Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

2008 Pest Management Research Report (PMRR) 2008 Growing Season

2008 Rapport de recherches sur la lutte dirigée (RRLD) pour la saison 2008

Canada

English

2008 PEST MANAGEMENT RESEARCH REPORT

Prepared by: Pest Management Centre, Agriculture and Agri-Food Canada
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The Official Title of the Report

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[1] This is the ninth year that the Report has been issued a volume number. It is based on the number of years that it has been published. See history on page ii.

This annual report is designed to encourage and facilitate the rapid dissemination of pest management research results, particularly of field trials, amongst researchers, the pest management industry, university and government agencies, and others concerned with the development, registration and use of effective pest management strategies. The use of alternative and integrated pest management products is seen by the ECIPM as an integral part in the formulation of sound pest management strategies. If in doubt about the registration status of a particular product, consult the Pest Management Regulatory Agency, Health Canada at 1-800-267-6315.

This year there were 62 reports. Agriculture and Agri-Food Canada is indebted to the researchers from provincial and federal departments, universities, and industry who submitted reports, for without their involvement there would be no report. Special thanks is also extended to the section editors for reviewing the scientific content and merit of each report and to Andrea Labaj and Nadine Lavigne for editorial and computer compilation services.

Suggestions for improving this publication are always welcome.

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Procedures for the 2009 Annual PMR Report will be sent in fall, 2009. They will also be available from Andrea Labaj or Nadine Lavigne.

Pest Management Research Report History.

1961 - The National Committee on Pesticide Use in Agriculture (NCPUA) was formed by its parent body, the National Coordinating Committee of Agricultural Services. It had three main duties: to define problems in crop and animal protection and to coordinate and stimulate research on pesticides; to establish principles for drafting local recommendations for pesticide use; and to summarize and make available current information on pesticides.

1962 - The first meeting of the NCPUA was held, and recommended the Committee should provide an annual compilation of summaries of research reports and pertinent data on crop and animal protection involving pesticides. The first volume of the Pesticide Research Report was published in 1962.

1970 - The NCPUA became the Canada Committee on Pesticide Use in Agriculture (CCPUA).

1978 - Name was changed to the Expert Committee of Pesticide Use in Canada (ECPUA).

1990 - The scope of the Report was changed to include pest management methods and therefore the name of the document was changed to the Pest Management Research Report (PMRR). The committee name was the Expert Committee on Pest Management (1990-1993) and the Expert Committee on Integrated Pest Management since 1994.

2006 - The Expert Committee on Integrated Pest Management was disbanded due to lack of funding.

2007 - Agriculture and Agri-Food Canada agreed temporarily to take over responsibility for funding and compilation of the Pest Management Research Report until an organisation willing to assume permanent responsibility was found.

The publication of the Report for the growing season 2008 has been assigned a Volume number for the ninth year. Although there was a name change since it was first published, the purpose and format of the publication remains the same. Therefore based on the first year of publication of this document, the Volume Number will be Volume 47.

An individual report will be cited as follows:
Author(s). 2008. Title. 2008 Pest Management Research Report - 2008 Growing Season. Agriculture and AgriFood Canada. May, 2009. Report No. x. Vol. 47: pp-pp.

Français

Rapport de recherches sur la lutte dirigée - 2008

Préparé par: Centre de la lutte antiparasitaire, Agriculture et Agroalimentaire Canada
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Titre officiel du document

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Mai, 2009. volume 47[1]. 209 pp.
Publié sur Internet à http://www.cps-scp.ca/publications.htm.

[1] Ce numéro est basé sur le nombre d'année que le rapport a été publié. Voir l'histoire en page iv.

La compilation du rapport annuel vise à faciliter la diffusion des résultats de la recherche dans le domaine de la lutte antiparasitaire, en particulier les études sur la terrain, parmi les chercheurs, l'industrie, les universités, les organismes gouvernementaux et tous ceux qui s'intéressent à la mise au point, à l'homologation et à l'emploi de stratégies antiparasitaires efficaces. L'utilisation de produits de lutte intégrée ou de solutions de rechange est perçue par Le Comité d'experts sur la lutte intégrée (CELI) comme faisant parti intégrante d'une stratégie judicieuse en lutte antiparasitaire. En cas de doute au sujet du statut d'enregistrement d'un produit donné, veuillez consulter Santé Canada, Agence de réglementation de la lutte antiparasitaire à 1-800-267-6315.

