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BLACKBIRD-RESISTANT HYBRID CORN REDUCES DAMAGE BUT DOES NOT INCREASE YIELD

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Red-winged blackbirds (*Agelaius phoeniceus*), the most abundant bird species in North America (Dolbeer and Stehn 1983), annually destroy 15 million bushels of ripening field corn in the United States and Canada (Tyler and Kannenberg 1980, Besser and Brady 1982, Weatherhead et al. 1982) and inflict substantial economic loss to sweet corn growers (Dolbeer et al. 1986). Blackbird depredations to corn and other crops also generate opposition in agricultural communities to certain environmental laws and conservation programs such as wetland preservation (e.g., Anon. [1983], Stone et al. [1984]). However, these same abundant birds play important roles in natural ecosystems and benefit man. For example, redwings consume large quantities of insect pests in corn, especially rootworm beetles (*Diabrotica longicornis*) and corn borers (*Ostrinia nubilalis*) (Bendell et al. 1981, McNicol et al. 1982, Bollinger and Caslick 1985). Redwings, prey themselves to a variety of vertebrate predators, may buffer predation on other birds, including waterfowl (Dolbeer 1980).

One means of reducing blackbird feeding on corn while maintaining the birds' beneficial attributes is the use of corn varieties resistant to damage. We have shown in aviary and field tests that varieties of field and sweet corn vary in susceptibility to damage (Dolbeer et al. 1982, 1984, 1986). Less susceptible varieties generally have longer, heavier husks that are difficult for birds to penetrate to reach the ripening kernels. Chemical composition of the kernels may also affect feeding preference by blackbirds (Mason et al. 1984).

However, a farmer may not gain financially by using a bird resistant variety if reduced damage is outweighed by low yield, high water content, or other undesirable features. Our objective was to compare under commercial conditions in areas of high bird damage the yield and damage of a bird-resistant field corn hybrid with those of a high-yielding, bird-susceptible hybrid, and hybrids of the farmers' choosing.

METHODS

We used 17 fields owned by 9 farmers in 7 Ohio counties (Columbiana, Guernsey, Licking, Lucas, Ottawa, Sandusky, Summit) in 1983 for the evaluations. Our criteria for including a field were that the farmer felt blackbird damage had been serious in that location in recent years and that he was interested in trying a bird-resistant hybrid to reduce damage.

Gries 622A and U.S. Steel 1010 were selected as the resistant and susceptible hybrids, respectively. Previous evaluations in aviary and field tests in 1980 and 1981 had shown that U.S. Steel 1010 received 2.2–3.6 times more bird damage than Gries 622A (Dolbeer et al. 1984). Farmers were provided with enough seed to plant 1.2–2.8 ha to each of these hybrids in each field.

For each field the farmer was instructed to plant 3 adjacent 1.2-ha plots, 1 with his choice of hybrid seed and the other 2 with the 2 test hybrids. If the field was >3.6 ha, the farmer planted the remainder of the field to his hybrid. The order of planting was randomized in 15 of the fields; U.S. Steel 1010, Gries 622A, and the farmer's hybrid were the middle plot in 6, 5, and 4 fields, respectively. In the 2 remaining fields, the farmer planted only 1 of the 2 test hybrids (U.S. Steel 1010 in 1 field and Gries 622A in the other) and his

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Table 1. Losses and field performance of hybrid corn resistant and nonresistant to blackbird damage in Ohio, 1983.

	Resistant		Nonresistant			
	Gries 622A		U.S. Steel 1010		Farmer's hybrid	
Loss or performance variable	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Loss to birds						
Ears damaged (%)	32A[a]	6	55B	8	45B	6
Weight (kg/ha)[b]	157A	24	406B	109	242A	67
Percent of yield	3.3A	0.7	6.7B	1.7	3.8A	0.9
Nonbird loss[c] (percent of yield)	0.8A	0.2	0.9A	0.3	0.7A	0.2
Percent water in kernels	32.0A	1.4	35.9B	1.3	32.0A	1.4
Final yield (kg/ha)	5,323A	442	5,637A	321	5,983A	327

[a] Means in a row with different letters differ ($P < 0.05$), Duncan's multiple range test.
[b] Divide kg/ha by 60.5 to obtain bushels/acre.
[c] Losses to mold, sprouting, and insects.

own hybrid selection. Field size averaged 6.9 ha (range 2.8–26 ha). In the 26-ha field, the farmer planted 2.8 ha to each of the test hybrids.

Damage and yield estimates were obtained during 11–18 October 1983, just prior to harvest. In each hybrid plot 2 rows were randomly selected and 6 subplots, each consisting of 5 consecutive plants, were located along each row. The first subplot was randomly located within the first ⅙ of the row and the remaining 5 subplots were systematically located at intervals of ⅙ length of the row.

The ear on each plant in a subplot was picked and the husk removed before the percent of kernel biomass destroyed by birds or other factors (mold, insects, sprouting) was visually estimated (Woronecki et al. 1980). All ears within a subplot were placed in a burlap bag and the length of each subplot was measured. The corn from each group of 6 subplots was weighed and the percent water content measured with a moisture meter. Yield (kg corn/ha adjusted to 15% water) was obtained for each plot by combining the adjusted weight of corn with the length of the subplots and the spacing between rows (76 cm in all fields).

A randomized block design with fields as blocks and hybrids as treatments was used to test the hypothesis of no differences in mean yields or bird damage among hybrids.

