 i</td>
</tr>
</tbody>
</table>

<sup>1</sup>Mean of 3 replications.

<sup>2</sup>Duncan's New Multiple-Range Test at the 5% level.

1. **Maturity.** The length of growth period of sesame varieties is greatly concerned by the farmers due to the intensive methods of agriculture in China. In this trial, most varieties, except Ciano 27, Pachequeno, Instituto 81 and J8-1-7, are able to grow and mature normally planting in summer in Zhengzhou area. Some varieties like No 455 S. Sindos, No 381 white Sindos, No 456 Sindos 64 have shorter duration than the local variety Yuzhi No 1.

2. **Number of Capsules per Plant.** According to our former study, the number of capsules per plant has very significant correlation with the yield. In this trial, No 449 Kostantsa and No 453 Makrokapso had 140.1 and 134.8 capsules per plant respectively, 4 to 9 capsules more per plant than Yuzhi No 1.
### Table 2. Characteristic performance of twenty two sesame varieties. Zhengzhou, 1986

<table>
<thead>
<tr>
<th>Variety</th>
<th>Days to Flower</th>
<th>Maturity</th>
<th>Plant Height</th>
<th>Capsules per plant</th>
<th>Seed weight per plant</th>
<th>1,000 Seed Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yuzhi No. 1</td>
<td>39</td>
<td>98</td>
<td>134.1</td>
<td>131.2</td>
<td>20.0</td>
<td>3.18</td>
</tr>
<tr>
<td>Teras 77</td>
<td>39</td>
<td>105</td>
<td>174.6</td>
<td>106.7</td>
<td>15.5</td>
<td>3.38</td>
</tr>
<tr>
<td>No.456 Sindos 64</td>
<td>31</td>
<td>96</td>
<td>141.3</td>
<td>95.6</td>
<td>17.0</td>
<td>3.47</td>
</tr>
<tr>
<td>No.449 Kostantsa</td>
<td>31</td>
<td>96</td>
<td>160.4</td>
<td>140.1</td>
<td>18.5</td>
<td>3.56</td>
</tr>
<tr>
<td>No.247 Dodekaniso/A</td>
<td>39</td>
<td>96</td>
<td>183.9</td>
<td>101.1</td>
<td>12.0</td>
<td>3.31</td>
</tr>
<tr>
<td>No.455 Ba. Sindos</td>
<td>23</td>
<td>91</td>
<td>143.7</td>
<td>95.8</td>
<td>14.5</td>
<td>3.10</td>
</tr>
<tr>
<td>Ciano 16</td>
<td>37</td>
<td>96</td>
<td>165.8</td>
<td>70.9</td>
<td>12.5</td>
<td>3.42</td>
</tr>
<tr>
<td>No.454 Alb. Sindos</td>
<td>22</td>
<td>86</td>
<td>122.3</td>
<td>97.1</td>
<td>12.0</td>
<td>3.15</td>
</tr>
<tr>
<td>No.37 Rodos</td>
<td>35</td>
<td>105</td>
<td>173.6</td>
<td>88.3</td>
<td>12.3</td>
<td>3.77</td>
</tr>
<tr>
<td>No.463 Tetrahori</td>
<td>37</td>
<td>98</td>
<td>157.9</td>
<td>85.7</td>
<td>12.0</td>
<td>3.63</td>
</tr>
<tr>
<td>No.458 Makrokapslo</td>
<td>31</td>
<td>96</td>
<td>143.5</td>
<td>134.8</td>
<td>16.0</td>
<td>3.20</td>
</tr>
<tr>
<td>No.471 Proimo</td>
<td>36</td>
<td>98</td>
<td>173.0</td>
<td>104.2</td>
<td>17.5</td>
<td>3.53</td>
</tr>
<tr>
<td>No.464 J-4 Sindos</td>
<td>36</td>
<td>96</td>
<td>152.7</td>
<td>104.4</td>
<td>14.0</td>
<td>3.00</td>
</tr>
<tr>
<td>No.381 White Sindos</td>
<td>22</td>
<td>92</td>
<td>121.4</td>
<td>99.9</td>
<td>-</td>
<td>3.13</td>
</tr>
<tr>
<td>No.450 Katy</td>
<td>33</td>
<td>96</td>
<td>153.7</td>
<td>95.4</td>
<td>14.0</td>
<td>3.94</td>
</tr>
<tr>
<td>Ciano 27</td>
<td>50</td>
<td>113</td>
<td>175.0</td>
<td>65.4</td>
<td>11.0</td>
<td>3.56</td>
</tr>
<tr>
<td>No.451 Balmi</td>
<td>35</td>
<td>96</td>
<td>155.1</td>
<td>113.5</td>
<td>10.5</td>
<td>2.94</td>
</tr>
<tr>
<td>Yori 77</td>
<td>39</td>
<td>105</td>
<td>168.7</td>
<td>115.6</td>
<td>12.0</td>
<td>3.32</td>
</tr>
<tr>
<td>Pachequeno</td>
<td>49</td>
<td>113</td>
<td>182.1</td>
<td>60.7</td>
<td>10.0</td>
<td>3.74</td>
</tr>
<tr>
<td>No.452 Aspa</td>
<td>39</td>
<td>10d</td>
<td>147.4</td>
<td>87.2</td>
<td>6.5</td>
<td>3.27</td>
</tr>
<tr>
<td>Instituto 81</td>
<td>64</td>
<td>113</td>
<td>186.6</td>
<td>55.0</td>
<td>7.5</td>
<td>2.83</td>
</tr>
<tr>
<td>38-1-7</td>
<td>69</td>
<td>113</td>
<td>197.0</td>
<td>few</td>
<td>-</td>
<td>3.28</td>
</tr>
</tbody>
</table>
3. **1,000 Seed Weight.** 1,000 seed weight is considered as one of the component factors of the yield. In this trial, most exotic varieties had higher 1,000 seed weight than the local variety. No 450 Katy (3.94 g.), No 37 Rodos (3.77 g.), Pachequeno (3.74 g.), No 463 Tetrahori (3.63 g.), No 449 Kostantsa (3.56 g.), Ciano 27 (3.56 g.) and No 471 Proimo (3.53 g.) had the 1,000 seed weight over 3.5 gram.

4. **Plant Height.** All the exotic varieties grew quite vigorously in this trial. Most varieties were taller than the local one except No 454 Alb. Sindos (122.3 cm.) and No. 381 White Sindos (121.4 cm.). Photoperiod sensitive varieties like 38-1-87 and Institute 81 had the plant height near 200 cm., but very late in flowering.

5. **Diseases.** The main diseases occurred in 1986 in this area were caused by *Fusarium* and Virus. It, however, was not serious in the experiment field. No 454 Alb. Sindos, No 449 Kostantsa, No 381 White Sindos, No 451 Balmi, No 452 Aspa and Ciano 27 were less susceptible to diseases than other varieties.

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**INSECT SURVEY OF SESAME IN WESTERN ARIZONA**

Susanne T. Cotty  
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Although sesame has been grown commercially in Yuma County, Arizona since 1982, a survey of its insect fauna has never been conducted. A study was undertaken to identify the types of insects present and to determine whether they adversely affect yield. Sweep net samples were taken weekly and insect species and numbers were recorded for one growing season (Table 1). Insecticides were applied five times during the season to establish yield loss information.

Based on observations from the experimental plot and other sesame fields in the area, beet armyworms, *Spodoptera exigua* Hubner, and saltmarsh caterpillars, *E stemena acrea* (Drury), appear to be the most damaging insect pests of sesame. The seedling stage is the most severely affected by the foliar feeding and stem boring habits of *S. exigua.* This boring damage destroys the plant terminal and results in plant death and stand reduction. Older seedlings can compensate for this damage by producing lateral branches.
Table 1. Insects Collected from Yuma County Sesame during 1986.

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Genus Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thysanoptera</td>
<td>Thripidae</td>
<td><em>Frankliniella occidentalis</em> (Pergande)</td>
</tr>
<tr>
<td>Heteroptera</td>
<td>Anthocoridae</td>
<td><em>Orius tristicolor</em> (White)</td>
</tr>
<tr>
<td></td>
<td>Miridae</td>
<td><em>Cyrtoptilis tenuis</em> Reuter</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lygus hesperus</em> Knight</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Spananonicus aldofasciatus</em> (Reuter)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Pseudatomoscelis seriatus</em> (Reuter)</td>
</tr>
<tr>
<td></td>
<td>Nabidae</td>
<td><em>Nabis americoferus</em> Carayon</td>
</tr>
<tr>
<td></td>
<td>Reduviidae</td>
<td><em>Sinea confusa</em> Caudell</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Zelus renardii</em> Kolenati</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Z. socius</em> Uhler</td>
</tr>
<tr>
<td></td>
<td>Lygaeidae</td>
<td><em>Geocoris punctipes</em> (Say)</td>
</tr>
<tr>
<td></td>
<td>Pentatomidae</td>
<td><em>Chlorochroa sayi</em> Stal</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Euschistus impictiventris</em> Stal</td>
</tr>
<tr>
<td>Homoptera</td>
<td>Membracidae</td>
<td><em>Spissistilus festinus</em> (Say)</td>
</tr>
<tr>
<td></td>
<td>Cicadellidae</td>
<td><em>Empoasca faeae</em> (Harris)</td>
</tr>
<tr>
<td></td>
<td>Aleyrodidae</td>
<td><em>Bemisia tabaci</em> (Gennadius)</td>
</tr>
<tr>
<td></td>
<td>Aphididae</td>
<td><em>Myzus persicae</em> (Sulzer)</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>Nitidulidae</td>
<td><em>Conotelus mexicanus</em> Murray</td>
</tr>
<tr>
<td></td>
<td>Coccinellidae</td>
<td><em>Hippodamia convergens</em> Guerin-Meneville</td>
</tr>
<tr>
<td>Neuroptera</td>
<td>Chrysomelidae</td>
<td><em>Systena blanda</em> Melsheimer</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>Chrysopidae</td>
<td><em>Chrysopa carnea</em> Stevens</td>
</tr>
<tr>
<td></td>
<td>Noctuidae</td>
<td><em>Estigmene acrea</em> (Drury)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Spodoptera exigua</em> (Hubner)</td>
</tr>
</tbody>
</table>

which bear pods. *E. acrea* are also foliar feeders and were observed defoliating an entire field during 1986. This behavior occurred in a mature field and probably did not affect yield. However, if immature fields were invaded, economic damage could result. A more acute problem associated with *E. acrea* is their migration from sesame into Yuma's fall vegetable plantings.

Populations of a mirid, *Cyrtoptilis tenuis* Reuter, were high, peaking at 11 per 180-degree sweep net sample. *C. tenuis* have been collected in alfalfa, bermudagrass and in cotton fields in the area but the largest populations
were found in sesame. Although C. tenuis feeding distorts and browns sesame leaves, yield was not affected (Table 2). Similar results have been reported in other sesame growing areas (Pulido 1986). Migrating populations of C. tenuis are of economic concern to lettuce growers, however. Leaf browning resulting from their feeding is sufficient to warrant chemical control in lettuce.

Table 2. Average yield of four replicated (kg/ha) from 1986 experimental plot in Wellton, Arizona.

<table>
<thead>
<tr>
<th>Insecticide (Rate kg a.i./ha)</th>
<th>Yield (kg/ha)*</th>
<th>Average of four replicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methamdiophos (1.1)</td>
<td>1337 ± 120 a</td>
<td></td>
</tr>
<tr>
<td>Methomyl (1.0)</td>
<td>1320 ± 48 a</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>1218 ± 63 a</td>
<td></td>
</tr>
</tbody>
</table>

* Numbers followed by the same letter are not significantly different (p = 0.05).

Two pentatomid species, Chlorochroa sayi Stal and Euschistus impictiventris Stal, were collected from sesame and could cause economic damage if large populations were present.

Although Heliothis zea (Boddie) and H. virescens (Fabricius) larvae were not observed, pod browning damage similar to that previously associated with these larvae was observed (Rivers et al. 1965). Hence, Heliothis spp. could be potential pests of Arizona sesame since they have been reported feeding on sesame in other U.S. cotton growing areas (Rivers et al. 1965, Laster et al. 1972, Mulkey et al. 1985).

This preliminary study has identified some insect species which may cause economic damage in Arizona sesame and points to sesame as a potentially important source of insect pests for adjacent vegetable crops.

REFERENCES

REPORT ON A VISIT TO SESAME GROWING REGIONS OF KENYA

B. Manzani
CENIAP, Maracay, Venezuela

The following is a short report on a two-week visit by Dr. B. Mazzani, from February 23 to March 6 1987, to the West and the Coast sesame growing regions of Kenya. The visit was sponsored by the Government of Venezuela, through the Embassy of Venezuela in Nairobi, by the Ministry of Agriculture of Kenya, by the U.N.D.P., by F.A.O. and by Ufuta Limited. The visiting team was comprised of Mr. S.O. Ogila, Head of Oil Crops Department at the Ministry of Agriculture, Dr. L Bertolli, Director of Ufuta Limited, Mr. E.B. Kingi, Project Manager Ufuta Limited and myself. We attended meetings at Njoro (Agricultural Research Station), Kakamega (P.D.A.), Busia (F.T.C.), Alupe (Western Agricultural Research Station), Kisumu (P.D.A.), Kisii (Nyanza Agricultural Research Station), all of them for Western and Nyanza Provinces; and at Kwale, Kilifi, Mtwapa (Coast Agricultural Research Station), Magarini, Garsen and Witu, Lake Kenyatta Settlement Scheme (F.T.C.) and Lamu for the Coast Province.

In the Western and Nyanza Provinces no sesame was observed in the field, because it had all been harvested already, prior to our visit. However, we visited many local markets where sesame is regularly offered for sale as a routine and popular food. The meetings with local agricultural officers, as well as informal talks with many people everywhere, were useful opportunities to draw up a realistic picture of what sesame represents for farmers and for consumers, as well as to realize the main problems the farmers are faced with.
As for the coastal region, many sesame fields were visited where plants were still growing, most of them in an advanced stage of their cycle, including fields just being harvested and others with plant bunches already drying up in the sun. In the coastal region we also met several farmers in their own fields, and exchanged comments and observations with them on their sesame growing.

All of the visits, meetings and talks have convinced me that the project of Ufuta Limited, aiming at the commercial production of sesame seed from smallholders for local industry of edible oil is apparently starting on a sound and logical footing, having its foundation on a crop already known to farmers who have been planting it over many generations. Farmers need it and like it both as a cash crop. In other words, the raw material Ufuta Limited is needing, is already produced in Kenya and increasing its production is not dependent on the introduction of new technology, unknown to the farmers and possibly unsuited to local requirements.

However, it is realistic to accept that what farmers have been doing for their sesame growing can be changed and improved. But, until researchers have obtained experimental results from field essays correctly designed and interpreted and repeated for at least three years in several different localities, covering such basic aspects as varieties, methods of planting, diseases, pest and weed control and methods of harvesting, present varieties and cultural practices as realized by farmers are to be kept as they are.

Summarizing some concepts I have expressed in a meeting with extension workers and farmers at the Lake Kenyatta Settlement Scheme, I will repeat here at least three recommendations that could be applied by farmers, without any increase (or an insignificant one), of the present cost of production. They are:

1) Doing everything necessary to improve the distribution of sesame plants in the field. That does not mean to introduce new seed rates or to change actual population densities per acre. It does mean to have as uniform as possible a distribution of plants through the field. It also means to avoid what is most commonly observed in sesame fields, not only in the Coastal Region, but elsewhere: patches where densities of population are exceedingly high, and where plants are weak, slender, with few or no branches, very high fruit set initiation and - last but not least - much susceptibility to diseases, especially those from soil born fungi.
On the other hand, patches where no plants - or almost no plants are left, and where a few seeds, if any, are to be harvested. This kind of double damage is no doubt one of the main causes of lower yields of sesame. Somebody suggested as most convenient a 60 x 60 cm. planting with 3 plants left on each spot. That seems to be a convenient planting system, provided no void spots are to be found throughout the planted area.

2) The second recommendation refers to the convenience of sesame seed treatment with some disinfectant prior to planting, that is, some of the commonly recommended chemical fungicides and insecticides. In all the sesame fields we visited, many plants were badly damaged, especially by soil born fungi (Phytophthora, Phytiurn, Fusarium, Macrophomina, etc). Many plants had been killed and many others were already dying. Seed treatment does not represent a final solution to this problem. The only real solution for it is a varietal resistance. But no doubt seed treatment will improve the present situation, with an insignificant increase of the cost of the seed. It is evident that this recommendation will be more easily applied whenever the seeds are distributed to the farmers from a central agency. As for foliar diseases, several pathogenic organisms were observed, but damages are scarcely important. The low humidity of the air at the sesame growing season and the well known low susceptibility of African types of sesame to the more destructive air born pathogens, are limiting their incidence.

3) The third recommendation is related to the right time for sesame to be harvested, that means for the plants to be cut and put to dry. This is one of the controversial point of discussion on sesame growing. However, the experimental results of trials conducted by myself and my collaborators, have evidenced that in the very last few days of their cycle, sesame plants are rapidly increasing the rate of seed maturation as well as of grain size increment. As compared with the ideally best time of harvesting, to anticipate the cutting of plants represents a greater seed loss than to delay the sesame cutting, indeed to delay till a few basal capsules of the plant begin to open. The seed loss from these open basal capsules is more than compensated for by the mature seed gains from the upper parts of the stems and branches. Moreover at a later stage the seed size on average is also greater.
The three recommendations, being of an immediate applicability, could be included in the present local technology at practically no additional cost or risk.

Other more transcendental aspects as varietal substitution and changes of most important cultural practices, need previous intense experimental work the results of which must be the base of any practical recommendation to be directed to the farmers. Meanwhile, I was unable to find better suggestions than the following two:

- Continue with the present varieties;
- Continue with the present cultural practices.