Cette année, nous avons donc reçu 62 rapports. Les membres du Comité d'experts sur la lutte intégrée tiennent à remercier chaleureusement les chercheurs des ministères provinciaux et fédéraux, des universités et du secteur privé sans oublier les rédacteurs, qui ont fait la révision scientifique de chacun des rapports et en ont assuré la qualité, et Andrea Labaj et Nadine Lavigne qui ont fourni les services d'édition et de compilation sur ordinateur.

Vos suggestions en vue de l'amélioration de cette publication sont toujours très appréciées.

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Des procédures pour le rapport annuel de 2009 PMR seront introduites à l'automne 2009. Elles seront aussi disponibles par Andrea Labaj ou Nadine Lavigne.

Historique du Rapport de recherche sur la lutte dirigée

Le Comité national sur l'emploi des antiparasitaires en agriculture (CNEAA) a été formé en 1961 par le Comité national de coordination des services agricoles. Il s'acquittait d'un triple mandat: cerner les problèmes touchant la protection des cultures et des animaux et coordonner et stimuler la recherche sur les pesticides; établir des principes pour l'élaboration de recommandations de portée locale sur l'utilisation des pesticides; synthétiser et diffuser l'information courante sur les pesticides.

À la première réunion du CNEAA, en 1962, il a été recommandé que celui-ci produise un recueil annuel des sommaires des rapports de recherche et des données pertinentes sur la protection des cultures et des animaux impliquant l'emploi de pesticides. C'est à la suite de cette recommandation qu'a été publié, la même année, le premier volume du Rapport de recherche sur les pesticides.

En 1970, le CNEAA est devenu le Comité canadien de l'emploi des pesticides en agriculture. Huit ans plus tard, on lui a donné le nom de Comité d'experts de l'emploi des pesticides en agriculture. En 1990, on a ajouté les méthodes de lutte antiparasitaire aux sujets traités dans le rapport, qui est devenu le *Rapport de recherche sur la lutte dirigée*. Par la suite, le nom du comité a changé deux fois: Comité d'experts de la lutte antiparasitaire de 1990 à 1993 puis, en 1994, Comité d'experts de la lutte antiparasitaire intégrée.

En 2000, on a commencé à attribuer un numéro de volume au rapport annuel. Même si ce dernier a changé de titre depuis sa création, sa vocation et son format demeurent les mêmes. Ainsi, si l'on se reporte à la première année de publication, le rapport portant sur la saison de croissance de 2008 correspond au volume 47.

En 2006, le Comité d'experts de la lutte antiparasitaire intégrée a été dissous en raison du manque de financement.

Depuis 2007, Agriculture et Agroalimentaire Canada assume temporairement la responsabilité du financement et de la compilation du Rapport de recherche sur la lutte dirigée jusqu'à ce qu'une organisation désireuse d'assumer la responsabilité pour ce rapport sur une base permanente soit déterminée.

Modèle de référence:
Nom de l'auteur ou des auteurs. 2008. Titre. 2008 Rapport de recherche sur la lutte dirigée. Agriculture et Agroalimentaire Canada. Mai 2009. Rapport n^{o} x. vol. 47: pp-pp.

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2008 PMR REPORT # 01 **SECTION A: TREE FRUIT - Insect Pests**

CROP: Apple (*Malus domestica* L.)
PEST: Codling moth, *Cydia pomonella* L.

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TITLE: CODLING MOTH INSECTICIDE-RESISTANCE MONITORING IN ONTARIO APPLE ORCHARDS

MATERIALS: GUTHION 50 WSB (azinphos-methyl 50%) and CALYPSO 480 SC (thiacloprid 48%) insecticides

