Resistance of Crucifers to Root Maggot Complex, *Delia* spp. (Diptera: Anthomyiidae)

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Abstract

In field tests conducted at Saskatoon, Melfort, Scott, and Shellbrook, crucifer species differed in their levels of damage from crucifer-feeding root maggots of the *Delia* species complex. *Sinapis alba* was less injured than *B. carinata, B. rapa, B. juncea,* or *B. napus*. Root diameter may play a part in this difference in susceptibility. Differences in root injury levels within species occurred frequently, but were less consistent than among species. Location and year strongly influenced maggot infestation and damage levels.

Introduction

Crucifer feeding root maggots recently have become recognized as an important pest of canola production in Western Canada (Liu and Butts 1982, Soroka et al 1999). In Alberta, yield losses from root maggots in Argentine canola (*B. napus)* have been recorded as high as 20%, with over 50% yield reductions seen in Polish canola (*B. rapa)* (Griffiths 1991). Canola yield losses to root maggots in years favourable for infestation have been estimated at over $100 million (P. Thomas, personal communication). Host plant resistance offers several advantages over other means of pest control, including reduced use of pesticides and user friendly technology. In order to determine if functional sources of resistance to root maggot could be found and incorporated into the crucifer breeding program at Saskatoon Research Centre, selected breeding and agronomic trials were assessed for maggot damage from 1995 to 2000.

Materials and Methods

Numerous crucifer variety trials were rated for infestation and root injury levels from 1995 to 2000. Four or six row plots were seeded in 6.1 m lengths with 30 cm between rows in a randomized complete block design with four replicates. Shortly after swathing in the autumn, 25 roots per line or cultivar were extracted from the two inner rows of each plot and rated for maggot damage. The percentage of roots that were damaged by maggots and the average degree of damage, based on the damage scale of Dosdall et al. (1994), were determined for each cultivar and line. The damage scale used ranged from 0, no evidence of root maggot feeding, to 5, greater than 75% of the surface area of the root was eaten or was entirely severed by maggot feeding. Most tests were sown at Saskatoon Research Centre's research farm just outside of Saskatoon, but some tests were conducted near Melfort, 160 km NE, near Scott, 160 km NW, or near Shellbrook, 150 km N of Saskatoon.

Results and Discussion

In Regional Variety Trials of *B. napus* and *B. rapa* entries over three years, a comparison of maggot damage within years and canola species found that test location had more of an effect on maggot levels than did cultivar (Table 1). These differences may be a factor of the composition of the *Delia* species complex at each sampling location. When compared among locations, there was little consistency in ranking of cultivars in maggot infestation or damage levels. Yearly differences in maggot damage to roots were often of greater magnitude than were differences among cultivars within years.

Table 1. Average Root Damage Index on a Scale of 0 (no damage) to 5 (root completely severed), of *B. rapa* Entries in the Regional Canola Variety Trials in Saskatchewan 1995 - 1997.

	Average Root Damage Index (0-5)		
Test Location	1995	1996	1997
Scott	1.54 a1	0.32 a	—
Saskatoon	1.39 a	1.63 b	0.96 a
Melfort	2.17 b	2.21 b	1.42 b
Shellbrook	2.78 b	—	—

[1] Numbers within columns are not significantly different from each other, P≤0.05, Tukey's Studentized Range Test.

Trials of diverse germplasm within and among species examined open pollinated and synthetic *B. rapa*, *B. rapa* with varying levels of glucosinolates, open pollinated, doubled haploid, hybrid, and herbicide tolerant *B. napus,* and breeding material and/or cultivars of *B. juncea, B. carinata, Sinapis alba, Crambe abyssinica*, *C. hispanica hispanica, C. hispanica glabrata, Camelina sativa,* and *Eruca sativa*. Glucosinolate levels did not appear to affect feeding by maggots (Table 2). Damage levels were often variable and inconsistent among subspecies or lines within a species (Table 3). When tested with other crucifers, false flax, *Camelina sativa,* suffered very little infestation or root feeding (Table 3).

Table 2. Average Root Maggot Damage Index, on a scale of 0 to 5, of Roots of *Brassica rapa* Lines and Cultivars with Differing Levels of Glucosinolates, Saskatoon, SK, 1995-1997.

		Average Root Damage Index (0-5)		
Test line	Attribute	1995	1996	1997
86xDLY	double 0 gluc	1.76 a[1]	1.20 a	1.00 a
CompH	HT rapeseed	1.71 a	1.12 a	0.77 a
Tobin	rapeseed	1.45 ab	1.16 a	0.59 bc
Echo	rapeseed	1.36 ab	1.51 a	0.50 c
ACS-C5	canola	1.36 ab	0.85 a	0.42 c
Imp8628	low alkenyl	1.26 b	1.12 a	0.56 c

[1] Numbers within columns are not significantly different from each other, P≤0.05, Tukey's Studentized Range Test.