Both of these are the issue of so many generations of sesame planting as to assure that genetic variability and environmental fitting are very well adapted to climatic, edaphic and, in general, ecological requirements of Kenyan sesame growing regions.

That it is really so, is confirmed by comparing sesame yield from Kenyan fields with the average yield on a world scale. Kenyan sesame yield average is approximately two times as high as world average yield. As for quality of sesame grains several chemical analysis results from 1985-86 and 1986-87 harvests can be summarised as follows:

- high oil content (48.6 to 55.12%)
- low levels of FFA (0.16 to 1.7%)
- very low moisture content (3.5 to 5.0%)
- high protein content (44.2 to 48.6%)

HANSEOMGGAE: NEW EARLY MATURING SESAME VARIETY

Industrial Crops Research
Korea

A branched, tricapsules, early maturity and high yielding new sesame variety "Hanseomggae". "Hanseomggae" originated from crossing "Suwon 9"/"Early Russian"/"PI 195123" was developed through conventional pedegree breeding method from 1973 to 1978 and was named as "Suwon 63" after three years of yield productive test from 1979 to 1982. "Hanseomggae" showed earliness and high productivity through four years regional yield trial at 18 locations from 1983 to 1986, two years of farmer's field trial from 1985 to 1986, and is adaptable to the whole area of Korea.
There are two kinds of plant types in sesame, no branched and branched. Generally no branched type has tri-capsules bearing habit while mono-capsule bearing habit in branched type however "Hanseomggae" is tri-capsules habit in spite of its branched plant type, consequently it has ten more capsules per plant and higher maturity compared to those of recommended variety, "Danbaekggae".

Table 1. Agronomic characteristics of "Hanseomggae"  
(CES, 84-86)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plant type</th>
<th>Capsules bearing habit</th>
<th>Seed coat color</th>
<th>Flowering date</th>
<th>Maturing date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanseomggae</td>
<td>Branched</td>
<td>3</td>
<td>White</td>
<td>Jul. 2</td>
<td>Aug. 10</td>
</tr>
<tr>
<td>Danbaekggae</td>
<td>No branched</td>
<td>3</td>
<td>White</td>
<td>Jul. 2</td>
<td>Aug. 13</td>
</tr>
</tbody>
</table>

Table 2. Agronomic characteristics of "Hanseomggae"  
(CES, 85-86)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plant height (cm)</th>
<th>No. of branches/capsules plant</th>
<th>No. of capsules plant</th>
<th>1,000 grain weight (g)</th>
<th>Percentage of maturity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanseomggae</td>
<td>110</td>
<td>3.5</td>
<td>98</td>
<td>2.38</td>
<td>81</td>
</tr>
<tr>
<td>Danbaekggae</td>
<td>132</td>
<td>0</td>
<td>88</td>
<td>2.48</td>
<td>78</td>
</tr>
</tbody>
</table>

"Hanseomggae" showed stronger resistance than "Danbaekggae" in seedling blight and lodging caused by short plant height, and almost same in the other diseases compared to those of "Danbaekggae".

Table 3. Disease and lodging resistance of "Hanseomggae"  
(CES, 85-86)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seedling blight</th>
<th>Leaf blight</th>
<th>Phytophthora blight</th>
<th>Fusarium wilt</th>
<th>Lodging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanseomggae</td>
<td>MR</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>MR</td>
</tr>
<tr>
<td>Danbaekggae</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

"Hanseomggae" showed higher content of linoleic fatty acid and similarity on the other fatty acids, oil and protein content compared to those of "Danbaekggae".
Table 4. Qualitative characteristics of "Hanseomggae" (CES, 85-86)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Oil content %</th>
<th>Protein content %</th>
<th>Palmitic %</th>
<th>Stearic %</th>
<th>Oleic %</th>
<th>Linoleic %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanseomggae</td>
<td>53.2</td>
<td>22.0</td>
<td>7.1</td>
<td>4.4</td>
<td>42.3</td>
<td>44.5</td>
</tr>
<tr>
<td>Danbaekggae</td>
<td>53.0</td>
<td>22.3</td>
<td>7.3</td>
<td>4.8</td>
<td>43.0</td>
<td>41.9</td>
</tr>
</tbody>
</table>

"Hanseomggae" showed a yield increase of 9% in mono cropping and 8% in double cropping after barley compared to that of "Danbaekggae" and "Pungnyeonggaae" in regional yield trial and four % increase in farmer's yield trial compared to "Danbaekggae".

EFFECTS OF BIO-FERTILIZER "VK-81" ON CONTINUOUS CROPPING IN SESAME

Industrial Crop Research
Korea

Sesame is regarded one of the most promising income crop for Korean farmers so that it is easy to see continuous cropping fields of sesame on the countryside, and by that reason, increasing of diseases and allelopathic materials and lack of minor nutrients on sesame cultivation field are serious problem now a days. "VK-81" consisted of antagonistic bacillus to soil born diseases and beneficial soil born microorganisms showed relatively good effects for controlling soil born diseases with 9 percentage less than those of no treatment, and good productivity of 923 kg/ha which is 11 percentage higher than no treatment on five year continuous cropping field of sesame.

Thirty sacks (600 l) per hectare of "VK-81" were mixed with 3 tons of unfermented compost fermenting more than 30 days before planting time with optimum water absorption, and then turned over the pile twice times during the period finally well fermented "VK-81" with compost were scattered to the sesame field just before planting time.
Grain Yield Index

Percentages of diseases attack

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional cult.</td>
<td>&quot;VK-81&quot;</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>111</td>
<td></td>
</tr>
<tr>
<td>832 kg/ha</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Percentage of matured number of grain

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional cult.</td>
<td>&quot;VK-81&quot;</td>
</tr>
<tr>
<td>90</td>
<td>93</td>
</tr>
</tbody>
</table>

Fig. 1. Effects of bio-fertilizer "VK-81" on a continuous cultivation field of sesame.

DEVELOPMENT OF CALLUS FOR SESAME ANther CULTURE

Industrial Crop Research
Korea

Anther culture is being attempted using the in vitro techniques for shortening the breeding cycles, inducing haploidy plants and chromosome doubling.

The effective medium and growth regulators for callus induction was MS medium (Murashige and Skoog) appended with 2.4-2 25 mg/l and BA 1 mg/l. On that medium 55.1% of anthers inoculated formed callus.

Table 1. Contents of growth regulator for callus induction in sesame anther culture.

<table>
<thead>
<tr>
<th>Medium</th>
<th>Content of growth regulators</th>
<th>No. of anthers inoculated</th>
<th>No. of callus-induced anthers</th>
<th>Percentage of callus-induced anthers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4-D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS 25 mg/l</td>
<td></td>
<td>784</td>
<td>432</td>
<td>55.1</td>
</tr>
<tr>
<td>+ BA 1 mg/l</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STUDIES ON GIEMSA C-BANDING. PATTERNS OF CHROMOSOME IN SESAME (Sesamum indicum L.)

Zhan Yingxian Cheng Ming Wu Aixnong (Beijing Agricultural University)

The purposes of present paper will be to analyze the C-banding patterns of chromosome in sesame and to find out a better method of Giemsa-C-banding technique for sesame breeding research with a cultivar, called Beijing Sa-Wang-Bian as a material and the Giemsa C-banding technique to be concluded as follows: (1) The form of Giemsa C-banding Patterns or chromosome in sesame: 2n=26=CLTOW type=8C=8CI+4Cl++20+2W. (2) According to the morphological indices (relative length and chromosome position) and Giemsa C-banding patterns (C. I. T, C. and W). The thirteen pairs of homologous chromosomes in sesame karyotype may be separated and recognized each other and (3) Among these plant chromosome techniques, the BSG method of Giemsa C-banding technique is the better one for studying the Giemsa C-banding in sesame. Three figures and one table are present and some problems having relation to C-banding pattern are also discussed.

EFFECT OF DIFFERENT PE MULCHING DURATION ON THE COMPETITION ABILITY OF SESAME GROWING IN ASSOCIATION WITH VARIOUS WEED COMMUNITIES

Lee, J.I.1, C.W. Kang1, and Y.W. Kwon2

1Crop Experimental Station, RDA, Suwon, 170, Korea
2Seoul National University, Suwon, 170, Korea

This experiment was conducted to determine the influence of weed competition in sesame and the periods for weed control. Competition periods (days), for which sesame was seeded under transparent polyethylene film at May 15, were 10, 15, 30, 45, 60, 75, 90, and full growth season of sesame. Weed control periods (days), for which sesame was seeded under black polyethylene film at June 15, were 10, 15, 30, 45, 60, and full growth season of sesame.

Dominant weeds were Portulaca oleracea, Digitaria sanguinalis, Acalypha australis, L. Cyperus arnuricus, Arenaria aestphilifolia, Cardamine flexucosa, Mollugo Stricta and Digitaria eschaemum.
The number of weeds was maximum at the 30 days after planting. Broad leaf weeds were more dominant than grass weeds, and then decreased the total number of weeds by the reason of major decrease of broad leaf weeds. However, the weight of weeds increased continuously. No weeds appeared until the 15 days after planting and the weight of broad leaf weeds was heavier than that of grass weeds until 45 days after planting. However, grass weeds were heavier than broad leaf weeds after 60 days after planting.

The hazards of weeds on the growth and development appeared seriously from the 60 to 75 days after planting, but main yield reduction appeared from 30 days after planting. Therefore once more hand weeding should be practiced within 30 days after planting to minimize yield decrease.

Serious hazards by weed growing appeared by removing black PE film after 15 to 30 days after planting in growth characteristics and 30 days later in grain yield.

Leaf growth showed maximum from 45 to 60 days after planting and then decreased as compared with the continuous increase of stem and root in optimum planting, transparent PE film mulch and hand weeding. Leaf growth didn't show reducing in PE film and weedy check but total weight of weeds increased and growth of sesame decreased as compared to PE film mulch and hand weeding.

Leaf, stem and root growth of sesame, and weed weight under black PE film mulch showed same tendency and lower growth of sesame as compared with optimum planting, transparent PE film mulch.

Correlation between sesame yield and weeds weight were \( r = -0.874 \) in the optimum planting and \( r = -0.712 \) in the late planting, so that the more weeds increase, the lesser sesame yield.

OPTIMUM CONCENTRATION & TREATMENT TIME OF SODIUM AZIDE (NaN₃) FOR INDUCED MUTATION IN SESAME (Sesamum indicum L.)

J.I. Lee¹, C.W. Kang¹, H.J. Kwon², and S.T. Lee¹
¹Crops Experiment Station, Suweon, Korea
²Korea University, Seoul, Korea

This study was performed to determine optimum chemical concentration, soaking time of sodium azide (NaN₃) and pre-soaking time to induce mutation with Pungnyeon and Kwangsan sesame cultivars.

Germination percentages of the seed were decreased more by higher concentration, longer soaking and pre-soaking hours. Germination percentage decreased rapidly at ten to fifteen hours of pre-soaking hours, and this period was considered as S-phase of germination processes in sesame. Four mM, two hours sodium azide treatment and twenty five hours pre-soaking appeared as the critical points for germination. Germination percentage of the cultivars was 48 percent for Pungnyeon and 41 percent for Kwangsan. Therefore, Pungnyeon was higher than Kwangsan in tolerance to chemical hazards. Consequently, optimum sodium azide concentration was 2mM along with two to three-hour soaking and fifteen to twenty-hours pre-soaking time.

* The full paper was published (in Korean) in: Research Reports, RDA, Crops (1986), 28(2):212-216.

SESAME RESEARCH IN KOREA

Jung Il Lee, Nak Sul Seong and Cbul Whan Kang
Crop Experiment Station, R.D.A.

Sesame (Sesamum indicum L.) is one of the oldest oil crops cultivated by man and successfully grown during the summer season in the southern and central northern areas of Korean peninsula. Changes in dietary patterns have led to a move away from the supplementary staple foods, barley and potatoes, to a wider variety of animal foods, vegetables, and oil crops along with boiled rice and bread. Strong market demand for sesame in the Republic of Korea has led to the cultivation from around 10,000 hectares in the 1960's to 75,000 hectares in the 1980's.
Polyethylene film mulching in growing sesame is the most important cultural technique in Korea. Lower temperatures prolong the emergence period and lower the ability of sesame to complete with faster growing weeds. Sesame also is damaged by excessive moisture of drought at all stages of growth and development. Couple with higher soil moisture, lower temperature promotes seedling diseases, which often have devastating effects on sesame stand establishment. Fortunately, the vinyl mulching culture has averted the natural disasters and stabilized the highest productivity of sesame.

Sesame breeding began when a Korean domesticated sesame plants by growing them under controlled conditions and selecting those plant types that provided a dependable source of edible oil. This early sesame breeding was haphazard and slow. It remained an art, and not a science. As a science, sesame breeding was heavily dependent upon genetic principles starting from 1955 just after the Korean War. Over the last 30 years there has been a remarkable increase in the productivity of sesame crop, much of it due directly to the accomplishment of the sesame breeders and agronomists. We achieved higher yield level of sesame in the world being 930 kg per hectare. The sesame breeding was conducted with more precise control of the environment by practicing vinyl mulching culture. The superior sesame varieties developed under the vinyl mulching environment, were the result of a combination of genes that cooperate well with the environment. In a remarkably shorter period of time, sesame varieties have been developed which are able to be resistant of tolerant to the biotic and abiotic stresses in Korea.

This paper is provided to be used as a brief introduction of the achievements of the Korea sesame breeding programs and innovated cultural techniques during the last 30 years. We have made every efforts to bring all.

* Full paper published by the Crop Experiment Station RDA in Korean (1986).
STUDIES ON FLOWERING AND MATURITY IN SESAME  
(Sesamum indicum L.)  
VI. GRAIN FILLING RATE FOR DIFFERENTLY POSITIONED  
CAPSULES IN DIFFERENT PLANT TYPES

Jun Il Lee¹, Chul Whan Kang¹ and Eung Ryong Son²  
¹Crop Experiment Station, Suwon  
²Korea University, Seoul 1986, 3.24

This study was conducted to provide basic information  
to breeders and agronomists working with sesame.  

Grain filling rate were investigated for eight plant  
types classified by branching habit, capsules per axil,  
carpels and loculi of a capsule. Two typical cultivars were  
chosen for plant type among 527 gene pools.  

Grain filling rate didn't increase with little  
difference between lower and middle part capsules, but  
significantly decreased in upper part. Grain filling rate  
of lower part, main stem and center capsules appeared  
higher than that of upper part, branch and side capsule for  
grain filling.  

Mono-capsule setting and unbranched plant type were  
higher for grain filling than tricapsule setting and  
branched type due to inactive ripeness on branched  
capsule. NMB type showed that best maturity and relatively  
good grain filling in BTB type despite it's largest sink  
capacity. NTQ and BTQ type appeared poor ripeness because  
of immaturity of higher part side capsules; however it was  
believed that there were still possibilities for improving  
ripeness in 3 capsule and 4 carpels 8 loculi type by the  
good maturity of 1 capsule and 4 carpels 8 loculi type.  

* The full paper was published (in Korean) in: Korean S. of  
STUDIES ON FLOWERING AND MATURITY IN SESAME  
(Sesamum indicum L.)  
VII. GRAIN WEIGHT OF DIFFERENT-POSITIONED CAPSULES IN DIFFERENT PLANT TYPES

Chul Whan Kang and Jung Il Lee  
Crop Experiment Station, Suwon, Korea

One thousand grain weight were investigated for eight plant types classified by branching habit, capsules per axil, and loculi of a capsule. Two typical cultivars were chosen for plant type among 527 gene pools.

The order of 1,000-grain weights were arranged from high to low: lower part, main stem and center capsules appeared heavier than upper part, branch and side capsules. Mono capsule setting and unbranched plant type were heavier for grain weight than tricapsule setting and branched type due to inactive ripeness on branched capsules. NMB type showed the heaviest grain weight and thought that BTB type would be the best possibility in yield capacity due to it's largest sink capacity despite it's relatively lighter grain weight. NTW type appeared poor ripeness because of immaturity of higher part side capsules: however, it was believed that there were still possibilities for improving ripeness by enlarge source in 3 capsule and 4 carpels 8 loculi type by the good ripeness of 1 capsule and 4 carpels 8 loculi type. Relationship between grain filling rate and 1,000-grain weight were positive and high (R=0.977). The grain filling rate appeared to be the most effective component on grain yield among the growth and yield components by path coefficient analysis.

SEASONAL VARIATION IN GENE EFFECTS FOR YIELD COMPONENTS IN SESAME (Sesamum indicum L.)

M. Balakrishna Reddy¹, M.V. Reddy² and B.S. Rana³
Department of Genetics and Plant Breeding
Andhra Pradesh Agricultural University
Rajendranagar, Hyderabad 500030 (AP)

Gene effects were studied in four crossed of sesame (Sesamum indicum L.) in kharif and summer seasons. In Fubilejniji varietal crosses, plant height, number of branches, effective stem length and capsules per plant were mainly governed by additive gene effects during kharif season. The significance of gene effects was low in summer as compared to the kharif season indicating the inconsistency of gene effects on various characters. For plant height and number of branches, duplicate epistasis was consistent over seasons while for other characters both duplicate and complementary epistasis, were observed. The variety Fubilejniji produced significant additive effects and was therefore considered useful for a breeding programme.


ADAPTABILITY OF NEW SESAME VARIETIES IN GREECE

K. Halikiopoulou-Abatzoglou and Z.S. Michailidis
Cotton and Industrial Plants Institute. Sindos.
Thessaloniki, Greece

The seed yield of seven sesame (Sesamum indicum, L.) varieties developed in the Cotton and Industrial Plants Institute, were evaluated in eight nonirrigated field trials carried out in the Agricultural Research Stations of Palama and Serres and in the State Farm of Kalampace, during the period 1978-81.
To study and evaluate the adaptability and stability of the varieties in seed yield, methods of linear regression analysis, as well as, the method of Tai were used.

