REGISTRATION OF RUST RESISTANT
SAFFLOWER BREEDING LINES PCA,
PCM-1, PCM-2, PCN₁, AND PCO₂¹

D. E. Zimmer and A. L. Urie²

Rust, incited by Puccinia carthami Cela., is a common disease of safflower, Carthamus tinctorius L., in irrigated areas of the southwestern United States. It prevents continuous safflower cropping and frequently causes reduced stands even through crop rotation and seed treatment practices are followed. No variety is resistant to all races of rust. 'Ute,' a moderately resistant variety, and other lines with its resistance are the only rust resistant safflowers grown commercially.

Five improved lines (PCA, PCM-1, PCM-2, PCN₁, and PCO₂), each carrying a different dominant gene for rust resistance effective against all known races, were developed by the Crops Research Division, Agricultural Research Service, USDA, in cooperation with the Utah Agricultural Experiment Station. They were released as safflower breeders for selection or use as parents in hybridization programs. The resistance conditioned by each gene, separately or selectively, is sufficient to prevent yield loss from either seedling or foliage rust.

PCA (Reg. No. GP 1) is a striped-hulled F₆ selection from the cross (U-1421-6-11 × PI 253914-7) × Ute. U-1421-6-11 is a moderate rust-resistant selection from a cross between 'Pacific 7' and 'Nebraska 8.' PI 253914-7 is a selection of an Iranian introduction and possesses the A gene for resistance to both seedling and foliage rust.¹ PCA contains a higher type of resistance than Ute (Table 1). Seed from PCA, as a result of its striped characteristic, contains above 40% oil, 2 to 3 percentage points higher than Ute. PCA is a week later in maturity than Ute and 10 to 15 cm taller. In yield trials in 1969, PCA yielded 2,700 kg/ha, 7% more than US-10, a standard check variety.

PCM-1 (Reg. No. GP 2) and PCM-2 (Reg. No. GP 3) are resistant F₂ selections from the crosses PI 195895 × Frio and PI 195895 × U-5, respectively. PI 195895 is a plant introduction from Morocco and possesses the M gene for resistance to both seedling and foliage rust.¹ PCM-1 is equal in oil to 'Frio,' 5 to 10 cm shorter, and about a week earlier. PCM-1 is lower in oil than Frio, 5 to 10 cm taller, and 5 days later. In comparative yield trials in 1969, PCM-1 yielded 2,643 kg/ha (2,465 kg/ha) whereas PCO₂ yielded 2,633 kg/ha, 3% higher than US-10, a standard check variety.

PCN₁ (Reg. No. GP 4) is a striped-hulled F₂ selection from Nebraska 1-1-5 × Frio.¹ PCN₁ possesses the exclusionary rust resistance gene N₁. This gene although effective against the seedling phase, is ineffective against the foliage phase.¹ The utilization of a variety carrying the N₁ gene would presumably greatly reduce primary inoculum for foliage infection, thereby reducing the need of foliage resistance. The N₁ gene is inherited independently of the A, M, and O genes. Thus, it is possible to develop lines carrying the seedling-resistance gene and any of the foliage-resistance genes. PCN₁ is 5 to 7 days later in maturity than Frio, 5 to 10 cm taller, and equal to Frio in oil percentage. It has not been yield tested.

PCO₂ (Reg. No. GP 5) is a true breeding rust-resistant F₂ selection from Carthamus oxyacantha M.B. '59-270' × Frio.¹ Line 59-270 is a weedy rust-resistant selection of an introduction from Iran. It contains the dominant Oy gene which appears to be inherited independently of the A, M, and N₁ genes.¹ When crossed with cultivated safflower, it produces fertile progeny. The Oy gene presently known in cultivated safflower is the most resistant to seedling rust surpassed only by the exclusionary resistance of Nebraska 1-1-5 (Table 1). The level of resistance conditioned by the Oy gene suggests that its resistance may be more racestable than resistance conditioned by genes indigenous to C. tinctorius. PCO₂ produces seed equal in oil content to Frio and of the same maturity and height. It has not been yield-tested.

Small samples of seed of each of the released lines are available for breeding and other purposes upon request to the Agricultural Experiment Station, Utah State University, Logan, Utah.

REGISTRATION OF THIN-HULLED,
STRUCTURALLY MALE-STERILE
SAFFLOWER LINES, th-5 and th-10¹

A. L. Urie and D. E. Zimmer¹

Th-5 (Reg. No. PL 1) and th-10 (Reg. No. PL 2) are parental lines of safflower, Carthamus tinctorius L., developed by the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and the Utah Agricultural Experiment Station. The lines were released for use as female parents in hybrid development programs. Both are partially male-sterile and cannot be used directly as commercial varieties.

Both th-5 and th-10 were selected from many thin-hulled mutant lines grown at Logan, Utah. These lines have been shown to carry the uihsh gene pair identified by Rubis which conditions reduced-pollination and leads to an increase in oil percentage of the seed. (Agron. Abstr. 54:75. 1965). Both th-5 and th-10 exhibit less of the pleotropic manifestation of the

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Regression of Elite Germplasm

Table 1. Characteristics of breeding lines submitted for registration.

<table>
<thead>
<tr>
<th>Line or Variety</th>
<th>Reaction to Seedling rust</th>
<th>Foliage rust</th>
<th>Yield (kg/ha)</th>
<th>Oli (%)</th>
<th>Maturity (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA</td>
<td>R</td>
<td>2,700</td>
<td>39.5</td>
<td>+5</td>
<td>46 ± 4</td>
</tr>
<tr>
<td>PC-1</td>
<td>R</td>
<td>2,643</td>
<td>39.6</td>
<td>-5</td>
<td>46 ± 4</td>
</tr>
<tr>
<td>PC-2</td>
<td>R</td>
<td>2,633</td>
<td>39.4</td>
<td>-5</td>
<td>46 ± 4</td>
</tr>
<tr>
<td>PCN-1</td>
<td>M</td>
<td>3,114</td>
<td>35.6</td>
<td>+5</td>
<td>46 ± 4</td>
</tr>
<tr>
<td>PCO-1</td>
<td>R</td>
<td>3,124</td>
<td>38.4</td>
<td>+1</td>
<td>46 ± 4</td>
</tr>
</tbody>
</table>

¹ Percentage of seedlings which resulted from planting heavily rust infested seed.

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