Evaluation of European Corn Borer Resistance in Hardy Chrysanthemum[1]

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Abstract

Resistance of 12 yellow and 12 bronze chrysanthemum cultivars to the European corn borer, *Ostrinia nubilalis* (Hubner), was evaluated in laboratory studies. Yellow cultivars 'Freedom', 'Classic', 'Compatriot', and 'Fortune' and bronze cultivar 'Pancho' had significantly lower infestation percentages. In field monitoring of chrysanthemum grown in commercial nurseries, the cultivar 'Fireside Cushion' was significantly lower at both nurseries, with cultivars 'Buckeye', 'Grenadine', and 'Viking' also having significantly lower infestation percentages. A significant positive correlation between infestation levels and stem diameters indicated stem thickness may be an indicator of host plant resistance.

Index words: Chrysanthemum, host plant resistance, European corn borer

Introduction

Hardy or outdoor chrysanthemum is one of the most popular fall blooming, herbaceous, exterior landscape plants. Rooted cuttings are planted from late May to mid-June with plants being marketed in September. Periodic infestations of European corn borer (ECB), *Ostrinia nubilalis* (Hubner), have been reported on chrysanthemum and other perennials in addition to corn and vegetable crops (4). While three generations occur in eastern Virginia (1), injury to chrysanthemum is caused by the second generation which lays its eggs in mid-August when hosts are actively growing. Larvae tunnel into major stems causing breakage from wind or mechanical action. Since any amount of injury results in an unmarketable plant, growers and retailers discard damaged plants when injury is initially observed. Commercial growers of hardy chrysanthemum are aware of ECB damage, and apply weekly prophylactic insecticide treatments at an estimated annual cost of $800 per acre. Reports from commercial nurseries in eastern Virginia indicated differences in chrysanthemum susceptibility to ECB with several cultivars so susceptible that their production was considered uneconomical. Differential susceptibility of 11 cultivars of mixed colors of chrysanthemum to ECB was determined (3). Since selection by consumers is based upon flower color, the identification of resistant cultivars in the popular color groups would lower production costs and reduce losses to the retailer and consumer.

Our objectives were to evaluate 12 yellow and 12 bronze cultivars of hardy chrysanthemum in laboratory tests for resistance to ECB damage. In addition, field investigations of resistance in cultivars under commercial production in eastern Virginia nurseries were also conducted.

Methods and Materials

Laboratory Studies. Polyvinyl chloride assay plates with 96 flat bottom wells per plate were used to evaluate resistance to ECB larval feeding. Stem sections 1.5 cm(0.6 in) in length of each of 12 cultivars were placed in the wells in a randomized complete block design with 8 replications of each cultivar per plate, 6 plates per date. The plates were placed inside a glass culture dish with 40 ECB egg masses affixed to the lid. Egg masses of ECB were obtained from the USDA Corn Insects Research Unit at Ankeny, Iowa. Twelve yellow and 12 bronze varieties were compared on four dates from July to September 1986 at the Hampton Roads-Agricultural Experiment Station, Virginia Beach, Va. The dishes were placed in an environmental chamber (Percival Mfg. Co., Boone, IA) maintained at 27° C D, 22° C N (80°F D, 70°F N) with 16 hr light: 8 hr dark photoperiod. Stem sections were dissected and examined for the presence of ECB larvae after two weeks. The number of infested stem sections was recorded and analysis of variance was performed on all data using the general linear model. When $p < 0.05$ the data were subjected to mean separation using Duncan's multiple range test at the 5% level of significance (2). Mean values were converted to percentages for inclusion in the tables.

Field Studies. Nursery operations in Montross and Kilmarnock, Virginia reported severe ECB damage in mid-September, 1986. At the Montross nursery, 16 cultivars of chrysanthemum were evaluated by examining 30 pots of each cultivar (except the cultivar Stardom of which only 17 plants were available). Each pot was shaken for 5 seconds and those plants infested with ECB had stems broken by the movement. Each pot was recorded as either infested or uninfested. Similar evaluation was conducted at the Kilmarnock nursery with sample sizes ranging from 22 to 49 plants of each of 20 cultivars. The number of infested and uninfested plants of each cultivar was recorded and the data were subjected to analysis of variance using the general linear model. When $p < 0.05$, the means were separated using Duncan's multiple range test at the 5% level of significance.

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The relationship between infestation levels and stem diameter was investigated. Six mature plants of 11 yellow chrysanthemum cultivar overwintered in the greenhouse were pruned to a height of 6 cm (2.3 in). All stem diameters in each container were measured in millimeters with a micrometer. Infestation percentages from the laboratory study and their respective stem diameters were used. Correlation coefficient analysis was performed between ECB infestation percentages from the laboratory study previously described and their respective chrysanthemum stem diameters ($n = 11$, $P = 0.05$).

Results and Discussion

Laboratory studies. Analysis of variance showed highly significant differences in infestation levels between cultivars in both color groups ($p < 0.01$). Table 1 lists the yellow cultivars and their infestation percentages, which were subjected to Duncan's multiple range test at the 5% level of significance. Cultivars 'Freedom', 'Classic', 'Compatriot', and 'Fortune' had significantly lower infestation percentages than six of the remaining cultivars, with no significant differences between two of the cultivars. Cultivars 'Jackpot', 'West Point', and 'Bruin' had the highest infestation percentages, which were significantly greater than the remaining nine varieties.

Table 1. Percentage of yellow flowering hardy chrysanthemums infested with European corn borer on four dates, 1986.