The test of the parallelism of the regression lines of the varieties and the significance of the distance of the parallel lines which are used to analyze the variety x environment interaction, as well as, the estimation of the confidence limits of the environments for non parallel lines within which the varieties are considered interchangable showed that:

The varieties Dodekanisos and Proimi are of general adaptability combining high seed yields in all the environments. The varieties Tetrachori and J-4/156 showed the same response with the above varieties in the various environments but they were proved less productive, while Aspa/452 and Balmi/451 responding likewise, had the lowest yields. The variety Sindos Lefki is interesting in the low yielding environments, being interchangable with the varieties Dodekanisos and Proimi. It is also interchangable with the varieties Tetrachori and J-4/153 in high yielding environments, while in comparison with Balmi/451 is interchangable in the whole range of the sampled environments.

Considering the varietal stability according to the Tai's method, the variety Sindos Lefki, with the lowest value of $\hat{a}$ and $l$ gave more stable yields in comparison with the rest of the varieties which had medium stability ($\hat{a}=0$).

STUDIES ON SESAME GENETIC STOCKS FOR THE PHOTOSYNTHETIC EFFICIENCY

A.R.G. Ranganath¹, G. Shivashankar, K. Viruparkshappa
T.A. Govinda Raju and J.A. Sastry¹
University of Agricultural Sciences,
Bangalore 560 065 (India)
¹Present address: Directorate of Oilseeds Research,
Rajendranagar, Hyderabad 500 030 (India)

Sesame exhibits considerable amount of variation for biomass and effective capsules production. Studies on the cultivars based on visual assessment in major crop plants have produced significant results in the absence of detailed investigations with large number. In the present study 1040 lines were visually evaluated for the photosynthetic area in relation to matured capsules. These were the derivatives of seven crosses handled by six selection methods. Wide variability was observed within as well as between crosses. The selection methods showed differences for the photosynthetic area. The cultivars with high multicapsular nature produced more number of abortive capsules due to greater competition for photosynthates. The types derived from indigenous cultivars produced higher biomass and low economic yield. The derivatives of early bulk of Jordan early produced minimal biomass and greater number of abortive capsules than general bulk and late bulk of Kanakapura local and Phule Til-1. The results were discussed in view of formulating a physiological ideotype in sesame to realize higher productivity.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
DRY MATTER PRODUCTION AND NUTRIENT UPTAKE IN SESAME (Sesamum indicum L.) GENOTYPES

K.B. Reddy and A. Narayanan
Department of Plant Physiology, College of Agriculture, Rajendranagar, Hyderabad 500 030

Field experiments were conducted at Agricultural College, Hyderabad (Andhra Pradesh) to find out the amount of dry matter produced at various stages of plant growth, assimilate distribution in plant parts, nutrient uptake patterns in cvs. Gour and TMV-3.

The rate of dry matter production in sesame was slow up to flowering. Only 16% of total seasonal dry matter was produced at the time of flowering. While most of the dry matter (80%) was produced during reproductive phase i.e. from 50 to 92 days after sowing. The growth rate during 50-92 days period was more than 200 kg. ha⁻¹ day⁻¹.

Total dry matter ranged from 11291.0 to 11485.0 kg. ha⁻¹ with seed yield ranging form 109.0 to 156.0 kg. ha⁻¹. The drymatter distribution in mature plants was 11% in roots, 18.5% in leaf, 51% in stem and 19% in reproductive structures.

Average total amounts of N, P and K accumulated in plant parts was 159, 32 and 154, 33 and 154 kg. ha⁻¹ respectively. In mature plants the average accumulation of N was maximum in the leaves (35%), followed by capsules (31%), whereas the accumulation of P and K was maximum in the stem with 55 and 53%, respectively. During the peak periods of adsorption, daily uptake per hectare was 2.9 kg. N, 0.6 kg. P and 3.0 kg. K. The amount of dry matter needed to produce 100 units of seed contained 23 units of N, 6 units of P and 26 units of K.

EFFECT OF FOLIAR APPLICATION OF POTASSIUM ON TWO CULTIVARS OF SESAMUM UNDER SALT STRESS

Ch. Suhasini, B. Prabhakar, C.V. Krishna Mohan and G. Rajeswara Rao
Department of Botany, S.V. University, Tirupati 517 502

In the present investigation the role of foliar applied potassium on salinity induced processes in two cultivars of Sesamum namely Gowri and Madhavi has been studied. Salinity induced changes in plants contribute to growth suppression. Two cultivars of Sesamum were grown on soil in pots. Salinity was induced with 0.3% (w/w) NaCl on 10th day after germination. Potassium (20 mM, K⁺) in the form of K₂SO₄ was applied by foliar spray at regular intervals of 10 days up to 50th day after germination. The yield parameters like flower count, capsule and seed number, their fresh and dry weights were determined. Decrease in yield aspects under salinity was noticed. Budding and flowering is delayed. However, foliar application of potassium reduced the effects of salt stress in the parameters mentioned above. The results showed that the application of potassium is found to be beneficial for sensitive cultivars (Madhavi) than tolerant (Gowri) ones under salt stress. The role of foliar application of potassium by way of recovery is thus discussed from the results obtained.

* Abstract of the National Seminar of Physiology and Biocnemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
VARIABILITY FOR SEEDLING VIGOUR IN SESAME

A.R.G. Ranganatha, G. Shivashankar, K. Virupakshappa
T.A. Govinda Raju and J.A. Sastry
University of Agricultural Sciences, Bangalore 560 065

Seedling vigour was identified as one of the important factors determining the productivity of sesame, since the plant growth was very slow in the early stages. Efforts are in progress to identify the genetic stocks with higher degree of early vigour to increase the yield levels in sesame. In this direction 30 lines derived by selection from each of six selection methods of each of three crosses were studied for seedling vigour. In another experiment 25 lines derived by random sampling from each of five methods of each of four crosses were evaluated. Variability was considerable among the genotypes developed by different procedures from different crosses. The types with greater seedling vigour were identified for use in sesame improvement programmes.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.

LOSS OF VIABILITY OF SESAME

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Botany Department, University School of Sciences,
Gujarat University, Ahmedabad 380 009

The two important factors which influence seed longevity are relative humidity and temperature. The storage potential of Sesamum indicum L. cv. Chokdi seeds store in polythene bag and cloth bag, at 41, 62, 84 and 96 per cent relative humidity at ambient temperatures (25-38°C) and B.O.D. incubator (25 ± 1°C) was studied. Seed lots were evaluated every month for seed moisture content, per cent germination, seedlings growth, enzyme activities and composition of seed leachates.
Seed moisture content increased with increasing the relative humidity during storage. Seeds in the cloth bag get equilibrizdr quicker with their surroundings than seeds in the polythene bag. Per cent germination and seedling growth decreased with an increase in the storage period, along with the increase in RH and temperature. Enzyme activities of catalase, peroxidase, amylase and acid phosphatase were decreased in dry seeds. Total dehydrogenase activity showed positive correlations with the loss of viability.

Electroconductance, free sugars, orcinol and folin positive compounds and inorganic phosphate were increased in the seed leachate with the loss of viability. Seeds stored under higher RH had more leakage as compared to lower RH levels. GA3 and kinetin (10^-4 M) enhanced seedling performance of stored seeds.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.

DETERMINATION OF PHYSIOLOGICAL MATURITY IN GINGELLY (Sesamum indicum CV TMV 3)

T.V. Karivaratharaju and V. Ramakrishnan
Department of Seed Technology, T.N.A.U., Coimbatore 641 003

The seed followed simple, sigmoidal pattern through out the period of its development. Seed moisture-content, which was 88.6 per cent on the fifth day after anthesis, decreased to 21.6 per cent at the final phase of maturation. Accumulation of protein and oil continued steadily and reached the maximum on 35th and 40th day after anthesis, respectively. The maximum dry weight accumulation on the basis of oil- and protein-content coincided with the steep rise in the germination of seeds, which touched the 90 per cent level. At final maturation phase, there was no increase in protein content. The oil content and
germination of seeds had, however, registered a further increase of 0.25 and 3.0 per cent, respectively. Thus, the study indicated that in TMN 3 gingelly the seeds attained physiological maturity between 35th and 40th day after anthesis.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.

CHEMICAL INFUSION IN SESAME SEEDS THROUGH ORGANIC SOLVENT AND ITS INFLUENCE ON VIABILITY AND VIGOUR POTENTIAL

T.V. Karivaratharaju, V. Ramakrishnan and K.R. Ramasamy
Department of Seed Technology, T.N.A.U.,
Coimbatore 641 003

Experiments to study the influence of different seed treating chemicals and their infusion separately via water or dichloromethane on seed viability and vigour immediately after treating revealed that the seeds treated with dursban (1 ml) + benlate (1 g) + dichloromethane (15 ml) and dursban (1 ml) + difolatan (1 g) + dichloromethane and recorded higher germination of 100 and 99 per cent, respectively which were on par with dursban + thiram + water, dursban + captan + dichloromethane, dursban + difolatan + water, dursban + thiram + dichloromethane, dursban + captan + water, dursban + benlate + water and dursban + bavistin + dichloromethane. The untreated seeds recorded the lowest germination of 62 per cent which were on par with those soaked in water, in dichloromethane, and in dichloromethane containing dursban. The seedling vigour was not influenced by the treatments.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
YIELD RESPONSE OF SAFFLOWER TO DIFFERENT NP FERTILIZER LEVELS

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1Department of Agronomy, Sind, Agriculture University, Tandojam, Sind, Pakistan.

2Division of Plant Genetics, Atomic Energy Agricultural Research Centre, Tandojam, Sind, Pakistan.

ABSTRACT

To evaluate the yield response of safflower to six NP fertilizer combination levels (120-0, 120-60, 120-120, 140-0, 140-60 and 140-120 kg/ha), an experiment was conducted in split plot design with four replications.

The results showed that F4 (140-0 kg NP/ha) fertilizer level affected yield and yield components favourably. Hence as per results of this study it is concluded that 140 kg N/ha alone could be safely recommended for getting maximum yield in safflower under agroclimatic conditions of Tandojam.

INTRODUCTION

Edible oil situation in Pakistan is very tight and huge quantity is being imported every year. Last year (1986) import bill of edible oils was in the region of Rupees 90 million (Nishter, 1986). To relax this situation and achieve self sufficiency in edible oils among the newly introduced non-traditional oil seeds crops safflower has bright prospects of successful cultivation in Sind (Chaudhry et al 1975). As safflower is comparatively new crop, very little is known about its optimum fertilizer, irrigation, sowing date and allied agronomic requirements.

To work out optimum fertilizer needs and varietal response to different NP fertilizer combinations, experiments were undertaken during 1982-83 at Students Farm, Sind Agricultural University, Tandojam. Fertilizer levels tried earlier (Wyayyum et al 1986) were not sufficiently high, because no significant differences were observed among them. Hence new studies were conducted with higher levels of NP fertilizer combinations to elucidate the effect on yield and yield related characters.
MATERIAL AND METHODS

To assess the effect of different NP fertilizer combinations on yield and yield components in safflower (Carthamus tinctorius L.) an experiment was conducted in split plot design with fertilizer levels in the main plots and varieties in sub plots having four replications. Two safflower varieties Gila (spiny) and Local (spineless) and 6 NP combination levels (F1 = 120-0, F2 = 120-60, F3 = 120-120, F4 = 140-0, F5 = 140-60 and F6 = 140-120 Kg/ha) were used. The plot size was kept 2.25 x 4.8 m i.e. 5 rows of 5 m length, with inter row spacing of 45 cm. The thinning of crop was done before first irrigation keeping intra-plant distance of 15 cm.

The full dose of phosphorus and half dose of nitrogen in the form of DAP was applied at sowing time. Remaining half dose of nitrogen in the form of urea was applied at first irrigation. At maturity 5 properly spaced normal looking plants were tagged from the inner rows of each treatment in all the replications for recording observations. In the present paper effect of different NP fertilizer levels on yield and yield components in safflower are discussed.

RESULTS AND DISCUSSION

Biological yield per plant

The fertilizer levels had exerted significant effect (P .05) on biological weight per plant. The varieties were also significantly different (P .01) in biological yield (Table - 1). The variety Gila (spiny) recorded more biological yield per plant (67.47 gm) than variety Local (52.62 gm) i.e. 25% increase over the Local (spineless) variety. Similar findings have already been reported by Haog et al (1968).

Table 1. Effect of NP fertilizer on biological yield per plant (gm) in safflower.

<table>
<thead>
<tr>
<th>NP fertilizer combination levels (kg/ha)</th>
<th>Varieties</th>
<th>Mean of NP fertilizer levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gila (spined)</td>
<td>Local (spineless)</td>
</tr>
<tr>
<td>F1 = 120-0</td>
<td>60.56</td>
<td>47.38</td>
</tr>
<tr>
<td>F2 = 120-60</td>
<td>68.20</td>
<td>43.47</td>
</tr>
<tr>
<td>F3 = 120-120</td>
<td>56.87</td>
<td>44.94</td>
</tr>
<tr>
<td>F4 = 140-0</td>
<td>70.28</td>
<td>66.90</td>
</tr>
<tr>
<td>F5 = 140-60</td>
<td>72.47</td>
<td>63.42</td>
</tr>
<tr>
<td>F6 = 140-120</td>
<td>76.47</td>
<td>49.25</td>
</tr>
<tr>
<td>Average of varieties</td>
<td>67.47</td>
<td>52.62</td>
</tr>
<tr>
<td>NP fertilizer levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cd1 = 12.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Varieties</td>
<td>Cd1 = 8.67</td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>S.E. = 2.68</td>
<td></td>
</tr>
<tr>
<td>Cd1 = 11.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Higher biological yield of variety Gila (spiny) than variety Local (spineless) could be explained because of higher stem thickness, bold and more number of seeds per plant and higher yield potential as already reported by Chaudhry and Farid (1975). There was no interaction of fertilizer levels which revealed that the fertilizer effect was similar in both the varieties.

Seed yield per plant

The fertilizer levels affected seed yield per plant significantly (P 0.05). Maximum seed yield per plant (15.15 gm) was recorded at the fertilizer level of 140-0 kg NP/ha. Any addition of phosphatic fertilizer at this level of nitrogenous fertilizer has shown antagonistic effect on safflower yield (Table 2). The seed yield per plant in spiny variety (Gila) was significantly higher (P 0.05) than variety Local (spineless). Gila being significantly higher in biological yield (Table 1) also produced significantly higher grain yield (Table 2). There was no interaction of fertilizer with varieties which indicated that the fertilizer effect was similar in both varieties.

Table 2. Effect of NP fertilizer on seed yield per plant (gm) in Safflower.

<table>
<thead>
<tr>
<th>NP fertilizer combination levels (kg/ha)</th>
<th>Varieties</th>
<th>Mean of NP fertilizer levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gila (spined)</td>
<td>Local (spineless)</td>
</tr>
<tr>
<td>F1 = 120- 0</td>
<td>12.95</td>
<td>10.37</td>
</tr>
<tr>
<td>F2 = 120- 60</td>
<td>14.39</td>
<td>9.10</td>
</tr>
<tr>
<td>F3 = 120-120</td>
<td>13.48</td>
<td>9.08</td>
</tr>
<tr>
<td>F4 = 140- 0</td>
<td>15.00</td>
<td>15.30</td>
</tr>
<tr>
<td>F5 = 140- 60</td>
<td>12.61</td>
<td>13.83</td>
</tr>
<tr>
<td>F6 = 140-120</td>
<td>15.09</td>
<td>11.84</td>
</tr>
<tr>
<td>Average of varieties</td>
<td>13.92</td>
<td>11.59</td>
</tr>
</tbody>
</table>

NP fertilizer levels Varieties Interaction

Cd_i = 2.76 Cdi = 1.98 S.E = 1.64

1000 seed weight

In 1000 seed weight the varieties did not differ significantly. However, variety Gila (spiny) has slightly bolder seeds (Table 3). The mean 1000 seed weight of variety Gila (spiny) was 38.87 gm while that of Local (spineless) was 30.21 gm. The fertilizer levels had significant effect (P 0.05) on 1000 grain weight in both the varieties. Esendal (1986) has also reported positive
effect of applied fertilizer on 1000 seed weight in safflower. The treatments F5 and F6 gave on an average the highest 1000 grain weight (39.67 gm) which was significantly greater than all the other treatments. Non-significant interaction of fertilizer with varieties indicated similar effect of fertilizer levels on both the varieties.

Table 3. Effect of NP fertilizer on 1000 seed weight (gm) in safflower.

<table>
<thead>
<tr>
<th>NP fertilizer combination levels (kg/ha)</th>
<th>Varieties</th>
<th>Mean of NP fertilizer levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gila (spined)</td>
<td>Local (spineless)</td>
</tr>
<tr>
<td>F1 = 120-0</td>
<td>37.75</td>
<td>37.62</td>
</tr>
<tr>
<td>F2 = 120-60</td>
<td>38.87</td>
<td>38.27</td>
</tr>
<tr>
<td>F3 = 120-120</td>
<td>37.85</td>
<td>38.10</td>
</tr>
<tr>
<td>F4 = 140-0</td>
<td>38.37</td>
<td>37.35</td>
</tr>
<tr>
<td>F5 = 140-60</td>
<td>39.92</td>
<td>39.42</td>
</tr>
<tr>
<td>F6 = 140-120</td>
<td>40.47</td>
<td>38.47</td>
</tr>
<tr>
<td>Average of varieties</td>
<td>38.87</td>
<td>38.21</td>
</tr>
</tbody>
</table>

Seed yield/hectare

Seed yield was not affected significantly by fertilizers and varieties (Table 4). However, the effect of fertilizer levels on individual variety was significantly different at 5% level of significance, though no clear cut trend of fertilizer level on yield was observed on variety Gila, while in case of variety Local (spineless) seed yield generally increased with increased level of fertilizer. Consistently enhanced seed yield was also obtained by Esendal (1986) with the application of increased level of nitrogenous fertilizer. Maximum yield 915 kg/ha was obtained at F4 fertilizer level followed by F2 and F6 levels (856 kg/ha).
Table 4. Effect of NP fertilizer on seed yield per hectare (kg) in safflower.

