Resistance in Sunflower to Head Infesting Insects

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Sunflower *(Helianthus annuus* L.) is beset by many insect pests. The red sunflower seed weevil (RSSW), *Smicronyx fulvus* (LeConte), the banded sunflower moth (BSM), *Cochylis hospes* (Wlshm.), and the sunflower midge (SFM), *Contarinia schulzi* (Gagne), have caused economic loss in cultivated sunflower (Schulz, 1978).

These three pests of sunflower feed as larvae on the developing sunflower head. RSSW larvae feed on the developing sunflower kernel and develop internally in seeds (Oseto and Braness, 1979). The BSM consumes both florets and the kernel of seeds (Beregovoy and Riemann, 1987). The SFM does little feeding on seeds, but high larval populations feeding on the receptable and bracts cause abnormal growth of the sunflower head, resulting in reduced seed production.

The cryptic habits of RSSW and BSM larvae make the effective use of chemical controls difficult. Insecticides are directed at egg-laying adult RSSW (Osteo and Braness, 1980) and against early instar BSM (Charlet and Busacca, 1986). No insecticides have been found effective against the SFM (Busacca, 1983). Precise timing of insecticide application is essential to maximize control of RSSW and BSM. In addition, insecticide treatments are detrimental to non-target organisms such as pollinators and natural enemies of sunflower pests. Genetic resistance of sunflower hybrids to sunflower insect pests would lessen or eliminate reliance on chemical control methods for these pests.

The objective of this study was to identify sunflower germplasm with resistance to the RSSW, the BSM, or the SFM.

MATERIALS AND METHODS

Evaluations for resistance to RSSW were made near Wahpeton in 1984 and near Leonard in 1986 and 1987. BSM resistance trials were conducted near Oriska in 1986 and at Prosper Research Farm in 1987. Three evaluation sites were used in the 1987 SFM hybrid trials. They were located at Mapleton, the University of Manitoba Research Farm, Winnipeg, and Glen Lea, Manitoba, Canada.

Plant introductions (PI) were obtained from the North Central Regional Plant Introduction Station, Ames, Iowa. Germplasm with the SW designation (Table 1) came from the USDA, ARS Oilseeds Project, Fargo. Hybrids were obtained from Agriculture Canada and commercial sources.

Over 1,000 PIs were evaluted for RSSW resistance in 1984 and 1986 and 300 were evaluted for BSM resistance in 1986. Single row evaluations were used in 1984 and two-row evaluations in 1986. Evaluations for resistance to the RSSW and BSM were made by hand threshing mature heads and examining the seeds for feeding damage.

Sunflower with resistance to the RSSW were evaluated for two or three years. Initial selections made from the 1984 and 1986 PIs were seed from the best single plants evaluated within each line. Second and third year populations were from open pollinated seed of the previous generation and were tested in a randomized complete block design with four replications.

Evaluations for BSM resistance were made in 1986 and 1987. Selections in 1986 were the best single plants of each resistant PI. Open pollinated seed from 1986 selected plants was retested in 1987 in a randomized complete block design with four replications.

Resistance to the SFM was evaluated in 10 sunflower hybrids. These included four commercially available and six experimental hybrids. A completely randomized design with four or five replications, depending on location, was used at each test site.

Table 1. Percent seed damaged by the red sunflower seed weevil.

Original population	% damaged seed		
	1984	1986	1987
cv. 894		28[1]	70[2]
PI 253417	5	18	37
PI 343793	8	16	41
PI 431537		16	52
PI 431542	3	11	40
PI 000000	3	15	40
SW 1095		12	36
SW 1300		13	30
SW 965		16	22
SW 992		12	43

[1] Average of two trials.

[2] Average of three trials.

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A five-point damage rating based on plant growth reaction to SFM larvae was used to compare hybrid response to SFM infestations. Plants with normal growth were rated 0, those with moderate cupping and cracking of the center of the head were rated 2, heads with cupping so extreme that no harvestable seed were present were rated 4.

A similar planting scheme was used in all trials. Sunflower was seeded at a rate to insure 20 plants in 20 foot rows with 2.5 feet between rows. Plantings were made in the second or third week of May to ensure that the sunflower were in a susceptible stage when insect populations peaked.

In 1984, germplasm with low RSSW damage was classified resistant. Hybrid 894, a widely available cultivar, was used as a standard check in 1986 and 1987. It has an average response to insect attack and lacks notable resistance or susceptibility. Germplasm with reduced RSSW, BSM or SFM damage, compared to hybrid 894, were considered resistant.

RESULTS

Resistance to RSSW was found in five plant introductions and in four SW lines (Table 1). Resistance was maintained in subsequent years' open pollinated seed.

Adult populations of the RSSW at the Leonard nursery were high in 1986 and 1987. In 1987, 70 percent of the seed in hybrid 894 was damaged. Damage in the RSSW resistant populations was only 30 percent to 70 percent of that of hybrid 894.

Five PIs tested in 1986 were re-evaluated in 1987 for resistance to the BSM (Table 2). PI 432517, identified as resistant to the BSM in 1986, was heavily damaged in 1987. The other four 1986 resistant PIs maintained their resistance in 1987. Based on 1987 data, five other plant introductions and one hybrid, Asgrow 521, have been classified as resistant to the BSM. Some of the PIs determined as resistant were later maturing than hybrid 894.

Several experimental and two commercial cultivars (Seed Tec 315 and 316) were found resistant to the SFM. These cultivars had reduced infestations compared to hybrid 894 and had little damage.

Table 2. Percent seed damaged by the banded sunflower moth.

Sunflower population	% damaged seed 1986	1987
cv. 894	11	21[1]
ASGROW 521		12
PI A 3081		8
PI 175723		12
PI 195945	1	16
PI 250085	1	4
PI 323279		11
PI 372175		11
PI 413016	1	1
PI 413119	1	1
PI 432517	1	33
PI 476660		5

[1] Average of two trials.

DISCUSSION

Sunflower germplasm with resistance to RSSW, BSM, and SFM was identified. Resistance to the RSSW was maintained through three generations. Efforts to further select for resistance and determine the mechanisms involved are under way.

Identification of sunflower resistant to the BSM has been more difficult than for the RSSW. This is partly due to the variation in flowering time of the sunflower germplasm tested. If sunflower is not in the bud stage when egg-laying BSM females are abundant, then infestations will be low (Beregovoy and Riemann, 1987) and an accurate determination of resistance cannot be made. Another factor is that BSM populations were lower than RSSW populations. Late flowering sunflower and low infestations result in escapes, where by chance a susceptible plant is not infested. This occurred with PI 432517. Progress toward BSM resistance will continue to be slow until artificial infestation techniques are developed.

RSSW and BSM resistance has not been identified in commercial sunflower hybrids available in the USA. Although Asgrow 521 showed resistance to the BSM, the resistance is moderate and the hybrid is not marketed in this country. The other sources of resistance are agronomically undeveloped and are presently not suitable as cultivars.

Resistance to the SFM is presently available in two commercial and several experimental hybrids to a sufficient degree to provide protection against economic loss during most seasons. Resistant hybrids, such as Seed Tec 315 and 316, should be used in locations where an economic SFM infestation is expected. Resistance to this pest may be present in other commercial hybrids but, to date, few have been tested.

Our research has shown that resistance to the RSSW, the BSM, and the SFM is present in sunflower germplasm. Resistance adequate to reduce SFM damage is available in at least two commercial hybrids. The identification of germplasm with RSSW or BSM resistance provides a basis for further development of sunflower resistance to insects.

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