Section VII
Foliage & Seed Insects

RESISTANCE OF *Sinapis alba* AND *S. alba* x *Brassica* spp. CROSSES TO THE CABBAGE SEEDPOD WEEVIL

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INTRODUCTION

The objectives of these studies were to determine if pod trichomes contributed to resistance (antixenosis) of *Sinapis alba* (yellow mustard) to the cabbage seedpod weevil (*Ceutorhynchus assimilis* Payk.) (CSPW), a major pest of rapeseed and canola in the Pacific Northwest, U.S.A. Also, to determine if intergeneric crosses of *S. alba* with *Brassica napus* and *B. rapa* confered resistance to weevil attack.

MATERIALS AND METHODS

Assessment of pod trichomes as a source of resistance to CSPW. Two paired choice ovipositional bioassays were conducted: a) *S. alba* pods with trichomes versus *S. alba* pods with trichomes removed, and b) undamaged *S. alba* pods versus damaged *S. alba* pods. All pods were excised from field-grown 'Gisilba' plants. Trichomes were plucked from the pods with forceps. Damaged pods received a slit along each side of the pod with a razor blade. Undamaged pods received neither trichome removal nor damage. Adult weevils were field-collected from flowering canola (*B. napus*). Weevils were put individually into several cages with one 'Bridger' (*B. napus*) pod and pods were dissected 24 h later to assess if weevils oviposited. Only females producing eggs in this susceptible host were used in the bioassays. One weevil was confined with two pods, one of each test type (i.e., with and without trichomes) in a 185 cm^3 cage. Bioassays were conducted at 20°C and 15:9 (L:D) photoperiod and conducted over a 4 d period with pods replaced daily. Feeding punctures and eggs were recorded. Each test was replicated 20 times.

Assessment of *S. alba* and *S. alba* x *Brassica* spp. crosses for resistance to CSPW. Paired choice and no-choice ovipositional bioassays were conducted using 185 cm^3 cages. Test lines included: *B. napus* 'Cyclone', *B. rapa* 'Tobin', *Sinapis alba* 'Gisilba' or a numbered line 034535, *S. alba* (034535) x *B. napus* (Cyclone), and *S. alba* (Gisilba) x *B. rapa* (Tobin). In the choice tests, one female weevil was confined with four pods (2 of a test line and 2 of the standard, Bridger (*B. napus*)) per cage. In the no-choice tests, one female weevil was confined with four pods of the same line per cage. All pods were excised from plants grown in a greenhouse. Weevils were collected from flowering winter rapeseed (*B. napus*) in Latah and Nez Perce Counties, Idaho. Field collected weevils were put individually into several cages with one Bridger pod. Pods were dissected 24 h later to determine the presence of eggs. Only females producing eggs were used in the bioassays. Each bioassay was conducted over a 4 d period with pods changed daily. Feeding punctures and eggs were recorded. Each test was replicated 20 times.

Field Tests. Seedlings of tested lines were transplanted to the University of Idaho Plant Science Farm, Moscow, Idaho. Thirty pods per plot were removed on 22 May 1994 to counts egg and feeding punctures. Also, 200 pods per plot were removed from *B. rapa* and *S. alba* (034535) plants on 25 July and from the other lines on 29 July 1994 to determine the incidence of larval exitholes within each test line.

RESULTS AND DISCUSSION

Assessment of pod trichomes as a source of resistance to CSPW. No eggs were laid in pods with or without damage (Table 1). Signficantly ($P<0.05$) more feeding punctures were recorded on pods without trichomes than on pods with trichomes. However, no significant difference ($P < 0.05$) in egg numbers was found in *S. alba* pods with or without trichomes.

Assessment of *S. alba* and *S. alba* x *Brassica* spp. crosses for resistance to CSPW. In paired choice tests, the *B. napus* parent Cyclone and the *S. alba* x *B. napus* cross received significantly ($P < 0.05$) more eggs than the standard, test line Bridger (Table 2). Weevil oviposition did not differ significantly ($P > 0.05$) among the *B. rapa* parent, Tobin, the *S. alba* x *B. rapa* cross and the Bridger standard.

In no-choice tests, the *S. alba* x *B. rapa* cross received significantly ($P < 0.05$) fewer eggs than the *B. rapa*, the *B. napus* parent, and the *S. alba* x *B. napus* cross (Table 3). However, the *S. alba* x *B. rapa* pods used in the experiment were more mature than the other lines tested, potentially impacting the acceptibility of the pods to the weevils. Laboratory assessment of intergeneric crosses and their parental sources to weevil oviposition indicated that the relative susceptibility of intergeneric crosses paralleled that of the specific parental *Brassica* line.

Field Tests. There were no significant differences ($P > 0.05$) in the number of eggs per pod among the *Brassica* parents and the intergeneric crosses (Table 4). Weevils laid no eggs in *S. alba* pods. The *B. napus* parent, Cyclone, had significantly ($P < 0.05$) more CSPW exitholes than the other line tested.

CONCLUSIONS

Apparently, trichomes are not the only factor mediating resistance of *S. alba* to CSPW. Other factors, such as the presence of allelochemicals that are deterent to CSPW, or the lack of kairomones mediating host recognition may also inhibit weevil oviposition in *S. alba* pods. Also physical factors such as pod wall thickness and pod size may be important factors mediating host acceptance by the weevil. In any event, the integeneric crosses between *S. alba* and *Brassica* spp. did not confer resistance of the parental *S. alba*. Further studies focusing on ovipositional behavior of the weevils may help to further elucidate the mechanisms associated with host acceptance and plant resistance.