Cultivar	Percent infested[z]
Freedom	8.5 a
Classic	12.5 ab
Compatriot	14.8 abc
Fortune	16.4 abc
Nuggets	21.0 bc
Sunbeam	24.2 c
Goldstrike	26.5 de
Goldmine	31.7 ef
Goldtone	36.7 f
Bruin	50.7 g
West Point	51.5 g
Jackpot	53.1 g

[z]Means followed by the same letter are not significantly different using Duncan's multiple range test at the 5% level, $n = 128$.

Table 2. Percentage of bronze flowering hardy chrysanthemums infested with European corn borer on four dates, 1986.

Cultivar	Percent infested[z]
Pancho	8.7 a
Tiger	17.6 ab
Brown Eyes	18.0 abc
Revere	18.4 abc
Roll Call	19.6 abc
Bandit	23.2 bc
Flaming Sun	23.8 bc
Remarkable	23.8 bc
Cougar	28.8 bc
Grenadine	30.0 bc
Zonta	34.6 d
Ironsides	65.3 e

[z]Means followed by the same letter are not significantly different using Duncan's multiple range test at the 5% level, $n = 128$.

Of the bronze cultivars, 'Pancho' had a significantly lower infestation percentage than seven of the remaining cultivars (Table 2). The cultivar 'Ironsides' with 65.3% of the stem pieces infested had significantly greater infestation levels than the other 11 cultivars.

Field studies. Examination of chrysanthemum plants at the Montross site showed significant differences between the 16 cultivars (Table 3). Cultivars 'Buckeye', 'Fireside Cushion' and 'Grenadine' had significantly lower infestation percentages than six of the remaining cultivars. The cultivars 'Pancho', 'Lipstick', and 'Bruin' had significantly higher levels of infestation than nine of the remaining cultivars. At the Kilmarnock site, the cultivars 'Viking' and 'Fireside Cushion' had significantly lower infestation percentages than 12 of the remaining 18 cultivars (Table 4). In contrast,

Table 3. Percentage of chrysanthemum cultivars infested with European Corn borer at Montross, VA nursery, 1986.

Cultivar	Percent Infested[z]	N
Buckeye	0.0 a	30
Fireside Cushion	6.6 ab	30
Grenadine	16.6 abc	30
Brown eyes	30.0 bcd	30
Starlet	33.3 b-e	30
Minnwhite	33.3 b-e	30
Sun Devil	33.3 b-e	30
Bandit	33.3 b-e	30
Stardom	41.1 c-f	17
Jackpot	46.6 c-g	30
Minngopher	56.6 d-h	30
Tinkerbell	63.3 e-i	30
Yellow Jacket	66.6 f-i	30
Bruin	73.3 ghi	30
Lipstick	83.3 hi	30
Pancho	86.6 i	30

[z]Means followed by the same letter are not significantly different using Duncan's multiple range test at the 5% level.

Table 4. Percentage of chrysanthemum cultivars infested with European corn borer at Kilmarnock, Va. nursery, 1986.

Cultivar	Percent infested[z]	N
Viking	0.0 a	22
Fireside Cushion	3.3 ab	30
Wolverine	6.1 abc	49
Seminole	8.5 abc	35
Minnautumn	9.0 abc	33
Quaker	10.3 abc	29
Ruby Mound	20.5 a-d	34
Baby Tears	23.3 bcd	30
Ironsides	26.8 cd	41
Minngopher	33.3 de	30
Grenadine	37.1 de	35
Tinkerbell	51.5 ef	33
Remarkable	64.2 fg	28
Pancho	71.4 fgh	35
Penguin	76.4 ghi	34
Light Lavender Stardom	82.8 g-j	35
White Stardom	87.2 hij	47
Powder River White	87.8 hij	41
Cougar	97.1 ij	35
Debonair	100.0 j	40

[z]Means followed by the same letters are not significantly different using Duncan's multiple range test at the 5% level.

'Debonair' and 'Cougar' had significantly higher levels of infestation than 14 of the remaining cultivars.

There was a positive correlation between ECB infestation level and chrysanthemum stem diameter ($r=0.61$, $p=0.05$). The more resistant cultivars had narrower stem diameters, and were likely too narrow to support ECB larvae to pupation. Field observations indicated that ECB infests cultivars with narrow stem diameters, but the site of the infestation is nearer the crown where the stem is thicker. Stem diameter measurements of the cultivars 'Pancho' and 'Bruin' were compared from plants at the commercial nurseries and at the Experiment Station. In both cultivars, stem diameters were greater from the commercial nurseries than from the chrysanthemum used in the laboratory study (4.7 and 2.9 mm (0.2 and 0.1 in), respectively, for 'Pancho', 5.0 and 2.7 mm (0.2 and 0.1 in), respectively, for 'Bruin'). The cultivar 'Pancho' had low infestation in the laboratory study (2.8%), but had high infestation at both commercial nurseries (71.4 and 86.6%) (Tables 2,3,4). The cultivar 'Bruin' had high infestation in both laboratory and field studies (50.7 and 73.3% respectively) (Tables 1,3). This indicates that stem diameter, whether due to growing conditions or cultivar, is an important factor in host plant resistance of chrysanthemum to European corn borer.

Both nurseries experienced significant crop losses as a result of ECB. The close proximity to large corn acreages from where ECB adults would have migrated in early August contributed to the heavy infestation. Also, the lack of rainfall during the summer months in 1986 reduced alternative oviposition sites. This resulted in an increase in insect pressure on the irrigated chrysanthemum plantings. Despite the heavy insect pressure, several cultivars at both nurseries had low infestation levels.

Significance to the Nursery Industry

The substantial expense in insecticide treatments to control ECB emphasizes the benefits of utilizing resistant cultivars in chrysanthemum production. This study demonstrates that differences in resistance to ECB exist between chrysanthemum cultivars of similar color. Commercial growers should consider host plant resistance to ECB when making cultivar selections.

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