<table>
<thead>
<tr>
<th>NP fertilizer combination levels (kg/ha)</th>
<th>Varieties</th>
<th>Mean of NP fertilizer levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gila (spined)</td>
<td>Local (spineless)</td>
</tr>
<tr>
<td>F1 = 120-0</td>
<td>787</td>
<td>463</td>
</tr>
<tr>
<td>F2 = 120-60</td>
<td>903</td>
<td>810</td>
</tr>
<tr>
<td>F3 = 120-120</td>
<td>625</td>
<td>741</td>
</tr>
<tr>
<td>F4 = 140-0</td>
<td>810</td>
<td>1020</td>
</tr>
<tr>
<td>F5 = 140-60</td>
<td>729</td>
<td>926</td>
</tr>
<tr>
<td>F6 = 140-120</td>
<td>648</td>
<td>1065</td>
</tr>
<tr>
<td>Average of varieties</td>
<td>750</td>
<td>826</td>
</tr>
</tbody>
</table>

NP fertilizer levels | Varieties | Interaction
S.E = 1.69 | S.E = 0.3388 | C_d1 = 232

According to the results of this investigation under the ecological conditions of Tandojam 140 kg nitrogen per hectare could be safely recommended for getting maximum grain yield in safflower.

REFERENCES


JLSF 88 - A NEW PROMISING SAFFLOWER VARIETY

B.N. Narkhede, A.B. Deokar and A.M. Patil
Oilseeds Research Station, Jalgaon 425001, India

Safflower (Carthamus tinctorius L.) is the main oilseed crop grown in winter season in Maharashtra (India) which has 6.19 lakh ha with total production of 3.69 lakh tonnes and productivity of 596 kg/ha (1985-86). Maharashtra ranks first in area and productivity of safflower in India. In percentage terms, the area and production of the State work out to 70 and 73 per cent of the area and production of the country respectively.

History and Development

A safflower variety 'Tara' was released in the year 1976 (Dokar et al 1977) and 'Bhima' was recommended in the year 1983 (Deokar et al 1984). Bhima has a good potential under rainfed as well as under limited irrigations. In order to increase yield per nectare of the crop, hybridization programme in safflower was enhanced in 1981-82. Good recombinations in F2s of the cross Al x G-1254 were obtained and bulked in 1983-84. This bulk in F3 was tested in preliminary yield trial in the year 1984-85. It gave 97.8% and 59.3% increase in yield over Bhima (Local check) and A 1 (National check) respectively in the said trial. Subsequently the bulk was numbered as JLSF 88 and tested across the locations and seasons.

Brief description

JLSF-88 has a rosette period of 24-26 days and grows to a height of 70-75 cm. It is semi-spreading in nature and the fruiting branches starts from 9th to 10th node on the main stem. Foliage colour of JLSF-88 is dark green with broad bracts. Leaves and bracts are spiny. Its flower colour is yellow when fresh and orange on fading. It blooms in 75-78 days and matures within 130-135 days. The capitulum is extra medium in size with broad bracts. The number of capitula per plant varies from 30 to 35 and number of seeds/capitulum is 25 to 28. The capitulum is closed. The seed is without pappus, white and bold in size. The weight of 1000 seeds ranges from 60 to 65 g. On whole seed basis JLSF-88 contains 29 to 30% oil. It is, moderately resistant to Alternaria and tolerant to aphids.

Yield Performance

In the year 1985-86 JLSF-88 was evaluated simultaneously in co-ordinated trial under All India
Co-ordinated Research Programme and in multilocation varietal trial on various research stations in the Maharashtra State. (Table 1). In the co-ordinated trial at five locations JLSF-88 gave 7.65 per cent and 16.85 per cent more seed yield (1408 kg/ha) than local check, Bhima (1304 kg/ha) and national check, A-1 (1205 kg/ha) respectively.

Table 1. Performance of JLSF-88 in various trials in Maharashtra.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Location</th>
<th>Seed yield (kg/ha)</th>
<th>C.D. (at 5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JLSF-88</td>
<td>Shima</td>
<td>A-1</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.</td>
<td>Jalgaon</td>
<td>1368</td>
<td>1264</td>
</tr>
<tr>
<td>2.</td>
<td>Akola</td>
<td>2037</td>
<td>2061</td>
</tr>
<tr>
<td>3.</td>
<td>Parbhani</td>
<td>1705</td>
<td>1112</td>
</tr>
<tr>
<td>4.</td>
<td>Latur</td>
<td>725</td>
<td>719</td>
</tr>
<tr>
<td>5.</td>
<td>Badnapur</td>
<td>1207</td>
<td>1384</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1408</td>
<td>1308</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>JLSF-88</td>
<td>Shima</td>
<td>A-1</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.</td>
<td>Jalgaon</td>
<td>1258</td>
<td>1019</td>
</tr>
<tr>
<td>2.</td>
<td>Buldhana</td>
<td>1691</td>
<td>1145</td>
</tr>
<tr>
<td>3.</td>
<td>Akola</td>
<td>1422</td>
<td>1140</td>
</tr>
<tr>
<td>4.</td>
<td>Badnapur</td>
<td>886</td>
<td>742</td>
</tr>
<tr>
<td>5.</td>
<td>Latur</td>
<td>789</td>
<td>587</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1209</td>
<td>927</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>JLSF-88</td>
<td>Shima</td>
<td>A-1</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.</td>
<td>Buldhana</td>
<td>926</td>
<td>886</td>
</tr>
<tr>
<td>2.</td>
<td>Akola</td>
<td>1100</td>
<td>831</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>1013</td>
<td>858</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Pooled for 2 seasons</td>
<td>1153</td>
<td>907</td>
<td>1079</td>
</tr>
<tr>
<td>Mean of 12 tests</td>
<td>1461</td>
<td>1255</td>
<td>1299</td>
</tr>
</tbody>
</table>

MLT = Multilocation trial, NS = Non-Significant

On pooling the data of multilocation varietal trial over two years and locations, differences in yield due to varieties were non-significant. However, on the basis of mean value, JLSF-88 gave 1153 kg/ha seed yield over local check, Bhima (907 kg/ha). The increase in yield is 27.12 per cent. It was on par with national check, A-1. On an average of 12 tests in the co-ordinated trials and multilocation varietal trials, JLSF-88 (1461 kg/ha) and
12.47 over A-1 (1299 kg/ha). The variety is pre-released for farmers' field trials during 1987-88 in Maharashtra.

Acknowledgement

The present work was carried out in All India Co-ordinated Research Project on Oilseeds (Safflower), Main Centre, Jalgaon financed by Indian Council of Agril, Research, New Delhi. The authors are thankful to all the research workers who rendered their co-operation in testing the variety under multilocation trials.

REFERENCES


SAFFLOWER REGISTRATION OF CV. SIRONARIA

E.K.S. Harrigan
CSIRO, Centre for Irrigation and Freshwater Research, Griffith, nsw 2680, Australia

Origin

The cultivar Sironaria (Carthamus tinctorius L.) originated from a complex crossing procedure involving selections from a Polish accession PI 311-737, an Iranian accession CPI 69039, Iranian number V50-243 and the recurring female parent Gila.

Accession PI 311-737 is resistant to Alternaria leaf blight caused by A. carthami chowd. Gila is a commercial cultivar adapted to Australian conditions. CPI 69039 has resistance to Phytophthora root-rot caused by P. cryptogea Pethyb. and Laff.

Accession PI 311-737 was part of the world safflower collection from Pullman, Washington State, which was donated by Mr G. Buzza of the Victorian Department of
Agriculture. CPI 69039 was received from the University of New England, Armidale, NSW.

PI 311-737 was selected in a glasshouse for greater resistance to A. carthami, and a selection was crossed and backcrossed to Gila. A selected backcross plant then was crossed to CPI 69039, and selection was practised for A. carthami resistance during three successive generations in the glasshouse (E.K.S. Harrigan. 1985. Sesame and Safflower Newsletter, No 1). This breeding and selection was conducted at the CSIRO Centre for Irrigation and Freshwater Research, Griffith, NSW.


A P. cryptogea disease nursery was established in the field to confirm the results of artificial glasshouse root-rot screening (Heritage, A.D., and Harrigan, E.K.S. 1984. Plant Disease 48: 767-769).

Sironaria was one of the 744 breeding lines, which were subject to ponding at high temperatures. Fifty P. cryptogea resistant breeding lines were selected to commence interstate evaluation trials. Disease resistance, seed quality and agronomic characteristics were assessed at 16 sites with the cooperation of the state departments responsible for agriculture in Queensland, New South Wales, South Australia and Victoria. Biloela in Central Queensland is climatically suited for the spread of A. carthami infection. Therefore it became the main screening area for the new breeding lines during 1983. The 5-week old seedlings were artificially inoculated at 150 000 spores per metre of row, and irrigated for half an hour in the late afternoons of alternate days for one month after inoculation. The technique was developed and applied by K.J. Jackson and J. Kochman of the Queensland Department of Primary Industries. Eleven breeding lines were re-tested in 1984-85 at all sites.

Breeder's seed will be maintained by the New South Wales Department of Agriculture.

Morphological description

Sironaria has similar morphology to that of Gila, with some modifications. It is 3 cm taller, but seed colour, seed hull, seed size, seedling vigour, leaf spininess, number of spines on the involucral bracts and flower colour are similar.
Agronomic characteristics

Sironaria has performed consistently when grown in Eastern Australia with regards to Alternaria and Phytophthora disease resistance, and has proven its ability to adapt to a wide range of regions. In the absence of heavy infection, Sironaria is not significantly different in seed yield and oil content from the reference line Gila, but in the presence of heavy infection, it is significantly better than Gila. (E.K.S. Harrigan, 1984-85 Oilseeds Research Committee Annual Report, pp. 36-38). A. carthami is seed borne and during conditions of high humidity is capable of destroying crops (K.J. Jackson and B.E. Birthelsen. 1986. J.Aust. Inst. Agric. Sci. 52: 63-72).

Sironaria matures 1 day later than Gila, the 1000 seed weight is 1.4 g greater, yields 133 kg/ha more, has 0.5% more protein and seed hull weight is 0.9% lower. However, oil content of Sironaria is 0.6% lower, linoleic fatty acid content is 0.3% lower and the oleic fatty acid is 0.1% lower than Gila.

Registered: 23-12-1986.

SAFFLOWER REGISTRATION OF CV. SIROTHORA

E.K.S. Harrigan
CSIRO, Centre for Irrigation and Freshwater Research, Griffith, NSW 2680, Australia

Origin

The cultivar Sirothora (Carthamus tinctorius L.) was bred at the CSIRO Centre for Irrigation and Freshwater Research, Griffith, NSW, from crosses involving Gila, an Ethiopian accession PI 286-385 and a Turkish accession PI 237-538.

The two accessions from the USDA world collection at Pullman, Washington were donated by Mr G. Buzza of the Victorian Department of Agriculture. They showed good agronomic characteristics in a field test and later were found to be resistant to Phytophthora root-rot caused by P. cryptogea Pethyb. and Laff. in a glasshouse screening procedure which killed all the plants of Gila (Harrigan, E.K.S., McRae, C.P. and Heritage, A.D. 1982. J. Aust. Inst. Agric. Sci. 48: 158-60; Heritage, A.D. and Harrigan,
E.K.S. 1984. *Plant Disease* 48: 767-69). Resistant selections from the accessions were each crossed to Gila, a commercial cultivar susceptible to *P. cryptogea* but widely grown in Australia. Selected F1 plants were intercrossed, the progeny were screened for *P. cryptogea* resistance, and selections were backcrossed to Gila. The progeny were screened in the glasshouse for three successive generations, and 744 F4 families were screened in test bays in an infected field nursery. The bays were flooded to a depth of 15 cm during 6 hours when the air temperature was above 35°C (Heritage, A.D. and Harrigan, E.K.S. 1984. *Plant Disease* 48: 767-69). Fifty breeding lines with good agronomic characteristics resisted the *P. cryptogea* attack, which killed all Gila plants. These lines were field tested in cooperation with the departments responsible for agriculture in Queensland, New South Wales, South Australia and Victoria. For the following three years, 11 lines were sown on an average of 16 sites each year.

Breeder's seed will be maintained by the New South Wales Department of Agriculture.

**Morphological description**

Sirothora has similar morphology to that of Gila with respect to seed colour, seedling vigour, number of spines on the involucral bracts, leaf spininess and flower colour, but, at maturity, Sirothora is 6 cm shorter than Gila.

**Agronomic characteristics**

Sirothora matures one day earlier than Gila, yields about 70 kg/ha more, has 0.3% more seed protein and the 1000 seed weights are 1.7 g greater. However, oil content of Sirothora is 1.7% lower, linoleic fatty acid content is 0.5 lower, and seed hull weight is 0.2% lower.

Sirothora proved to be susceptible to *Alternaria carthami*. In the absence of *Alternaria*, and when grown under irrigation on raised beds, it's ability to resist *Phytophthora* root-rot infection has been its principal beneficial characteristics.

Registered: 23-12-1986.
SAFFLOWER PRODUCTION IN ALBERTA

H.H. Mündel
Agriculture Canada Research Station, Lethbridge, Canada
Blair Roth
Agriculture Center Alberta, Canada, T1J 4 C7
and
J. Kudik Jr
Bankview Farms Ltd. Wrenthan, Canada

Introduction and Description

Safflower (Carthamus tinctorius L.) an annual crop is a thistle-like plant with a taproot which can penetrate soils to a depth of 2.5 to 3 m (8 to 10 ft). The rooting depth assists safflower to be more drought tolerant than cereal crops and because of its ability to use water from a great depth, it helps prevent the spread of dryland salinity. The sturdy upright plant has several branches terminating in seed heads, with enclosing bracts. The number of branches depends on environmental and soil conditions as well as on variety and population. Each developed head contains from 15 to 30 or more seeds. The crop varies in height from 45 to 75 cm (18 to 30 in.) when not irrigated. After a slow-growing rosette stage, safflower stems elongate quickly. Branching head development and flowering follow. Each head flowers over several days, from the outside towards the centre. Seed reaches physiological maturity within about 30 days of flowering, after which time another two weeks or so are required to dry the crop for harvest. A frost during this dry down period would hasten time to harvest without reducing yield or oil levels.

The safflower variety currently available is adapted mainly to the southern prairies, growing well on deep, well drained soils. Good yields can be achieved with high amounts of stored soil moisture or with a good rainfall distribution. Dry atmospheric conditions enhance yield potentials.

The main use of safflower in Alberta is currently the bird seed trace, for which a shiny white seed coat (pericarp) is required. Oilseed safflower is most commonly grown in the northern Great Plains of the U.S. High safflower oil levels are often associated with a reduction in hull, with resultant discoloring of the seed surface.

Extracted from Alberta Agriculture Field Services publication, February 1987
Varieties with such discolored seed coats are not acceptable to the bird seed trade. The current industrywide accepted standard oil content for the oil crushing industry is 34 per cent.

Varieties

The variety, Saffire, developed at the Agriculture Canada Research Station in Lethbridge is jointly held by Alberta Agriculture and Agriculture Canada and was developed with the aid of a Farming for the Future grant. Licensed in 1985, it is currently the only licensed variety in Canada. It is well suited to the bird seed trade. Its low oil content does not make it attractive as an oilseed variety. Certified seed is being produced on contract to Secan, through an exclusive release to Bankview Farms Ltd., Wrenthem, Alberta.

Saffire was developed for its early maturity, good yield potential, and high level of resistance to head rot caused by sclerotinia. Table 1 and Table 3 present these characters as well as oil level and resistance to alternaria (moderate). As described by Mündel et al., 1985b: test weight averages 54 kg/hL (43 lb/du), with a seed weight of 34.6 g/1000. The major fatty acid in the oil is linoleic, at 81.5 per cent, followed by oleic at 10 per cent. The whole seed protein is 11.4 per cent. The early bloom of Saffire is reddish-orange turning to red in postbloom under cool environmental conditions, the colors tend more towards yellow and orange.

Current U.S. varieties, not licensed for use in Canada, but available for direct contract-growing, are mainly too late maturing to ensure a quality crop in Alberta. Frost damage prior to maturity can be expected in southern Alberta in seven out of ten years on S-208 and varieties requiring a similar number of days to maturity. See Table for comparison with Saffire.

Rotations and salinity control

As long as the soil is moist to a depth of 60 to 75 cm (24 to 30 in.) at seeding time, a reasonable safflower crop can be expected. Safflower draws more soil moisture and from greater depths than cereals do. Safflower can readily follow winter or spring wheat, and if adequate moisture is in the soil, be followed by barley, spring wheat, mustard or flax. Fallow is not generally recommended directly following safflower because of the small amount of crop residue remaining to hold the soil against erosion. A number of disease organism affecting safflower are carried over in the soil and on volunteer seed. The risk of stand and yield loss caused by disease is great if safflower follows safflower in a rotation. Thus, safflower should not follow safflower or other crops highly susceptible to the
same diseases (e.g. sclerotinia). A four year minimum rotation is suggested.

During germination, safflower is only about half as salt tolerant as it is at later stages. Once established it is almost as salt tolerant as barley, with electrical conductivity readings of 7 millimhos per centimetre reducing yields by 10 per cent and 11 millimhos reducing seed yield by 20 to 25 per cent (Francois and Bernstein, 1964). One method of vegetatively controlling dryland salinity is to grow safflower in recharge areas to use up moisture which would otherwise move through the soil to the discharge area, producing saline seeps. By extracting more water and from greater depths than cereal crops, safflower helps to lower the water table, drying out the subsoil and utilizing some of the excess moisture found in recharge areas.