METHODS: During the first codling moth flight (June 2008) 6 conventionally managed apple orchards in Essex County and 5 in Norfolk County, Ontario, were selected for the collection of codling moth (CM) adults. Over the past 5 seasons the selected orchards had relatively higher CM adult collections within each region. In each region 1 abandoned orchard was also surveyed to provide baseline insecticide susceptibility. At each orchard 30 sticky traps with pheromone lures were set up when monitoring traps indicated peak flight numbers. The traps were checked daily over a 2 - 3 week period. The male moths were returned to the insecticide toxicology lab, AAFC London, and selected for diagnostic dose (DD) treatment with either 1 µL dose of acetone (control), the active ingredient in either the organophosphate (OP) insecticide GUTHION 50 WSB (azinphos-methyl) at 250 ppm in acetone or the active ingredient in the neonicotinoid insecticide CALYPSO 480 SC (thiacloprid) at 625 ppm in acetone. The concentration for each compound that caused > 95% but < 100% mortality was designated as the DD. The DD was determined with dose-response data from 48 h tests with an insecticide-susceptible CM strain (AAFC, London ON) using the contact bioassay technique and a range of up to 3 concentrations. The daily trials were repeated until each treatment tested 30 to 50 moths / orchard minimum. The treated moths were held at 25˚C, 50% RH, 16:8 L:D and mortality was checked after 24 and 48 h. If 48 h mortality was less than 50%, higher doses (500 ppm azinphos-methyl or 750 ppm thiacloprid) were applied to newly collected moths where possible.
During the second CM flight period (August 2008) the collection of male moths was repeated as previously described at 2 - 3 orchards in each region where apple damage was considered high and where tolerance to OP and/or neonicotinoids was noted in the June trials.

RESULTS: As outline in Tables 1 - 4.

CONCLUSIONS: The tolerance of CM to the OP GUTHION 50 WSB (azinphos-methyl) was highest in Norfolk County moths collected during the first flight in June (Table 1). In 3 of 5 orchards the azinphos-methyl DD caused less than 10% mortality within 48 h. Even when treated with the higher azinphos-methyl concentration (500 ppm) the mortality of moths from 1 of 5 orchards remained less than 50%. Abandoned orchard populations of CM were more susceptible to the azinphos-methyl DD with mortality typically greater than 90%. The DD for the neonicotinoid CALYPSO 480 SC (thiacloprid) was also less effective against the Norfolk moths collected from the managed orchards in June (Table 1). In 4 out of 5 orchards the mortality was less than 35%. The Essex County collected moths were more susceptible to the azinphos-methyl DD (32 to 57% mortality) than the CM from Norfolk, but the range of response to the thiacloprid DD was the same (14 to 31% mortality) (Table 2).

During the 2nd flight in August, CM moths collected from 2 managed Norfolk County orchards were found to be more susceptible to both the azinphos-methyl and thiacloprid DDs than the CM tested during June (Table 3). This was not the case in the 1 Essex County orchard surveyed in August, where the treated moths were more tolerant to the azinphos-methyl DD (43% versus 56% mortality) (Table 4). Of the original 6 orchards tested in Essex County in June, this was the only orchard that had obvious fruit damage. This may have resulted from the grower not following the recommended resistance management strategy of not using repeated applications of the same insecticide class (Pyrethroid) in the same generation.

The number of moths collected during June in both regions was much greater than in August. Several factors are thought to be responsible for this difference including: 1) the use of new insecticide classes such as ASSAIL 70 WP (acetamiprid 70%), DELEGATE (spinetoram 25%) and ALTACOR (chlorantraniliprole 35%); and 2) cool, wet weather conditions and a more dispersed second flight period. Based on these trials, tolerance to OP and neonicotinoid insecticides is established in Ontario. Follow up studies with CM larvae will confirm the level of tolerance observed with the adults and test for cross-resistance to newly registered products including the diamides and insect growth regulators (IGRs).

ACKNOWLEDGEMENTS: We greatly appreciate the data collection support from OMAFRA and K. Webb. We gratefully acknowledge the apple growers in Essex and Norfolk Counties for allowing the use of their orchards.

Table 1. 48 h corrected percent mortality for the June first flight codling moth from Norfolk County treated with GUTHION 50 WSB (azinphos-methyl at 250 and 500 ppm) and CALYPSO 480 SC (thiacloprid at 625 and 750 ppm).