Table 3. Average Infestation Rate and Root Maggot Damage Index, on a scale of 0 to 5, of roots of Selected* Crucifer Lines and Cultivars, Saskatoon and Melfort, SK, 2000.

	Saskatoon		Melfort	
Species	% Infestation	Root Damage Index (0-5)	% Infestation	Root Damage Index (0-5)
Brassica rapa Hysyn 110	98 a[1]	2.34 a	90 ab	1.48 abc
Crambe hispanica glabrata	91 abc	2.12 abc	98 ab	1.67 abc
B. carinata S-67	88 abc	1.98 abcd	100 a	1.68 abc
Crambe hispanica hispanica	62 ef	0.98 fgh	85 ab	1.09 c
Sinapis alba Ochre	42 fg	0.50 hij	89 ab	1.12 c
Camelina sativa	5 h	0.05 k	50 c	0.50 d

[1] Numbers within columns are not significantly different from each other, P≤0.001, Tukey's Studentized Range Test.
* Test included 30 crucifer varieties and lines.

A 3-year trial at Saskatoon that compared five species and 5 lines found consistent differences in infestation (Figure 3) and damage level among crucifer species. Infestation and feeding levels in *Sinapis alba* roots were much less than in any other species tested. Over the three years, *B. carinata* lines averaged greater maggot damage than did the other four species. Differences in maggot damage among cultivars were not significant (P≤0.05) with the exception of the *B. carinata* line S-67, which had higher damage levels than the other four *B. carinata* entries. Root diameters measured at the root crown in 1999 were positively correlated with damage index. *S. alba* roots were of significantly smaller diameter than roots of the other species (P≤0.0001). This may contribute to *S. alba*'s low level of infestation.

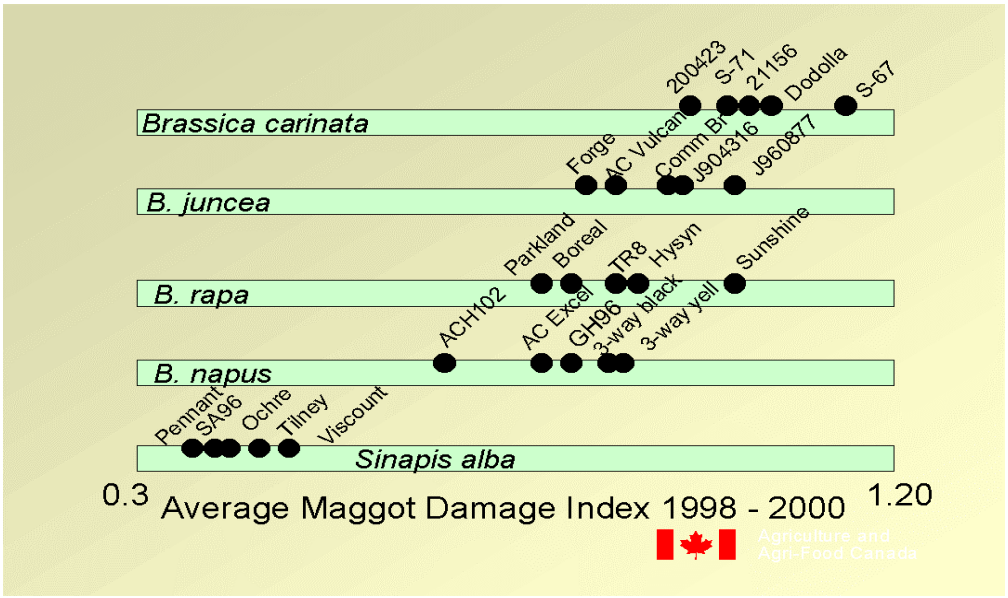

Figure 1. Root maggot (*Delia* spp.) damage levels in a 5 species, 5 line crucifer trial at Saskatoon, SK, 1998-2000.

The study illustrates the multiplicity of factors that affect host plant resistance. Unlike the work of Dosdall et al. (1994), in the five species trial *B. rapa* was not the most severely damaged

crucifer species at Saskatoon. Similar to the Alberta work (Dosdall et al.1994), *S. alba* was the least injured species. These results may be a function of the difference in fly species composition at the two locations, which has not been adequately researched. They also may be influenced by year, location, or root diameter. In this study, comparison of damage to roots of commercial canola cultivars found few consistent differences among them. However, tests with diverse crucifer germplasm such as *Crambe* and *Camelina* point to the presence of resistance factors in field crucifers. Biochemical differentiation between susceptible and resistant crucifer species is the next step in developing host plant resistance to crucifer-feeding root maggots.

Acknowledgements

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