Fertilizers and weed control

Fertilizer amounts required depend on the yields to be attained, the position of safflower in a rotation and the other crops included, as well as on the soil type used. On fallow land, the most limiting nutrient may be phosphorus, while with continuous cropping nitrogen is the nutrient most recurred. Information on specific fertilizer practices is based on studies in North Dakota (Helm, et al, 1985) and Montana (Bergman, et al., 1979).

On summerfallow, good dryland yields are achieved with little or no additional N fertilizer. On continuously cropped land, typically the top metre of soil will contain 35 kg of N per ha (30 lb/ac). Nitrogen fertilizer to bring the total soil N to a maximum of 130 kg/ha (120 lb/ac) can be drilled (anhydrous ammonia) or broadcast (urea) and worked into the soil shortly after application. Seedling injury will result with high nitrogen rates or direct contact with the seed. Excess nitrogen will delay maturity.

Phosphorus can be the most limiting nutrient to safflower production on summerfallow. If soil tests indicate low levels of phosphorus, applications of 30 to 45 kg/ha (35 to 50 lb/ac) of P.O. by banding or drilling can be expected to produce good yields, once the nitrogen fertilizer needs of the crop have been supplied. Banding or drilling of phosphorus is more efficient than broadcasting. If broadcasting, use rates approximately one third greater than indicated above and the fertilizer should be thoroughly mixed with the soil.

Potassium is applied mainly in situations where very low levels in the soil exist. The Montana recommendations do not even mention the use of K.
Safflower does not respond consistently to applications of P or K unless the soil tested is in the low range. It is possible to build up levels of these two nutrients so that yearly applications in a field may not be required.

Selections of fields is important because no herbicides are currently registered for use on safflower. Data are being collected at Lethbridge and Indian Head to lead towards minor use registration of appropriate herbicides. Once these are registered, safflower could help reduce grassy weeds in a rotation. The crop does not compete well with weeds. Safflower and other broadleaf crops should not be seeded for several years into soil with 'Glean' or 'Torcon' residues, as severe plant injury will result. Trifuralin herbicides registered for use on such broad-leaf crops as mustard and canola can be tolerated by safflower considerably better than by cereals. Postemergent herbicides for control of grasses and registered for use on canola and flax have also been effective in safflower, but are not registered for this purpose. In emergencies, since numerous weeds emerge earlier than safflower, a spike tooth harrowing can kill weeds.

**Seeding**

Late April to the first week of May seems, on the average, the most appropriate planting time once soil temperatures at seeding depth have reached 5°C. The application of a seed treatment is generally advisable to ensure optimum emergence. At present no seed treatments are registered for use on safflower in Canada. Successful crop establishment has, however, been attained using fungicides as seed treatments. The use of a dual formula containing an insecticide as well as a fungicide is useful where wireworms are likely to be a problem. Depending on the soil temperature, emergence requires from one to three weeks or more, if the soils is dry and cold.

After emergence, because of the protective rosette around the growing point, safflower seedlings are quite resistant to frost. Safflower has recovered from frost of -10°C while in the rosette stage. The first few leaves emerging after a frost may show injury but the plant grows quite normally after such damage.

Elongation of the stem usually begins within two to three weeks, at which time a strong frost may damage plants to ground level. Plants can survive by new branches being produced at or near ground level, however, maturity will be delayed. Fall frost damage to maturing seeds results in lighter seeds and hence reduced yields, as well as reduced oil levels.
Sallow planting at 2.5 to 3 cm (1 to 1.5 in) into a firm moist seedbed is recommended to encourage uniform emergence. Deeper seeding of seedling into a predominantly dry seedbed may result in nonuniform emergence and thin stands, with reduced yield potential. Seeding rates should be in the range of 20 to 25 kg/ha (20 to 25 lb/acre). Lower seeding rates may provide acceptable yields when moisture levels are good, but weed control will be more difficult and maturity will be delayed. Higher seeding rates may result in increased disease incidence in years with a high rainfall from flowering on, or may lead to overcrowding, with reduced yields in very dry years. Safflower can compensate greatly in branch and head development in response to varying environmental and soil conditions, thus maintaining yield levels. See Table 2 for yields on one-acre strips in a field near Wrentham, in 1966, when good moisture levels pertained.

Seeding can be done with a regular grain drill in rows from 15 to 22 cm (6 to 9 in.), as used for cereals. Safflower seed is approximately the size of barley seed, and similar settings can be used. Seeding 20 kg/ha in 15 and 22 cm rows requires that 10 and 15 seeds per metre (3 and 4 per ft) of row, respectively, be seeded. Heavy crusting of soil after seeding can greatly reduce emergence of seedlings. If gaps are less than 50 cm in a row, the remaining plants can often compensate by extra head and seed production, without major reductions in seed yield.

Table 2. Saffire yields at different seeding rates.

<table>
<thead>
<tr>
<th>Seeding Rate (lb/ac)</th>
<th>Plants/m² (developed)</th>
<th>Net yield kg/ha</th>
<th>lb/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2d</td>
<td>1466</td>
<td>1333</td>
</tr>
<tr>
<td>20</td>
<td>41</td>
<td>1438</td>
<td>1307</td>
</tr>
<tr>
<td>25</td>
<td>71</td>
<td>1498</td>
<td>1362</td>
</tr>
<tr>
<td>30</td>
<td>67</td>
<td>1472</td>
<td>1338</td>
</tr>
</tbody>
</table>

Diseases and their control

The disease with the most potential for crop losses in southern Alberta is head rot caused by the fungus, Sclerotinia sclerotiorum. This is the same organism which also affects other broad-leaf crops such as beans, peas, lentils, canola, mustard, and sunflowers. Moist soil surfaces from early flowering on induce the production of spores and spread of the disease. Affected heads produce few, if any, fertile seeds, with heads characteristically discoloring prematurely and failing off, even with relatively light winds. While the outer seed coat appears normal, harvested seeds are hollow, without an endosperm or embryo inside. These seeds can readily be blown out of the
combine with appropriate adjustments. A large number of the heads will have fallen to the ground by harvest, or be lost during the harvesting operation.

Yield losses from head rot can be substantial (Mundel et al. 1985a). In contrast to S-20d, the main U.S. variety contracted in Canada in recent years, Saffire has a good level of resistance to sclerotinia head rot (Table 3). Stem rot, also caused by sclerotinia, results from sclerotia coming in direct contact with the upper safflower root. Prematurely wilted plants can occur scattered throughout a field. Generally yield losses caused by this stem rot are not significant.

Table 3. Sclerotinia

<table>
<thead>
<tr>
<th>ENTRY</th>
<th>1982</th>
<th>1983</th>
<th>1985</th>
<th>1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-20d</td>
<td>-</td>
<td>-</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td>S-541</td>
<td>-</td>
<td>11</td>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>Hartman</td>
<td>25</td>
<td>6</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Oker</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>AC-2</td>
<td>-</td>
<td>17</td>
<td>39</td>
<td>50</td>
</tr>
</tbody>
</table>

Leaf spot, caused largely by *Alternaria carthami*, reduces yields from loss of photosynthetic area and if infection begins early enough, from loss of head development. Brownish water-soaked lesions appear on the lower leaves and develop upwards to the bracts enclosing the flower heads. Heavy dews or rainy periods during flowering (late July to early August) contribute to the spread of this disease. With severe or late-season infection, seeds become severely discolored and may lose their ability to germinate. Any such discoloration will result in reduced marketability for the bird seed trade. As much as possible, alternaria-free seed should be used for planting. Saffire has moderate resistance to alternaria head rot.

Safflower rust, caused by *Puccinia carthami*, can spread considerably during the growing season, but is not likely to greatly reduce yields in most years. Diseased seed can result in reduced stands caused by seedling rust. Rust-free seeds is recommended.

Other diseases observed in Alberta include various root rots (Pythium spp., Phytophthora, Fusarium and Rhizoctonia spp.) bacterial blight caused by *Pseudomonas syringae*, and head rot caused by *Botrytis cinerea*. Under special conditions, such as irrigation, serious damage from...
a number of these diseases can result if proper precautions are not taken.

**Insect pests and their control**

Damage from grasshoppers in years of heavy infestations can be considerable. As other crops mature, but safflower is still green, major infestations in this crop can occur. If seeds are well formed at that time, and as long as cool weather or a frost occurs before seeds are chewed or caused to fall out of the heads, yield losses can be expected to be minimal. The grasshopper species prevalent as well as the variety of safflower grown will determine the extent of the damage. For example, the clearwinged grasshopper will feed very little on safflower, but may chew through the delicate stems just below the heads, causing these to drop off (Mundel and Johnson, 1987).

Wireworms and cutworms in certain regions and under specific soil conditions may create a considerable amount of damage by chewing and thus destroying germination seeds and safflower seedlings.

Thrips and lygus bugs, if present in considerable numbers, may cause bronzing of the flower buds. A considerable insect population can be carried by the safflower crop, because it has the ability to produce extra branches, extra heads, an increased number of seeds, and/or higher seed weights in compensation.

Data are currently being collected to lead towards 'minor use' registration of insecticides for use against grasshoppers. Heavy infestations of grasshoppers can be quite readily controlled by spraying as required.

**Harvesting**

Safflower seed is considered dry for harvest at 9.5 per cent seed moisture or below. This moisture level will prevent heating, molding and deterioration in storage. A killing frost after maturity will help to dry stalks to facilitate harvesting. The Canadian Grain Commission (CGC)-Grain Inspection Division Memorandum No. 85-16 of Nov. 2d, 1985 outlines how to determine seed moisture using a formula and 150 g seed in a Laadtronics 919/3.5 meter, with a dial set at 73.

**Moisture content:**

\[
\text{Moisture content} = (\text{Meter reading} \times 0.183) - 8.43 - \text{T.C.} - 1.4
\]

where T.C. is the temperature correction of 0.09°C, which is to be added for every degree grain temperature below 22°C and subtracted from every degree grain temperature above 22°C.
For seed moistures of 12 per cent and up, the procedure outlined in the CGC Official Grain Grading Guide can be used, using the Century Pea table and subtracting 1.4 from the values obtained. The higher seed moisture levels established by the CGC are the following:

- 9.6 to 13.5% TOUGH
- 13.6 to 17.0% DAMP
- 17.1 to 22.0% MOIST
- over 22.0% WET

Straight combining is recommended at relatively low cylinder speeds: e.g. 500 rpm for a 56 cm (22-in.) cylinder. Concave clearances of 16 mm (5/8 in.) at the front and 13 mm (0.5 in.) at the back are suggested. In heavy crops, to prevent plant residue from clogging the machine, shaker speeds should exceed those used for small grains if possible. Air should be adjusted to reduce the number of empty seeds entering the grain hopper.

Reels may not be necessary for reasonably good crops. However, with light crops, the combine reel may help in proper feeding onto the header platform. If the reel is used, shattering at the header should be closely monitored when the early morning toughness has disappeared from the plants. The reel speed should be about 25 per cent faster than the forward speed of the combine. Care should be taken to minimize shattering at the cutter bar by increasing the ground speed and ensuring the reel is not overly aggressive.

The white fuzz from the seed heads may clog combine radiators not designed to mechanically remove the fuzz from the protective screening. Accumulations of the fuzz can create a fire hazard. Brushes attached to a rotating screen readily remove this fuzz on modern combines.

Safflower should be harvested as soon as it is mature. This will reduce the risk of seed discoloration or sprouting in the head caused by fall rains. Farmers with drying facilities available have found that harvesting safflower when it is tough or damp (using CGC moisture terminology) results in easier threshing with less shattering occurring at the cutter bar. Furthermore, seed color is normally maintained by permitting the crop to be harvested earlier. Artificial drying should be done with care, to avoid fires.

**Irrigated safflower**

With extra care, a considerable yield advantage can be expected with irrigated safflower. At present, information on this is limited in Alberta. A previous fall irrigation and one in late July prior to the onset of flowering may be all that is required. The late July irrigation should ensure saturation of the soil profile to
60 cm (2 ft). Safflower cannot tolerate soil puddling or wet feet. Plants will die under such circumstances. Root diseases can be particularly devastating, reducing stands considerably if proper precautions are not taken. Irrigating much beyond flowering will increase the risk of sclerotinia and botrytis head rot, as well as alternaria leaf blight and delay maturity to the point where frost is a serious hazard.

Higher seed rates can be used in irrigated crops. Seedling should be as early as possible, because of the potential delay in maturity associated with irrigation. Similar precautions need to be considered with fertilizer use. Heavy fertilizer use can result in higher yields with irrigation, but excess nitrogen delays maturity considerably.

Under irrigation only the variety Saffirre should be grown, because with ample moisture the later maturing U.S. varieties will rarely mature. Irrigated yields can be expected to be in the range of 2750 to 4400 kg/ha (2500 to 4000 lb/ac).

REFERENCES


Table 1. Comparison of Saffire with U.S. varieties

<table>
<thead>
<tr>
<th>Entry</th>
<th>Days to maturity</th>
<th>Yield(^2) (Kg/ha)</th>
<th>Yield Index</th>
<th>Oil% dry weight basis</th>
<th>Alternaria(^3)</th>
<th>Primary use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saffire(^1) range</td>
<td>117(33)(^4)</td>
<td>1623(18)</td>
<td>100</td>
<td>31.5(29)</td>
<td>3.9(7)</td>
<td>bird seed</td>
</tr>
<tr>
<td>S-208</td>
<td>99-141</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-541</td>
<td>126(33)</td>
<td>-6%(18)</td>
<td>94</td>
<td>37.0(29)</td>
<td>6.3(7)</td>
<td>oilseed-bird seed</td>
</tr>
<tr>
<td>Hartman</td>
<td>128(10)</td>
<td>-14%(7)</td>
<td>86</td>
<td>40.2(6)</td>
<td>6.1(5)</td>
<td>oilseed</td>
</tr>
<tr>
<td>Oker</td>
<td>125(33)</td>
<td>equal(18)</td>
<td>100</td>
<td>34.8(29)</td>
<td>3.6(7)</td>
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</tr>
<tr>
<td>AC-2</td>
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<td>insuffic.data</td>
<td>39.5(6)</td>
<td>3.5(2)</td>
<td></td>
<td>oilseed</td>
</tr>
<tr>
<td></td>
<td>129(6)</td>
<td>insuffic.data</td>
<td>36.8(4)</td>
<td>6.3(1)</td>
<td></td>
<td>oilseed</td>
</tr>
</tbody>
</table>

\(^1\)Saffire is the only variety licensed in Canada
\(^2\)Yields of Alberta test locations only were included
\(^3\)Alternaria rated on a scale of 1(no symptoms) to 9(severe symptoms)
\(^4\)Number of location-years in parentheses
USE OF THE MUTAGENIC AGENT EMS TO INDUCE USEFUL VARIATION IN SAFFLOWER

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CIDA Apartado 240 Cordoba-Spain

Safflower (Carthamus tinctorius L.) has been grown as an oil crop in Spain for many years. Although it has been displaced by sunflower, still competes with this crop in very localized areas of Southern Spain. This competition could be favorable to safflower if it could be grown as a winter crop, improving its adaptation drought conditions. However as safflower is a long day plant (Buzza, 1978) winter plantings reach flowering too late, in comparison with other winter crops, loosing their potential advantage. Efforts to identify, in the available germplasm collections, genotypes insensitive to photoperiod were unsuccessful (Fernandez Martinez et al 1985). Therefore, a mutation experiment was undertaken in 1986 with the aim of finding early mutants and eventually other useful mutations.

Seeds of the local high oil variety 'Rancho' were treated with four different concentrations of Ethyl methanesulfonate (EMS), 0.25, 0.50, 0.75 and 1%, combined with three treatment times of the seeds (10, 15 and 20 hours) in order to determine the optimum EMS doses and treatment times for future mutation experiments.

An inverse relation between EMS concentrations and percentage of seed germination was found with maximum of 72% of the control, for 0.25 EMS solutions, and minimum of 29% for 1% EMS concentration and 20 hours treatment time. M₁ plants showed different types of abnormalities, as slow vegetative growth, chlorophyll deficiencies, reduced height, twisted stems etc. The percentage of abnormal plants varied from 10% (treatment 0.25% EMS, 10 hours) to 82% (1%, 20 hours). The most remarkable effect of the EMS mutagenic agent on the M₁ plants was on the seed production per plant. M₁ plants from seeds treated with 0.25 % EMS dosis produced similar number of seeds than the control. With higher doses, a proportion of M₁ plants, which varied with the treatment, showed a significant decrease in the number of seeds per plant, 0 to 30 seeds in comparison with more than 300 of the control. This proportion varied between 50 and 80%, for the 50% EMS dosis, depending on the treatment time. For higher doses a 100% of plants had reduced number of seeds. Moreover the percentage of plants with no seed production was practically zero in the 50% EMS
treatment, varied from 50 to 90% for the 75% EMS treatment and was 100% for the 1% treatment with no seed production at all. These results indicate that doses of 50% of EMS and even 0.75%, depending on the treatment time could be used while still maintaining a reasonable M₁ survival and M₂ seed production.

M₂ generation was grown in 1987. A high frequency of visible mutated plants of 20 to 35% was observed in the 0.50 and 0.75 treatments, with different plant types, abnormalities (some of them lethals) and some variation in earliness. Some mutant showed improved plant types, including dwarf and semidwarf plants, and other showed a remarkable increase in the total leaf area and dry matter per plant of even more than three times than the control. The range of variation in flowering time was of two weeks, the earliest material being 10 days earlier than the control. Seeds from the mentioned M₂ mutants as well as from other abnormal plants were harvested separately and will be grown in 1988 to confirm them in M₃ generation and continuing the evaluation of the induced variation.