Table 1. Feeding and oviposition of *C. assimilis* on *S. alba* (Gisilba) pods in paired choice tests[a, b, c]

Paired choice test	Feeding punctures/pod/day Mean ± SE	*t*	*P*	Eggs/pod/day Mean ± SE	*t*	*P*
trichomes w/o damage	0.16 ± 0.07	1.26	0.2154	0.0 ± 0.0	-	-
pods with damage	0.06 ± 0.04			0.0 ± 0.0		
trichomes intact	0.23 ± 0.08	4.63	<0.0001	0.03 ± 0.02	0.59	0.5602
trichomes removed	1.48 ± 0.26			0.01 ± 0.01		

[a] *n* = 20.
[b] Treatment means compared using paired Student's *t* test (SAS Institute 1989).
[c] Bridger standard received 17.73 feeding punctures/pod/day and 3.47 eggs/pod/day.

Table 2. Feeding and oviposition of *C. assimilis* on *Brassica napus*, *B. rapa*, *S. alba* and crosses with *S. alba* in paired choice tests[a, b]

Paired choice test	Feeding punctures/pod/day Mean ± SE	*t*	*P*	Eggs/pod/day Mean ± SE	*t*	*P*
Bridger	9.84 ± 0.79	1.18	0.2445	1.22 ± 0.13	3.11	0.0036
B. napus (Cyclone)	8.73 ± 0.51			1.97 ± 0.21		
Bridger	10.46 ± 0.76	4.48	0.0001	1.39 ± 0.11	2.88	0.0066
S. alba (034535) x *B. napus* (Cyclone)	6.54 ± 0.44			2.00 ± 0.18		
Bridger	10.99 ± 0.80	4.33	0.0001	1.80 ± 0.15	0.72	0.4741
B. rapa	6.85 ± 0.52			1.64 ± 0.16		
Bridger	10.66 ± 0.52	3.90	0.0004	1.58 ± 0.18	1.03	0.3115
S. alba (Gisilba) x *B. rapa* (Tobin)	7.75 ± 0.54			1.33 ± 0.15		
Bridger	13.14 ± 0.78	16.76	<0.0001	2.08 ± 0.15	13.99	<0.0001
S. alba (034535)	0.03 ± 0.01			0.00 ± 0.00		
Bridger	11.71 ± 0.33	36.06	<0.0001	1.83 ± 0.09	19.42	<0.0001
S. alba (Gisilba)	0.04 ± 0.03			0.00 ± 0.00		

[a] *n* = 20.
[b] Treatment means compared using paired Student's *t* test (SAS Institute 1989).

Table 3. Feeding and oviposition of *C. assimilis* on *Brassica napus* , *B. rapa* and crosses with *S. alba* in no-choice tests[a]

Line	Feeding punctures/ pod/day ± SE	Eggs/pod/day ± SE	n
B. napus (Cyclone)	8.03 ± 0.52 b	2.23 ± 0.16 a	20
S. alba (034535) x *B. napus* (Cyclone)	7.44 ± 0.45 bc	1.99 ± 0.13 a	20
B. napus (Bridger)	9.36 ± 0.63 a	1.96 ± 0.15 a	20
B. rapa (Tobin)	6.23 ± 0.43 c	1.92 ± 0.20 a	14
S. alba (Gisilba) x *B. rapa* (Tobin)	4.42 ± 1.16 d	0.77 ± 0.22 b	12
S. alba (Gisilba)	0.60 ± 0.11 e	0.02 ± 0.01 c	20
S. alba (034535)	0.73 ± 0.07 e	0.00 ± 0.00 c	20

[a] Means in a column followed by the same letter are not significantly different (P=0.05) using Protected LSD (Eggs, $F = 50.25$; $P = 0.0001$; Feeding Punctures, $F = 26.09$, $P = 0.0001$; $F = 291.59$, $P = 0.0001$ [SAS Institute 1989]).

Table 4. *C. assimilis* feeding, oviposition, and exit holes, on *Brassica napus*, *B. rapa*, *S. alba* and crosses with *S. alba* in field plants[a, b]

Line	Feeding punctures/pod ± SE	Eggs/pod ± SE	Exitholes/100 pods ± SE
S alba (034535) x *B. napus* (Cyclone)	2.80 ± 0.40 a	0.65 ± 0.08 a	25.0 ± 14.0 b
S. *alba* (Gisilba) x *B. rapa* (Tobin)	3.45 ± 0.05 a	0.43 ± 0.00 a	26.8 ± 8.8 b
B. napus (Cyclone)	3.25 ± 0.55 a	0.40 ± 0.07 a	65.0 ± 0.5 a
B. rapa (Tobin)	2.63 ± 0.40 a	0.37 ± 0.20 ab	20.3 ± 1.8 b
S. alba (034535)	0.00 ± 0.00 b	0.00 ± 0.00 b	0.0 ± 0.0 b

[a] $n = 2$.

[b] Means in a column followed by the same letter are not significantly different ($P = 0.05$) using Protected LSD (Exitholes, $F = 10.07$, $P = 0.0131$; Eggs, $F = 5.36$, $P = 0.0471$; Feeding Punctures, $F = 15.59$, $P = 0.0050$) [SAS Institute 1989]).