	GUTHION (azinphos-methyl)				CALYPSO (thiacloprid)			
Orchard #	N	250 ppm	N	500 ppm	N	625 ppm	N	750 ppm
1[1]	12	100%	0	NA	0	NA	0	NA
2	51	0%	97	68%	50	18%	93	36%
3	53	5%	49	23%	100	2%	75	38%
4	90	1%	81	82%	133	32%	81	44%
5	50	26%	88	58%	82	33%	60	37%
6	50	49%	50	89%	50	44%	50	67%

[1] Orchard #1 is an abandoned orchard.

Table 2. 48 h corrected percent mortality for the June first flight codling moth from Essex County treated with GUTHION 50 WSB (azinphos-methyl at 250 ppm) and CALYPSO 480 SC (thiacloprid at 625 ppm).

	GUTHION (azinphos-methyl)		CALYPSO (thiacloprid)	
Orchard #	N	250 ppm	N	625 ppm
1[1]	86	83%	12	89%
2	23	57%	0	NA[2]
3	68	40%	71	25%
4	9	56%	0	NA
5	83	32%	62	31%
6	37	43%	0	NA
7	63	38%	40	14%

[1] Orchard #1 is an abandoned orchard.
[2] No moths were collected at this orchard for this treatment.

Table 3. 48 h corrected percent mortality for the August second flight codling moth from Norfolk County treated with GUTHION 50 WSB (azinphos-methyl at 250 ppm) and CALYPSO 480 SC (thiacloprid at 625 ppm).

	GUTHION (azinphos-methyl)		CALYPSO (thiacloprid)	
Orchard #	N	250 ppm	N	625 ppm
1[1]	13	89%	0	NA[2]
2	39	75%	26	61%
3	36	51%	36	47%

[1] Orchard #1 is an abandoned orchard.
[2] No moths were collected at this orchard for this treatment.

Table 4. 48 h corrected percent mortality for the August second flight codling moth from Essex County treated with GUTHION 50 WSB (azinphos-methyl at 250 ppm) and CALYPSO 480 SC (thiacloprid at 625 ppm).

	GUTHION (azinphos-methyl)		CALYPSO (thiacloprid)	
Orchard #	N	250 ppm	N	625 ppm
1[1]	85	97%	100	97%
2	46	43%	49	45%

[1] Orchard #1 is an abandoned orchard.

2008 PMR REPORT # 02 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Apple (*Malus domestica* L.) cv. Red Delicious
PEST: Apple rust mite (*Aculus schlechtendali* Nalepa), European Red Mite (*Panonychus ulmi* Koch)

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TITLE: ASSESSMENT OF BIFENAZATE (ACRAMITE 50WS) FOR CONTROL OF EUROPEAN RED MITE ON 'RED DELICIOUS' APPLES, 2008

MATERIALS: ACRAMITE 50WS (bifenazate), ENVIDOR 240 SC (spirodiclofen)

METHODS: The trial was conducted on fourteen-year-old 'Red Delicious' apple trees in an orchard on the AAFC research farm in Jordan Station, Ontario. Trees were spaced 4.8 m apart between rows and 3.0 m apart within rows. Two rates of ACRAMITE 50WS (425 g a.i./ha and 567.5 g a.i./ha) were compared to a single rate of ENVIDOR 240 SC (180 g a.i./ha) and an unsprayed control. Each treatment was replicated four times; each replicate had two trees. The trial was arranged according to a randomized complete block design. The acaricides were applied in 1000 L of water per hectare with a SOLO backpack sprayer. The acaricide application occurred on 7 July (timed for an elevated European red mite (ERM) population). Assessments for apple rust mite (ARM) motiles; ERM eggs, nymphs, and adults; and ERM predators (*Amblyseius* sp.) occurred on 10 July, 14 July, 21 July, 28 July, 4 August, and 11 August (three, seven, 14, 21, 28 and 35 days, respectively, after the application of 7 July) by harvesting 25 random leaves per replicate. Each sample of 25 leaves was brushed with a Henderson-McBurnie mite brushing machine onto an glass plate coated with a thin film of a 50:50 mixture of glycerine and corn syrup. The glass plates were examined under a stereo-microscope and the number of predatory mites, ARM motiles, and ERM eggs, nymphs and adults were recorded. Data were analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1, 2, 3, 4, 5, and 6. Pre-application counts on 4 July were 46-161 European red mite (ERM) eggs per leaf and 23 - 46 ERM nymphs/adults per leaf. There were no phytotoxic effects observed in any treatments at three, seven, 14, 21, 28, or 35 days after the application of 7 July. ERM egg count data of 14 July and 21 July; ERM nymph count data of 10 July, 14 July, 21 July, 28 July, and 11 August; and ERM adult count data of 14 July were not homogeneous and therefore were transformed using log(x+1). Predator count data of 21 July and 28 July were not homogeneous and therefore were transformed using log(x+1). Apple rust mite (ARM) data of 14 July, 21 July, 28 July, and 11 August were not homogeneous and therefore were transformed using log(x+1). ERM nymph data of 4 August; ERM adult data of 10 July, 21 July, 28 July and 4 August; and ARM data 10 July were not homogeneous but attempts to transform the data were unsuccessful, therefore the original data is presented.