REFERENCES


SAFFLOWER CROPPING IN SPAIN: Current status and prospects

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Safflower production, has undergone several fluctuations in the last twenty years in Spain. Before the introduction and complete establishment of sunflower, in the seventies, safflower became an important crop, in some areas, particularly in the province of Sevilla (Southern Spain) where were located near a 70% of the 70000 Has grown in Spain in 1967. In 1968 a disease apparently caused by a bacterium of the genus Pseudomonas affected severely or destroyed more than 90% of the 54000 Has grown that year, what entailed a drastic decline of the area dedicated to the crop the following year, 1969. A slow recovering was observed in successive years up to 1973 when new varieties apparently tolerant to Pseudomonas were released. This situation was maintained during the following five years. In 1978 new high oil sunflower hybrid cultivars were released by several seed companies in Spain, providing them more profits than safflower and also increasing the interest of the farmers for sunflower. This fact made that gradually sunflower started to displace safflower even in the areas where the latter had been traditionally grown. This displacement was also favoured by the better prices of the sunflower which had been similar for both oil crops in previous years. This price situation has been maintained up to date with even more enlarged differences against safflower which finally has became a practically marginal crop only cultivated in those areas where competes favourably with any other crop. The overall area cropped to safflower has been stabilized during the last five years in arround 15000 Has even although new varieties with higher oil were released.

There are several facts that will have influence in the future evolution of this crop in Spain. The introduction and release of safflower hybrid varieties with potential yield up to 50% higher than the actual open pollinated varieties may increase the interest of seed companies and farmers for this crop at least in those areas where it competes favourably with sunflower. However, these and other potential improvements, may not be sufficient for the future expansion of this crop while the difference of prices will continue favouring significantly the sunflower. Unfortunately, after the incorporation of Spain to the European Common Market this situation can be even worse since the prices of the agriculture products have to be considered inside the common policy and safflower has not been included as one of the oil crops subsidized within the CAP (Common Agrarian Policy)
1986 WEED CONTROL EXPERIMENTS IN SAFFLOWER IN MONTANA

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Central Agricultural Research Center, Moccasin, Montana

Introduction

Four studies were established to evaluate twenty-nine herbicide treatments for safflower tolerance and weed control. None of the herbicides tested exhibited significant phytotoxicity to the safflower. Several treatments gave acceptable control of the broadleaf weeds and/or grassy weeds.

I. Fall surface application of 40885 for weed control in safflower:

Characteristics of the experiment:

Planting date: 5-16-1986 (no till into standing Clark barley stubble); Variety: 5 Rows 'Oker', 4 Rows 'Finch', 1 Row each of S-208 and Saffire, 3 Rows of Sidney Bulk Pop. Safflower Seed Rate: 20 lbs/acre. Equipment IHC-150 hoe drill 12" spacing.

Date of application: 11-7-1986; Carrier/ 15 gal/acre. Weather: wind, 6 mph.

Weeds: The nursery appeared relatively weed free except for an occasional lansy 11-7-85. At planting the flixweed and lansy were 6-8 inches tall in the untreated check, with a density of about 1/sq ft.

Equipment: CO2, backpack, 8003, 4 nozzles, 20" spacing, 30 psi, 15 g/a. Design: Randomized complete blocks, 3 replications, 30" x 14'.

Location: Central Research Center Soil: Judith-Danvers Clay Loam. Condition: wet sticky.

Observations

40885 (CHEWRONS) at 16 and 32 oz ai/a provided excellent control of the tansy and flixweed. The tansy and flixweed severely inhibited establishment and seedling growth. The weeds were pulled 6-9-1986. The safflower never recovered from the effect of these weeds. The safflower yield was significantly lower for the check than the three rates of 40885 (Table 1).
### Table 1: 1986 FALL SURFACE APPLICATION OF CHEVRON 40885 TO CONTROL WEEDS IN SAFFLOWER.

**CENTRAL AGRICULTURAL RESEARCH CENTER, MOCASSIN MONTANA**

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>OZ AL/A</th>
<th>PERCENT CONTROL Flixweed &amp; Tansy</th>
<th>POUNDS/ACRE SAFFLOWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>40885 (CHEVRON)</td>
<td>32</td>
<td>97.67</td>
<td>801.9</td>
</tr>
<tr>
<td>40885</td>
<td>16</td>
<td>93.33</td>
<td>754.9</td>
</tr>
<tr>
<td>40885</td>
<td>3</td>
<td>56.67</td>
<td>579.4</td>
</tr>
<tr>
<td>CHECK untreated</td>
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<td>196.3</td>
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<tr>
<td><strong>MEAN</strong></td>
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<td>61.92</td>
<td>583.1</td>
</tr>
<tr>
<td><strong>CV (S/MEAN)</strong></td>
<td></td>
<td>11.85</td>
<td>17.13</td>
</tr>
<tr>
<td><strong>LSD (0.05)</strong></td>
<td></td>
<td>14.65</td>
<td>1995.</td>
</tr>
</tbody>
</table>

### II. Preemergence applied herbicides:

**Characteristics of the experiment**

- **Planting date**: 5-16-1986 (no-till into standing Clark barley stubble); Variety: 5-rows 'Oker', 4-rows 'Finch', 1-row each of 'S-208' and 'Saffire', 3-rows of 'Sidney Bulk Population' safflower. Herbicide application: MCP ester was applied to the nursery area the first of May to hill the broadleaf weeds. Paraquat was applied (5-19-1986) alone or in tank mixes with the appropriate herbicide to control emerging weeds and those that escaped the MCPester.

- **Date of application of herbicides**: Pre-Emergent 5-19-1986; weather: wind, 3 mph. Air temp: 65 F. Armony (post) 6-9-1986; weather: wind, 4 mph. Air temp: 60 F.

- **Equipment**: CO2, Backpack, 8003, 4 nozzles, 20" spacing, 30 psi.

- **Location**: Central Research Center. Design: Randomized complete Blocks, 80"x14. Soil type: Judith-Danvers clay loam.

**Observations**

All plots were weed free through the growing season after the post plant application of Paraquat. The three rates of Command had significantly higher yields than the untreated check. This cannot be explained. The three rows of bulk population safflower died out either partially or completely in the Harmony treated plots. This was possibly due to a combination of later emergence and/or weak seedling. The bulk population weed was 4.5 yrs. old (Table 2).
Table 2. 1986 WEED CONTROL IN SAFFLOWER-PREEMERGENCE APPLIED HERBICIDES FOR WEED CONTROL IN SAFFLOWER

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Rate</th>
<th>%Control</th>
<th>Pounds/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command+Parquat</td>
<td>16+4</td>
<td>96.00</td>
<td>570.7</td>
</tr>
<tr>
<td>Command+Parquat</td>
<td>8+4</td>
<td>61.33</td>
<td>516.6</td>
</tr>
<tr>
<td>Command+Parquat</td>
<td>12+4</td>
<td>93.33</td>
<td>516.3</td>
</tr>
<tr>
<td>40885(CHVRM)+Parquat</td>
<td>3+4</td>
<td>0.0000</td>
<td>468.6</td>
</tr>
<tr>
<td>40885+Parquat</td>
<td>12+4</td>
<td>0.0000</td>
<td>442.1</td>
</tr>
<tr>
<td>Check+Parquat</td>
<td>- +4</td>
<td>0.0000</td>
<td>382.8</td>
</tr>
<tr>
<td>Mowdown+Parquat</td>
<td>24+4</td>
<td>0.0000</td>
<td>351.2</td>
</tr>
<tr>
<td>Parquat+Harmony(seq)</td>
<td>4+.25</td>
<td>0.0000</td>
<td>351.2</td>
</tr>
</tbody>
</table>

**MEAN** 32.21 449.9  
**CV (S/MEAN)** 10.46 16.28  
**LSD (0.05)** 5.902 128.2

III. Control of broadleaf weeds and wild oats with postemergence herbicides

Characteristics of the experiment

- **Planting date**: 4-10-1986; **Variety**: S-203; **Rate**: 20 lbs/acre. Hoe Drill 10" spacing.
- **Date of application of herbicide**: 6-3-1986; **Growing staged safflower**: Rosette, with 4-8 Leaf, and 4-6 inches tall; **Carrier**: 10 gal/acre.
- **Weeds**: kochia 0.25-4" tall, Russian thistle 2-4" tall, wheat 4-6" tall. Weather calm air; temperature 70 F.
- **Equipment**: CO2, Backpack, 8003, 4 nozzles, 20" spacing, 30 psi.
- **Location**: P. Dosdal Farm Geraldine, MT. **Design**: Randomized complete Blocks, 3 Replications 70" x 30" Soil: p.H: 7.5, Silty Clay Loam.

Observations

The wild oat, Russian thistle, and volunteer wheat populations were erratic in the study area while the kochia was more uniform. The broadleaf control of Harmony appears to be enhanced in tank mixes with the grass herbicides. It may be the crop oil or surfactant improving the performance of the Harmony. Assert suppressed kochia growth significantly. All the grass herbicides controlled the wild oats at a significant level. Safflower yield increased as kochia and wild oat control increased (Table 3).
<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>OZ AL/A</th>
<th>PLANTS PER PLOT</th>
<th>LBS SEED/ACRE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>KOCHIA HT</td>
<td>KOCHIA</td>
</tr>
<tr>
<td>Harmony+Assert+Surf.</td>
<td>.25+6+.1%V</td>
<td>13.33</td>
<td>3.000</td>
</tr>
<tr>
<td>Harmony+Fulsilade+C.O.</td>
<td>.25+4+11fl.oz.</td>
<td>20.00</td>
<td>4.333</td>
</tr>
<tr>
<td>Assert+Surfactant</td>
<td>6+.124%V</td>
<td>18.67</td>
<td>17.67</td>
</tr>
<tr>
<td>Harmony+Poast+Crop Oil</td>
<td>.25+3+32fl.oz.</td>
<td>12.33</td>
<td>7.333</td>
</tr>
<tr>
<td>Harmony+Assure+Surf.</td>
<td>.25+1.6+.25%V</td>
<td>14.67</td>
<td>27.33</td>
</tr>
<tr>
<td>Harmony</td>
<td>.25</td>
<td>32.33</td>
<td>31.67</td>
</tr>
<tr>
<td>Poast+Crop Oil</td>
<td>3+32 fl.oz.</td>
<td>20.00</td>
<td>45.00</td>
</tr>
<tr>
<td>Fusilade2000+Crop Oil</td>
<td>4+11 fl.oz.</td>
<td>21.67</td>
<td>42.33</td>
</tr>
<tr>
<td>Harmony+Surfactant</td>
<td>.25+.125%V</td>
<td>23.33</td>
<td>36.33</td>
</tr>
<tr>
<td>Assure+Surfactant</td>
<td>1.6+.25%V</td>
<td>30.67</td>
<td>45.33</td>
</tr>
<tr>
<td>Check</td>
<td>---</td>
<td>36.00</td>
<td>31.33</td>
</tr>
</tbody>
</table>

|                  | MEAN          | 22.09          | 26.52         | 6.00         | 2.12          | 52.7 | 1049      |
|                  | CV(S/Mean)    | 24.36          | 44.21         | 93.66        | 75.62         | 54.03 | 11.16     |
|                  | LSD (.05)     | 9.16           | 19.97         | 9.73         | 2.73          | 63.4 | 199.4     |

Table 3. CONTROL OF BROADLEAF WEEDS AND WILD OATS IN SAFFFLOWER WITH POST EMERGENCE HERBICIDES. CENTRAL AGRICULTURAL RESEARCH CENTER, MOCCASIN, MONTANA.
IV. Control of broadleaf weeds with Harmony

Characteristics of the experiment

Planting date: 4-10-1986; Variety: S-208; Rate: 20 lbs/acre. Spacing: 10".

Date of application of herbicide: 5-30-1986; Growing stage of safflower: 3-6 leaves, 2-4" height. Kochia: 25-2" tall, Wild Oats: 3 leaves.

Weather: Air Temperature 70°F, Wind 3 mph, Carrier 10 gal/acre.

Equipment: CO2, Backpack, 8003, 4 nozzles, 20" spacing, 30 psi.

P. Dosdal Farm Geraldine, MT, Design: Randomized complete Blocks, 3 Replications, 70" x 30" Soil: Silty Clay Loam, pH. 7.

Observations

Safflower exhibited good tolerance to Harmony. There was some light yellowing within 10 days after application. The surfactant (R-11) improved the broadleaf control of the Harmony. The date would indicate Harmony + Surfactant (.75 oz ai/a + .25%V) was mis-applied (Table 4).
<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>OZ AI/A</th>
<th>PLANTS/LOT</th>
<th>POUNDS/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KOCHIA</td>
<td>KOCIA</td>
<td>SAFFLOWER</td>
</tr>
<tr>
<td>Harmony+Surfactant .25+.25%V</td>
<td>.6667</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>Harmony+Surfactant .125+.25%V</td>
<td>5.667</td>
<td>.0000</td>
<td>.6667</td>
</tr>
<tr>
<td>Harmony+Surfactant .375+.25%V</td>
<td>.3333</td>
<td>.0000</td>
<td>.3333</td>
</tr>
<tr>
<td>Harmony+Surfactant .125+.125%V</td>
<td>5.667</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>Harmony+Surfactant .75+.25%V</td>
<td>16.33</td>
<td>.0000</td>
<td>4.333</td>
</tr>
<tr>
<td>Harmony         .75</td>
<td>11.00</td>
<td>.3333</td>
<td>2.667</td>
</tr>
<tr>
<td>Harmony+Surfactant .25+.125%V</td>
<td>8.000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>Harmony         .125</td>
<td>27.00</td>
<td>2.000</td>
<td>11.33</td>
</tr>
<tr>
<td>Harmony         .25</td>
<td>21.00</td>
<td>1.333</td>
<td>10.00</td>
</tr>
<tr>
<td>Check 12       ---</td>
<td>34.00</td>
<td>.3333</td>
<td>5.000</td>
</tr>
<tr>
<td>Check 11       ---</td>
<td>29.00</td>
<td>2.000</td>
<td>6.667</td>
</tr>
</tbody>
</table>

| MEAN           | 14.97   | 545.65     | 3.727       | 132       | 1145       |
| CV (S/Mean)    | 46.39   | 155.40     | 117.3       | 22.89     | 13.1       |
| LSD (.05)      | 11.83   | 1.443      | 7.445       | 51.7      | 255        |
SAFFLOWER VARIETY EXPERIMENTS IN MONTANA

D.W. Wichman
Central Agricultural Research Center, Moccasin, Montana

I. 1986 Intra-state variety trials

Characteristics of the experiment

Planting date: 4-10-1986. Harvesting date: 10-14-1986. Soil: silty clay loam, dry cloddy seedbed. pH 7.5 Randomized complete blocks design, 3 replications, 3 row plots, 12" space, 20" length, hoe opener, 1-1.5" depth.

Observations

A pounding rain prior to safflower emergence resulted in a poor stand for some varieties and plots. The poor stand establishment may be an indicator of low seedling vigor, whether it be a character of the variety or seed lot, because some varieties had good stands in all 3 reps. However, it appeared some of the variability was caused by the drill openers. Seeding at a shallower depth would have prevented the establishment problem. Paired plots of Oker and Saffire, tagged on the end, were seeded at 0-.5" depth had good stand establishment.

The wet fall caused severe sprouting. There were differences between varieties in the amount of sprout damage. The varieties were rated as they were clean by visual assessment. No actual counts were made (0-no sprout and 5-severe sprouting). Cultivars Finch and S-317 appeared to have the most sprout damage.

Cultivar Finch was top yielder for actual plot yield and when the yield was adjusted for stand. The top 5 producers, for actual yield, had significantly greater yields than the bottom 4. Oker and Saffire, in paired plots, had mean yields of 1280 and 1332 lbs/acre respectively.
Table 1. 1986 MONTANA INTRA-STATE SAFFLOWER VARIETY TRIAL, DOSDAL FARM, GERALDINE, MT

<table>
<thead>
<tr>
<th>VARIETY</th>
<th>SPROUT DAMAGE</th>
<th>% BLOOM 8-1-86</th>
<th>ACTUAL YLD LBS/A</th>
<th>ADJUSTED YLD LBS/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINCH</td>
<td>4.000</td>
<td>86.67</td>
<td>1378</td>
<td>1378</td>
</tr>
<tr>
<td>82B2653</td>
<td>3.333</td>
<td>85.00</td>
<td>1313</td>
<td>1346*</td>
</tr>
<tr>
<td>S-541</td>
<td>2.000</td>
<td>65.00</td>
<td>1331</td>
<td>1331</td>
</tr>
<tr>
<td>S-317</td>
<td>4.000</td>
<td>71.67</td>
<td>1317</td>
<td>1317</td>
</tr>
<tr>
<td>82B2369</td>
<td>2.000</td>
<td>76.67</td>
<td>1316</td>
<td>1316</td>
</tr>
<tr>
<td>83B1954</td>
<td>3.000</td>
<td>71.67</td>
<td>1193</td>
<td>1265*</td>
</tr>
<tr>
<td>OKER</td>
<td>2.667</td>
<td>80.00</td>
<td>1043</td>
<td>1264*</td>
</tr>
<tr>
<td>81B3697</td>
<td>2.000</td>
<td>76.67</td>
<td>1044</td>
<td>1216*</td>
</tr>
<tr>
<td>81B2653</td>
<td>3.333</td>
<td>71.67</td>
<td>1086</td>
<td>1198*</td>
</tr>
<tr>
<td>HARTMAN</td>
<td>3.000</td>
<td>75.00</td>
<td>1193</td>
<td>1193</td>
</tr>
<tr>
<td>81B3636</td>
<td>2.333</td>
<td>70.00</td>
<td>1141</td>
<td>1187</td>
</tr>
<tr>
<td>S-208</td>
<td>3.000</td>
<td>80.00</td>
<td>1078</td>
<td>1180*</td>
</tr>
<tr>
<td>GIRARD</td>
<td>2.333</td>
<td>78.33</td>
<td>1108</td>
<td>1158</td>
</tr>
<tr>
<td>81B2253</td>
<td>3.000</td>
<td>83.33</td>
<td>987</td>
<td>1110</td>
</tr>
<tr>
<td>REHBEIN</td>
<td>3.667</td>
<td>90.00</td>
<td>873</td>
<td>1090*</td>
</tr>
<tr>
<td>OLEIC LEED</td>
<td>851127</td>
<td>1.667</td>
<td>76.67</td>
<td>766.1</td>
</tr>
<tr>
<td>PARTIAL HULL</td>
<td>290</td>
<td>3.667</td>
<td>91.67</td>
<td>983.1</td>
</tr>
<tr>
<td>MEAN</td>
<td>2.882</td>
<td>78.24</td>
<td>1126</td>
<td>1207</td>
</tr>
<tr>
<td>CV (S/Mean)</td>
<td>14.78</td>
<td>9.662</td>
<td>16.92</td>
<td>14.51</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>.7083</td>
<td>12.57</td>
<td>317.1</td>
<td>NS</td>
</tr>
</tbody>
</table>

* COL 1: 0-no visible sprout damage 5- severe sprout damage (% not determined)
* COL 4: Varieties which moved up in rank when yield was adjusted for stand

II. Variety-seed source study

Characteristics of the experiment


Seed of each variety was obtained from 3 different sources.