RESULTS

There were differences among hybrid groups in the amount of blackbird damage received (Table 1). Damaged ears averaged 32% for the Gries 622A plots, which was less ($P < 0.05$) than the 45% for the farmers' hybrids and the 55% for the bird-susceptible U.S. Steel 1010. Gries 622A and the farmers' hybrid losses averaged 157 and 242 kg/ha (2.6 and 4.0 bushels/acre), respectively, which were less ($P < 0.05$) than the 406 kg/ha (6.7 bushels/acre) lost to blackbirds in the U.S. Steel 1010 plots (Table 1). Gries 622A received less loss to birds than did the farmers' hybrid in 12 of the 16 fields in which both hybrids were planted ($P < 0.05$, Wilcoxon's signed rank test) and less loss than U.S. Steel 1010 in 12 of the 15 fields in which both were planted ($P < 0.05$). Other damage to kernels (mold, insects, sprouting) averaged <60 kg/ha (1 bushel/acre) for all hybrid groups.

Despite differences in bird damage, mean final yields of hybrids were similar ($P > 0.20$) (Table 1). Gries 622A, the farmer's hybrid, and U.S. Steel 1010 were the top yielder in 4, 5, and 6 fields, respectively. Overall yield in these fields averaged 5.6 metric tons/ha (92.9 bushels/acre) compared with 4.8 metric tons/ha (80.0 bushels/acre) for the statewide mean yield in Ohio for 1983 (Carter 1984).

DISCUSSION AND CONCLUSIONS

This experiment confirmed under commercial conditions that Gries 622A was less susceptible to bird damage than was U.S. Steel 1010. The results also suggested that Gries 622A was less susceptible to bird damage than were many of the hybrids grown by the farmers. Yet the use of Gries 622A did not result in higher mean yields, and its overall use would not have been warranted.

Two conclusions can be drawn from this test. First, even in areas where blackbird damage to corn is considered an important problem, many fields escape serious damage. The 17 fields used in this study were selected because of concern by the farmer for bird damage, yet only 6 of them had a hybrid plot with >600 kg/ha (10 bushels/acre) loss to birds. Statewide in Ohio, only about 0.5% of the fields have >600 kg/ha loss to blackbirds (Kelly et al. 1982). Thus, for the vast majority of farmers with only light to moderate bird pressure, their primary concern in choosing a corn hybrid should be potential yield and not bird resistance. Although blackbirds are often highly visible around corn fields and their damage is conspicuous, the actual amount of loss is not significant enough in most fields to warrant the use of a specially selected, resistant hybrid that might not yield as well as the farmer's preferred hybrid. The 1 condition under which the use of a resistant hybrid might be justified, even if yield remained unchanged, is if other damage (e.g., mold) became a serious secondary problem as a result of bird damage (Whitney 1954). This was not the case in this study.

The second conclusion is that if bird-resistant hybrids are to serve a useful role in integrated pest management programs for corn, they must be competitive with the high-yielding hybrids that farmers are already growing. Because the number of farmers affected by economically significant bird damage is small, it is unlikely that commercial seed companies will invest to produce special hybrid lines that are resistant to bird damage. An alternative is to develop a bird-resistance rating system for commercially marketed seed corn hybrids based on husk, ear, and kernel characteristics known to be correlated with bird damage (Dolbeer et al. 1982, 1986; Weatherhead and Tinker 1983). This would allow large numbers of hybrids (which are already grown annually under controlled conditions at state agricultural experiment stations) to be inexpensively and objectively rated for their resistance to bird damage. Then, farmers in high damage areas could include bird resistance along with other characteristics normally considered (e.g., yield, percent water) in selecting a hybrid for a particular situation.

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A HUMANE METHOD FOR REMOVING SNAKES FROM DWELLINGS

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Poisonous snakes should be removed when near human dwellings (Thompson 1975) and even nonpoisonous snakes may be undesirable under such circumstances (Stickel 1953). Snake-proof fences can prevent access to an area (Howard 1983), but snakes may be present before a fence is erected. Capturing, clubbing, or shooting is ineffective when snakes are not observable or when they are in houses, crawl spaces, and basements or under mobile homes. Effective traps have not been available. Therefore, I developed a nonlethal technique to remove snakes from dwellings.

METHODS

Snake traps were constructed by tacking a 15 × 30-cm glueboard (Eaton's Stick-Em Glue Traps, J. T. Eaton & Co., Inc., Twinsburg, Ohio; and Victor Holdfast Glue-board Traps, Woodstream Corp., Lititz, Pa.) on a sheet of plywood about 61 × 40.6 × 0.6 cm (Fig. 1). The plywood was anchored using 2 long nails driven through its corners; we avoided placing the boards near pipes or other objects that the snake might use for leverage to escape. A 2-cm-diam hole was made in the plywood to allow its retrieval with a hook on the end of a long stick.

Boards were tested using 2 bullsnakes (*Pituophis melanoleucus*), 1.5 and 1.6 m in length, and 7 western diamondback rattlesnakes (*Crotalus atrox*), 1.3–1.7 m in length. Testing was conducted in a 1.2 × 1.2 × 4.6-m tank. The edges of the plastic tray used by Eaton had to be cut off before mounting on the plywood to provide a flat surface. The snakes were placed in the tank singly and observed. Each snake was tested twice on successive days.

After the controlled tests, the method was tried at 13 field locations from 1 July 1982 to 1 July 1983.

RESULTS

Laboratory Tests

Elapsed time between placement of a snake in the tank and initial contact with the trap varied from 10 min to 12 hours. Bullsnakes, more active than rattlesnakes, encountered glueboards more quickly. Snakes tended to