Observations

Due to high variability no significant differences were found between treatments. (Table 2).
### Table 2. 1986 SAFFLOWER VARIETY-SEED SOURCE STUDY
CENTrAL AGRICULTURAL RESEARCH CENTER, MOCASIN MONTANA

<table>
<thead>
<tr>
<th>VARIETY</th>
<th>LBS/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OKER</td>
<td>890</td>
</tr>
<tr>
<td>2 OKER</td>
<td>891</td>
</tr>
<tr>
<td>3 OKER</td>
<td>973</td>
</tr>
<tr>
<td>4 HARTMAN</td>
<td>839</td>
</tr>
<tr>
<td>5 HARTMAN</td>
<td>860</td>
</tr>
<tr>
<td>6 HARTMAN</td>
<td>659</td>
</tr>
<tr>
<td>7 S-541</td>
<td>957</td>
</tr>
<tr>
<td>8 S-541</td>
<td>877</td>
</tr>
<tr>
<td>9 S-541</td>
<td>837</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td><strong>870</strong></td>
</tr>
<tr>
<td><strong>LSD (.05)</strong></td>
<td><strong>M S</strong></td>
</tr>
</tbody>
</table>

**RESULTATS ACQUIS EN MATIÈRE DE SELECTION GENETIQUE
DU CARTHAME AU MAROC**

M. Boujghagh  
Station Centrale des Plantes Oléagineuses  
INRA – SP. 415 Rabat

**Abstract**

Safflower is an oil crop, with a high degree of resistance to conditions of low temperature and drought, that can be cultivated in almost all areas of cultivation of Morocco. However the area dedicated to this crop in the last years is insignificant due in great part to the poor characteristics (low oil content and high hull %) of the used varieties. A research program was carried out from 1969 to 1986 with the following results and conclusions: 1) Average yields of all varieties tested were in general satisfactory although existed variation among them. On the other hand yields obtained severe drought conditions showed that safflower is the species with more potential under these conditions 2) The local spineless material showed higher resistance to diseases than the spiny germplasm of American origin. The latter showed higher oil content but lower grain yield 3) Same cultural practices as
fertilization, weed control and plant population need to be studied for different conditions and genotypes to allow this crop to show its maximum potential.

After the introduction and evaluation of germplasm, local parentals were combined with material with higher oil content with the objective of combining yield potential and resistance to diseases with a high oil content. This program currently is in progress.

INTRODUCTION

S'accommodant sur la majorité des sols-sous réserve d'un minimum de fertilité - le carthame plante rustique, résistant au froid et beaucoup plus à la sécheresse, peut pousser normalement dans presque toutes les zones de culture du Maroc. Cette culture nécessite un regain d'intérêt particulier dans le but de rentabiliser non seulement les terrains pauvres mais aussi les zones arides et semi-arides où d'autres espèces cultivées végétéraient moins facilement. Le développement de cette culture permetterait donc, à moyen ou à long terme, de couvrir, tout au moins en partie, nos besoins en huiles alimentaires dont le déficit pèse lourdement sur notre balance commerciale.

La culture du carthame a débuté dans notre pays en 1965 avec 20 Ha (Tableau 1). La plus grande superficie a été emblavée en 1967; 1300 Ha. Elle a été abandonnée en 1972 pour des raisons essentiellement qualitatives. En effet, les variétés utilisées présentaient une teneur en huile très faible (24 à 30%), un taux élevé de cellulose dans la coque et par conséquent dans les tourteaux, ce qui limite fortement leur valeur énergétique, en outre leurs graines étaient très difficilement décorticables.

Tableau 1. Evolution de la culture du Carthame au Maroc

<table>
<thead>
<tr>
<th>ANNEES</th>
<th>SUPERFICIES SEMÉES (Ha)</th>
<th>RENDEMENT EN qX/HA</th>
<th>PRODUCTION EN qX</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>20</td>
<td>12</td>
<td>240</td>
</tr>
<tr>
<td>1966</td>
<td>400</td>
<td>5</td>
<td>2.000</td>
</tr>
<tr>
<td>1967</td>
<td>1.300</td>
<td>5</td>
<td>6.500</td>
</tr>
<tr>
<td>1968</td>
<td>600</td>
<td>8</td>
<td>4.800</td>
</tr>
<tr>
<td>1969</td>
<td>350</td>
<td>6</td>
<td>2.100</td>
</tr>
<tr>
<td>1970</td>
<td>400</td>
<td>6</td>
<td>2.408</td>
</tr>
<tr>
<td>1971</td>
<td>200</td>
<td>15</td>
<td>3.000</td>
</tr>
<tr>
<td>1972</td>
<td>400</td>
<td>8,75</td>
<td>3.500</td>
</tr>
<tr>
<td>1982</td>
<td>15</td>
<td>13,4</td>
<td>94</td>
</tr>
<tr>
<td>1983</td>
<td>132</td>
<td>3,5</td>
<td>248</td>
</tr>
</tbody>
</table>

Source: - Les cultures oléagineuses annuelles DPV 1981 - Rapports annuels de la DPV.
RESULTATS ACQUIS EN MATIERE DE SELECTION VARIETALE

   - Periode 1969 a 1980 (Tableau 2).

   Par opposition aux varietes americaines epineuses testees, (Rio, Royal, Leed et Dart), les varietes locales inermes (serie de varietes VS et Zitghani) sont assez resistentes aux maladies cryptogamiques (notamment aux rouilles) et aux viroses.

   Les rendements moyens obtenus sont generalement satisfaisants pour toutes les varietes. Le rendement maximum, calcule sur plusieurs annees et plusieurs stations Experimentales (Tableau 2) a ete obtenu avec la variete Zitghani (24,21 qx/Ha) suivie de la variete VS 95 avec 21,29 qx/Ha). La premiere a pu donner 54,42 qx/Ha dans un essai irrigue realise en 1975 a M. Zhar.

   Les varietes americaines, introduites en collection depuis 1972, ont une teneur en huile assez elevee (40 a 42% par rapport a la matiere seche). Alors que les varietes marocaines presentent une teneur en huile tres faible (29 a 35% par rapport a la matiere seche), cette faiblesse en huile est tres largement compensee par le rendement en grains. Quoiqu'il soit ces varietes ont un taux de cellulose tres eleve dans leurs coques.

   - Periode 1981 a 1984 (Tableau 3).

   Les essais menes aux Stations Experimentales de J. Shaim et de Sidi el Aidi, durant les campagnes 1981-82 a 1983-84, caracterisees par une secheresse tres accentuee, ont montre que le carthame est la seule espece qui a pu presenter certaines potentialites et possibilites de production dans ces conditions (Tableau 3). A titre de comparaison, les cereales ont donne dans les memes Stations des rendements en grains variant de 0 a 0,8 qx/Ha. Ces rendements sont tres faibles neanmoins ils montrent bien que cette espece est tres resistant a la secheresse. Un programme d'amelioration, aussi bien cultural que genetique, est en mesure de redresser ces resultats sur le plan qualitatif et quantitatif.


   Vu le nombre de varietes testees jusqu'a present, vu les exigences de la grande culture (teneur en huile elevee, resistance a la secheresse, resistance aux maladies cryptogamiques, taux de cellulose reduit dans la coque...) l'Institut National de la Recherche Agronomique a introduit plus d'une quarantaine de lignees et varietes de Carthame d'origine divers. Cette voie s'impose bien entendu au
### Tableau 2. COMPARAISON DES RENDEMENTS* EN GRAINS ET EN HUILE (qx/ha) DES VALETES DE CARTHAME

**ESSAIS INRA STATION CENTRALE DES PLANTES OLEAGINEUSES**

**CAMPAGNES: 1969-70 à 1980-81.**

<table>
<thead>
<tr>
<th>ANNÉES d'essais</th>
<th>Vs. d</th>
<th>Vs. 11</th>
<th>Vs. 95</th>
<th>ZITGHANI</th>
<th>LEED</th>
<th>ROYAL</th>
<th>RIO</th>
<th>DART</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RG.</td>
<td>RH.</td>
<td>RG.</td>
<td>RH.</td>
<td>RG.</td>
<td>RH.</td>
<td>RG.</td>
<td>RH.</td>
</tr>
<tr>
<td>1969</td>
<td>4</td>
<td>17,73</td>
<td>-</td>
<td>19,80</td>
<td>-</td>
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**MOYENNE**

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* Moyenne sur plusieurs Stations.

RG: Rendement en grains en qx/ha.

RH: Rendement en huile en qx/ha.
Tableau 3. RÉSULTATS DES ESSAIS COMPARATIFS DE VARIÉTÉS DE CARTHAME RENDEMENTS EN GRAINS ET TENUES EN HUILE.

<table>
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<tr>
<th>STAT. EXP.</th>
<th>J. SHAIM</th>
<th>S. EL. AIDI</th>
<th>M. ZHAR*</th>
<th>DOUYET</th>
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<td>5,76</td>
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</table>

RG: Rendement en grains en q/ha.
TH: Teneur en huile en % par rapport à la matière sèche
*: En Irrigué
premier lieu en vue d'enrichir notre collection "germplasme" base de toute action d'amélioration génétique. L'expérimentation d'une partie de ce matériel en essais préliminaires et comparatifs (Tableau 4) a révélé la superiorité de trois variétés américaines; US-10, Oleic Leed et Parcial Hull. Ces variétés, notamment Oleic Leed et Parcial Hull, présentent une teneur en huile moyenne de 45%, une coque moins riche en cellulose, une productivité en grains élevée, et une certaine "tolérance" à la rouille...

La variété locale Zitghani crée en 1972 présente une forte variabilité phénotypique. Il semble que cette variabilité est dûe à une ségrégation des caractères parentales. Pour vérifier cette hypothèse plus de 400 pieds ont en été sélectionnés en 1984. Sur la base du poids total des graines par pied, du poids de mille graines, de la teneur en huile..., les meilleurs d'entre eux on été testés en 1985 en vue de s'assurer de la stabilité des caractères et de voir si c'est l'ensemble des phénotypes observés qui confèrent à la variété sa supériorité ou, au contraire, existe-t-il parmi eux des particularités meilleures ? Ce test a révélé qu'il existe au sein de cette "population" des lignées qui dépassent de loin la variété témoin au point de vue productivité et résistance à la rouille. Ces lignées sont utilisées actuellement, comme géniteurs, dans un programme d'amélioration génétique dans le but de combiner à la fois dans un seul génotype les caractères; résistance à la rouille et autres maladies cryptogamiques, haute teneur en huile, productivité, taux de cellulose réduit dans la coque...

En effet, quoique le nombre de génotypes composant notre collection est faible, il est d'ores et déjà possible d'entamer un programme de sélection à partir des croisements entre lignées génétiquement très éloignées...

CONCLUSION

Le Carthame est une plante à laquelle on a fait une réputation de rusticité exagérée basée sur une réponse moins nette que d'autres espèces à des facteurs comme la fertilisation ou l'irrigation. Cette image; plante capable de bien s'adapter à des terres de fertilité médiocre et de bien supporter un certain niveau de sécheresse, risque de conduire aussi bien le vulgarisateur que l'agriculteur à ne pas l'introduire dans les meilleures sols.

Pour permettre à cette culture d'exprimer ses potentialités génétiques aussi bien en zones arides qu'en zones semi-arides, il faut aller jusqu'à mettre en cause toutes les techniques culturales employées, valables, dans une certaine mesure, pour le pour favorable, et extrapolées sans être vérifiées dans ces zones. Autrement dit il faut reprendre le problème sur tous les aspect pour élaborer
### Tableau 4. RESULTATS DES ESSAIS COMPARATIFS DE VARIETES DE CARTHAME

RENDEMENTS EN GRAINS TENEUR, EN HUILE, POIDS DE MILLE GRAINES, ET RESISTANCE A LA ROUILLE.

CAMPAGNE 1985 - 86

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<tr>
<th>STAT. EXP.</th>
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<th>MOYENNE DES STATIONS</th>
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<td>14,53 37,19 51,73 3</td>
<td>11,01 30,15 48,90 3</td>
<td>14,30 34,78 51,03 5</td>
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RG: Rendement en grains (qx/ha)  
TH: Teneur en huile en % de la matière sèche  
PMG: Poids de mille graines (g)  
RR: Resistance à la rouille (échelle de 1 très résistant à 5 très sensible)
des techniques qui conviennent le mieux à ces conditions. A titre d'exemples:

- Fertilisation: les doses préconisées dans les fiches techniques sont à notre sens très élevées. La majorité des essais effectués sur d'autres espèces ont démontré que les faibles doses, et, même le temoin non fertilisé, donnent le plus souvent le meilleur rendement. Sur le plan théorique nous pouvons avancer que les apports d'azote ne feront que favoriser le développement végétatif, par conséquent un épuisement prématûre des réserves en eau du sol, et diminuer le rendement final. Par contre une fertilisation phosphatée (bien équilibrée) en améliorant la croissance et la vigueur des racines, ne fera que contribuer à améliorer la résistance de cette culture à la sécheresse.

- Le contrôle des adventices: les adventices concurrencent la culture pour les éléments minéraux, la lumière et l'eau. Dans ces zones arides et semi-arides, c'est évidemment la concurrence pour l'eau qui l'emporte. Leur contrôle apparait donc, au premier lieu, comme une des préoccupations les plus indispensables si on vise mieux valoriser les précipitations. L'emploi d'herbicides semble être la solution la plus sûre, car, la nécessité d'installer la culture juste après les premières pluies d'automne élimine tout contrôle par le travail du sol. D'où la nécessité de développer les recherches sur le choix des herbicides et les modalités de leur application.

- Les écarts entre les lignes: de très nombreux travaux ont montré qu'un accroissement de la densité s'accompagne d'une intensification des actions engagées entre compétiteurs et ceci vraisemblablement parce qu'au niveau de l'individu, cet accroissement équivaut à une réduction du volume de l'offre en facteurs physiques de l'environnement. Cette intensification intervient aussi bien à l'intérieur d'une même structure qu'entre structures génotypiques différentes. Ainsi, d'une façon comparable aux adventices, ces écarts doivent être adaptés à ces zones pour permettre à la culture de bénéficier au mieux du maximum d'eau possible. Ceci est à éviter bien entendu dans les zones favorables. En effet, le cardamine, parmi les espèces ayant la particularité de profiter de l'espace disponible développe dans le cas de très grands espacements entre plantes un système végétatif important; tige rigide, ligneuse très dure et très ramifiée. Ce qui a des répercussions néfastes à la récolte... Ainsi, sachant que le peuplement à l'hectare peut varier dans une assez large gamme sans grande influence significative sur le rendement (aussi bien en grains qu'en huile); un essai combinant à la fois différents peuplements et la récolte mécanique apparaît, dans ces conditions, comme une des préoccupations techniques la plus indispensable...
REFERENCES


COMPARISON OF YIELD COMPONENTS IN NATIVE AND FOREIGN ORIGIN SAFFLOWER (Carthamus tinctorius L.) VARIETIES

Ozer Koisarici
Deputy Director of Department of Agronomy
Faculty of Agriculture, University of Ankara, Turkey

In this research work 3 cultivars from U.S.A. with high ratio oil content (Oleic Leed, Reduced Hull-2 and Partial Hull-2) and 3 drought resistant cultivars from Spain (304, 308 and 308/1) were tested. In addition, two native varieties (one spiny and one spineless) were used.

Field trials were carried out two years at the Department of Agronomy, Faculty of Agriculture, University of Ankara. Experiment was laid out in a randomized block design with four replications. Plot size was 4 m² with 8 rows and 20 plants in each row.

Two years results can be summarized as follows:

1. The highest seed yield was 3168.8 kg/ha in native spineless variety and the lowest 1133.1 kg/ha in cultivar 308.

2. Plant height of cultivar Oleic Leed was found to be as 78.21 cm, whereas it was 94.4 cm in native spineless variety.

3. Minimum and maximum branch number per plant were 7.48 in cultivar 308 and 8.43 and in the native spiny variety. However differences between cultivars were not statistically significant.

4. Number of heads per plant varied from 12.45 (cv. Oleic Leed) to 16.66 (in native Spiny variety), but differences were not found statistically significant.

5. "Thousand seed weight" varied from 31.86 g (cv. Partial Hull-2) to 40.65 g (in native spineless variety). Effect of cultivars and years on thousand seed weight were statistically significant.
6. Oil content of seeds using the Soxhlet method varied between 29.71% (in native spineless variety) and 41.85% (Partial Hull-2 variety). Generally, oil rations were found in high content in foreign varieties in comparison with native cultivars.

Safflower cultivars were used in a hybridization programme from USA origin with native varieties and lines with the higher oil content and seed yield were obtained. Breeding programme of safflower varieties are still continuing in our Faculty of Agriculture.

**INFLUENCE OF WATER STRESS ON PROLINE ACCUMULATION, CHLOROPHYL CONTENTS AND PHOTOSYNTHETIC RATE IN FOUR CULTIVARS OF SAFFLOWER**

U.S. Sawant and B.A. Karadge  
Department of Botany, Shivaji University, Kolhapur 416 004

The effect of water stress on the tissue moisture level, proline accumulation, chlorophyll content and the rate of photosynthetic $^{14}$CO$_2$ fixation in four safflower (Carthamus tinctorius L.) cultivars, Local, Tara, N62-8 and A-300 has been investigated. The plants were grown on soil with adequate water supply in earthenware pots until the heading stage, after which water stress was created by withholding water supply for 15 days. It is found that proline content gradually increases in the first 96 hours after the initiation of water stress. However, at the wilting stage, there is a rapid increase in the level of proline particularly in cultivars A-300 and Tara. Chlorophyll content of the leaf is reduced under water stress in all cultivars except Tara. Water stress induced stomatal closure most of the time in a day except at about 10 to 11 a.m. when the stomata remain partially opened. Water stress caused slight decrease in the rate of photosynthetic $^{14}$CO$_2$ fixation in all the safflower cultivars. The mechanism of drought resistance in safflower has been discussed in the light of results obtained in the present investigation.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
RATES OF NITROGEN SUPPLY DURING DIFFERENT DEVELOPMENTAL STAGES AFFECT YIELD COMPONENTS OF SAFFLOWER (Carthamus tinctorius L.)

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C.S.I.R.O., Centre for Irrigation Research,
Griffith, N.S.W. 2680 (Australia)

1Present address: School of Agriculture, University of Western Australia, Needlands, W.A. 6009 (Australia)

The yield components of two safflower (Carthamus tinctorius L.) lines have been studied in glasshouse experiments. Three nitrogen supply rates were used in each of three developmental phases: emergence to the beginning of stem internode elongation, from stem elongation to when the terminal capitular bud became visible, and from then to maturity. The major component of yield was the number of capitula per plant. The successive orders of branches, primary to quaternary, are each terminated by capitula. The number of secondary capitula was determined by the nitrogen supply rates between the time of stem elongation and when the terminal bud became visible; the number of tertiary capitula by the nitrogen supply after both stem elongation and bud visibility; and the number of quaternary capitula by the nitrogen supply after terminal bud visibility. The number of filled seeds per plant was linearly correlated with the number of capitula which in turn was linearly related to the dry weights of the plants. This relationship differed between the two genotypes used: Gila and an experimental line, A1110. Total plant dry weights and nitrogen contents were positively affected by nitrogen supply rates after stem elongation, as were the separate organs: leaf laminae, stem + petioles, and roots.

Single seed weights did not differ much between nitrogen supply rates, and the only significant effect of nitrogen supply on oil concentration in the seeds was a depression by the highest rate after bud visibility. The product of these yield components, oil yield per plant, was significantly affected by the nitrogen supply rates between stem elongation and bud visibility. The nitrogen concentration in seeds was only affected by nitrogen supply rates after bud visibility; there were differences in the response of the two genotypes.

The results show that the most efficient time of application of nitrogen fertilizer to safflower crops is at stem elongation.

* The full paper was published in Field Crop Research (1986), 14: 221-231.
PRODUCTION OF SAFFLOWER, *Carthamus tinctorius* L., IN QUEENSLAND

K.J. Jackson and J.E. Berthelsen
Queensland Department of Primary Industries Research Station, Gatton, Qld 4343, Australia
Biloela Research and Station, Qld, 4715, Australia

Safflower was first grown commercially in Queensland in 1955. Adaptation problems encountered during the early years of safflower growing, as well as government and private research conducted during this period, are outlined. The current government research program, commenced in 1972, is discussed in relation to safflower production in a tropical to subtropical, subhumid to semi-arid climate where availability of water is the main constraint on production. Manipulation of planting date is necessary to prevent flowering during severe frosts in July and August, and to minimize the effects of rapidly rising temperatures in spring on yield potential. Presence of the disease *Alternaria carthami* (Chowd.) in commercial crops has been identified as a major cause of yield loss in seasons when extended wet periods are associated with rising spring temperatures, and flowering. Only 38,600 ha have been successfully cropped, but much larger areas (2.7m ha) could be utilised provided that better adapted varieties become available. The new varieties will have disease resistance, higher oil content and greater yield potentials. Photo-insensitivity and cold tolerance in these varieties will increase flexibility in cropping management.

SOURCES OF Alternaria Carthami INOCULUM IN SAFFLOWER

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Spread of the disease Alternaria leaf blight (Alternaria carthami) from infected safflower seed and stubble was studied at Biloela in central Queensland to determine the importance of these inoculum sources in the initiation of epidemics.

Seed infection levels of 20-55\% resulted in 1.4-2.0\% emerged diseased seedlings in the field. Levels of 1.0\% seed infection have previously caused severe disease outbreaks in commercial crops. Visual appraisal of seed health correlated highly with laboratory, glasshouse and field assessments of diseased seedlings. Glasshouse assessment of emerged diseased seedlings gave the best indication of expected disease incidence in the field. Seed germination in the laboratory correlated poorly with emergence in the glasshouse and the field.

Incidence of \textit{A. carthami} on seedlings following soil incorporation of diseased stubble in November 1977 diminished from 28\% in May 1978 to 0\% in September 1980. Burning of diseased stubble in November 1977 failed to eliminate the disease, but reduced the number of emerged disease seedlings by 66\% in May 1978. Dusting of healthy seed with a fungicide increased total emergence, but it did not control the spread of the fungus from the infected stubble as emergence of diseased seedlings was also increased.

BROADLEAF WEED CONTROL IN SAFFLOWER WITH POST EMERGENCE HERBICIDES

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Trifluralin is currently the primary weed control herbicide used in Northern Plains safflower (Carthamus tinctorius) production. Trifluralin provides satisfactory weed control under ideal conditions. However, under the dry windy conditions frequently experienced in the Northern Plains during March and April, proper application of trifluralin is often difficult. Further, the required two preplant incorporations of trifluralin dry and loosen the soil contributing to poor stand establishment and increased erosion potential in a region already experiencing severe wind erosion. Therefore post emergence herbicides were evaluated at Havre, Bozeman, and Geraldine, Montana for safflower weed control.

Safflower exhibited high tolerance to DPX-M6316 alone at: .125, .25, and .75 oz ai/a and to DPX-M6316 at .25 oz ai/a: and AC 222, 293 at 6.0 oz ai/a applied early post emergence (safflower 2-8 leaves and weeds 2-6 if). Safflower exhibited stunting and chlorosis 7-10 days after application, but grew out of these symptoms within 5 weeks. Safflower exhibited significant foliar injury from the DPX-M6316 + fluazifop (.25+4.0 oz ai/a) tank mix as late as August 14 at the Bozeman site. However, it did not significantly affect seed yields at Moccasin and Havre.

The use of a non-ionic surfactant, at .125% and .25% v/v rates, improved DPX-M6316 control of common lambsquarters, (Chenopodium album), cowcockle (Vaccaria pyramida), tansy mustard (Descurainia pinnata), field pennycress (Thlaspi arvense), redroot pigweed (Amaranthus retroflexus), and kochia (Kochia scoparia). Tank mixes with AC 222, 293 and the gramidicides did not affect DPX-M6316 control of most broadleaf weeds and improved its control of others. However, AC 222, 293 did appear to reduce DPX-M6316's control of Russian thistle at Havre. DPX-M6316 in tank mixes with AC 222, 293 and the gramidicides did not affect wild oat (Avena fatua) control. AC 222, 293 alone exhibited excellent control of wild and tansy mustards, common oestraw, and wild oats, fair-poor control of redroot pigweed, field pennycress, Russian thistle, kochia, and poor control of common lambsquarters and cowcockle.

* Presented in 1987 Proc. of Western Society of Weed Science.
SAFFLOWER SUSCEPTIBILITY AND RESPONSE TO FEEDING BY GRASSHOPPERS

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Feeding by three grasshopper species, Camnula pellucida, Melanoplus packardii, and Melanoplus sanguinipes, on three safflower (Carthamus tinctorius) lines for a 6-week period from anthesis was monitored under field conditions. Ratings of feeding damage to different plant parts (leaves, floral parts, capitula, and peduncles) and measurements after termination of feeding (dry weight, seed yield, seed weight, seeds per capitulum, and capitula per row) were compared among grasshopper species and safflower lines.

Wire mesh cages, covering one square meter of plot area, were placed over the crop when flowering commenced. Four cages were used per plot: for each of the three grasshopper treatments and a grasshopper-free check. Fifty adult grasshoppers were added to each cage and their numbers were replenished as required. Grasshopper feeding continued until cool weather in early September with daytime highs below the feeding threshold. This was approximately one to two weeks beyond physiological maturity of the crop.

The Melanoplus species fed preferentially on leaves, floral parts, and capitula, while C. pellucida exhibited only peduncle feeding, which resulted in head clipping. Defoliation of 20 to 30% was associated with significant increases in total dry matter, seed yield, and number of capitula. Further defoliation resulted in decreases.

The safflower lines differed in response to grasshopper feeding. S-208 was most susceptible to defoliation by grasshopper feeding, exhibiting decreased dry weight, seed yield, and capitula number. Lesaf 34C-00 (which gave rise to the only variety of safflower licensed in Canada, 'Saffire') was most tolerant and only M. packardii caused significant dry weight and seed yield reductions. Feeding by C. pellucida on this line resulted in an overall seed yield increase. Feeding by A. sanguinipes on Seedtec-5 resulted in yield increases of up to 16%. It appears that certain grasshopper species can increase seed yield in some safflower lines by stimulating the production of additional capitula. Therefore, moderate populations of such grasshoppers in fields of appropriate safflower cultivars do not necessarily require control.

Laboratory experiments were conducted to measure the feeding rates, preferences, survival rates, maturation times, and weight gain of four common species of grasshoppers (Orthoptera: Acrididae) on four lines of safflower (Carthamus tinctorius). When safflower lines were presented individually, all were readily consumed although consumption differed significantly according to grasshopper species, age, and sex, and to safflower line. Consumption was greatest on a safflower line devoid of spines (N-1). However, grasshoppers also fed readily on spiny lines, and results of experiments in which all safflower lines were presented together indicated preferences that did not necessarily correspond to the results of the single-line feeding trials. Camnula pellucida, a graminivorous species, did feed on safflower, but restricted feeding almost exclusively to stem cambium, whereas Melanoplus bivittatus, M. packardii and M. sanguinipes fed mainly on heads, flowers and leaves.

Highly significant differences in grasshopper maturation time and weight gain were apparent among grasshopper species, and among safflower lines. Seedtec-5, the line which was least digestible, least consumed, and least preferred nevertheless yielded rapid development and the greatest body weights of grasshoppers. All species of Melanoplus developed more quickly and gained more weight on safflower than on wheat. One species, M. packardii, was more able to utilize safflower than its congener, and may gain competitive advantage if safflower becomes widely grown.

ADAPTATION AND YIELDING OF SEVERAL SAFFLOWER VARIETIES IN TWO DIFFERENT ENVIRONMENTS IN SOUTHERN ITALY

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A comparison among different safflower varieties has been conducted for five years (1981-1985) in two localities of Apulia (Foggia) and Basilicate (Policoro) region.

It has been found during five years the high influence of environmental conditions particularly total rainfalls and its distribution and seeding time on seed production.

Low production (from 0.3 to 1 ton. ha\(^{-1}\)) has been obtained when total rainfall was lower than 250 mm or with spring seeding.

Under satisfactory environmental conditions (about 400 mm of rainfall) and with fall seeding, seed production showed a remarkable increase varying from 2.2 to 2.8 ton. ha\(^{-1}\).

Among varieties tested, Italian varieties, Bonello, Guaimaro and Senno furnished a satisfactory seed production (around 2.8 ton. ha\(^{-1}\)) with high oil percentage (42-46%) in the seed.

* Extracted from Proceeding of National meeting on Safflower an alternative crop. Full paper Published by the University of Bary 1986, 55-71.
INFLUENCE OF PLANT DENSITY AND MINERAL FERTILIZATION ON YIELD OF SAFFLOWER (Carthamus tinctorius L.)

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Experiment results on safflower gathered for 1 year at Policoro field in Southern Italy concerning of plant density and mineral fertilization are reported in this paper.

Thirty six treatments, obtained comparing 3 distances between rows (25-50-75 cm), two seed rates (30-50 kg ha\(^{-1}\)), two levels of P\(_2\)O\(_5\) (0-100 kg ha\(^{-1}\)) and 3 levels of N (0-80-160 kg/ha\(^{-1}\)), have been realized using a split-plot design.

Safflower seed yield has been positively influenced by nitrogen fertilization.

Higher seed production (2.5 t ha\(^{-1}\)) has been obtained by using 180 kg ha\(^{-1}\) of nitrogen. Nitrogen positively influenced also the 1000 "seed" weight. Phosphorus did not influence seed production.

Row distance of 25 cm furnished highest seed production (2.4 t ha\(^{-1}\)).

Seed rate did not influence seed yield; therefore seed rate of 30 kg ha\(^{-1}\) seems to be appropriated to obtain an efficient plant density (around 20 plants m\(^{-2}\)).

Safflower seems to be a promising crop for several environments of Southern Italy at the present dominated by wheat monoculture.

EFFECT OF POTASSIUM DEFICIENCY ON THE COMPOSITION OF CERTAIN PHOSPHATE COMPOUNDS IN SAFLOWERS

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The present investigation was undertaken to study the variations in the composition of different phosphate esters in safflower under potassium deficiency about which hardly any information is available. Safflower (Carthamus tinctorius L. var. T. 65) plants were grown at normal (3 M) and deficient (0.5 M) levels of potassium supply in sand culture up to 50 days of growth. Yellowing of older leaves which later turned necrotic was evident after 42 days of growth. After 50 days growth, a set of deficient plants were given normal supply of potassium as recovery treatment while plants in the other set continued to receive the deficient supply of potassium. After 51, 58 and 65 days growth (1, 3 and 15 days after the recovery treatment), young (24th -25th from the base) and mature (3rd - 4th from the base) leaves from normal, deficient and deficient plants given recovery treatment were analysed for various phosphorus fractions.

Potassium deficiency resulted in reduced growth and development and exhibited visible symptoms brown necrotic spots in middle leaves and paling followed by necrosis in older leaves. The leaves of potassium deficient plants, both young and old had high concentrations of Pi, total acid soluble-O and total phosphates. Potassium deficiency decreased the of activity of second peak while the first peak remained unaffected. This suggests that in groundnut seeds pre-formed enzymes are present in the dry seeds to initiate germination and a second phase of enzyme synthesis is required for further growth which as absent in dormant seeds.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
ASSESSMENT OF PHYSIOLOGICAL MATURITY IN SEEDS OF SAFFLOWER

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Safflower plant is characterised in having asynchronous branching. Hence, the commencement of anthesis in different branches takes place in different periods of the flowering season. It was observed that under local conditions of West Bengal, anthesis commenced at least five days after the main axis in the primary branch, 10 to 12 days in the secondary branch and 20 to 25 in the tertiary branch. The maximum dry matter accumulation in seeds of the main and the primary branches, was found at 30 to 35 days following the anthesis, while this was at 20 to 25 days in the secondary and tertiary branches. The seeds of the main and primary branches attained their harvest maturity when the seeds of secondary and tertiary were physiologically mature.

The seeds of the main axis harvested at 20 days after anthesis failed to germinate while that of primary branches showed 30 per cent germination. However, the seeds of secondary and tertiary branches showed 100 per cent germination. Leaching of electrolytes, soluble carbohydrates and amino acids was more in seeds of the main and primary branches than that of secondary and tertiary branches. The oil content in seeds of the main and primary branches was also found lower than others. Further, seed viability test showed that these are sound and healthy. The cause of failure in germination of these seeds appeared to be at least not due to deficiency in GA level because exogenous GA failed to induce germination.

Seed productivity is about 3, 35, 30 and 12 per cent in main, primary, secondary, and tertiary branches, respectively. Plants raised from seeds of main axis and tertiary branches produced plants with less vigour which subsequently produced less yield compared to plants raised from seeds of primary and secondary branches. Therefore, these results pointed out that the plant vigour and yield are not related to seed size and maturity in safflower.

Physiologically mature seeds (collected at about 130 days of plant age) showed 15 to 20 per cent moisture content in contrast to harvest mature seeds (collected at about 170 days of plant age) which has 10 to 12 per cent moisture. Germination tests during two years dry storage period showed that after 13 months the seeds of the main axis failed to germinate and of tertiary showed only 30 per
germination. But seeds of primary and secondary were fully viable. The cause of early deterioration of seeds of main and primary is under investigation.

Studies on the potentiality of physiologically mature (PM) seeds in comparison with harvest mature (HM) seeds showed that HM and PM seeds remained 100% viable for about 28 days of accelerated ageing. Seedling growth was also normal. In fact PM seeds of primary and secondary branches remained 90 to 100% viable for about 24 months under dry storage like HM seeds. Hence harvesting of seeds at PM stage may easily be practiced in this oil seed crop.

* Abstract of the National Seminar of Physiology and Biochemistry of Oilseeds plants, Feb, 5-7, 1987. SRI VENKATESWARA UNIVERSITY, TIRUPATI, INDIA.
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