CONCLUSIONS: On 10 July, 14 July and 21 July (three, seven and 14 days, respectively, after the application of 7 July), all treatments significantly reduced the number of European red mite (ERM) eggs compared to the control; there were no differences among the treatments on any of these dates. On 28 July (21 days after the application of 7 July), there were no significant differences in the number of ERM eggs among or between the treatments and the control. On 4 August (28 days after the application of 7 July), both rates of ACRAMITE 50WS (425 g a.i./ha and 567.5 g a.i./ha) had significantly fewer ERM eggs compared to the ENVIDOR treatment and the control. On 11 August (35 days after the application of 7 July), there were no significant differences in the number of ERM eggs among or between the treatments and the control (Table 1).
On 10 July, 14 July, 21 July, 28 July, 4 August and 11 August (three, seven, 14, 21, 28, and 35 days, respectively, after the application of 7 July), all treatments significantly reduced the number of European red mite (ERM) nymphs compared to the control; there were no differences among the treatments on any of these dates (Table 2).
On 10 July, 14 July, 21 July, 28 July, and 4 August (three, seven, 14, 21, and 28 days after the application of 7 July), all treatments significantly reduced the number of European red mite (ERM) adults compared to the control; there were no differences among the treatments on any of these dates. On 11 August (35 days after the application of 7 July), only the ENVIDOR treatment had significantly fewer ERM adults than the control, there were no significant differences among the treatments (Table 3).
On 10 July, 14 July, and 21 July (three, seven, and 14 days, respectively, after the application of 7 July), there were no significant differences in the number of ERM predators among or between the treatments and the control. On 28 July, 4 August and 11 August (21, 28, and 35 days, respectively, after the application of 7 July), all treatments had significantly fewer predators than the control. The reduction in predator numbers in the acaricide treatments over the last three assessment dates of 28 July, 4 August and 11 August may have been partially due to the reduced food source which was killed off by the acaricide treatments (Table 4).
On 10 July and 14 July (three and seven days after the application of 7 July), there were no significant differences in the number of apple rust mites (ARM) among or between the treatments and the control. On 21 July and 28 July (14 and 21 days after the application of 7 July), only the ENVIDOR treatment had significantly fewer ARM compared to the control. On 4 August (28 days after the application of 7 July), there were no significant differences in the number of ARM among or between the treatments and the control. On 11 August (35 days after the application of 7 July), only the ENVIDOR treatment had significantly fewer ARM compared to the control (Table 5). On 27 August (51 days after the application of 7 July), there were no significant differences in the weight of 50 apples among or between the treatments and the control (Table 6).

Table 1. Effect of bifenazate (ACRAMITE) on European red mite (ERM) eggs on apple leaves.

Treatment[1]	Rate (a.i./ha)	Number of ERM eggs per leaf					
		10 July 3 days[2]	14 July 7 Days[2]	21 July 14 days[2]	28 July 21 days[2]	4 August 28 days[2]	11 August 35 days[2]
ACRAMITE 50WS	425 g	23.7 b[3]	13.9 b	21.7 b	19.7 a	13.0 b	12.2 a
ACRAMITE 50WS	567.5 g	26.7 b	21.2 b	27.7 b	18.8 a	12.4 b	13.3 a
ENVIDOR 240 SC	180 g	38.4 b	29.9 b	48.0 b	35.4 a	27.2 a	11.0 a
CONTROL	-	69.5 a	127.9 a	171.0 a	33.4 a	29.3 a	19.0 a

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 2. Effect of bifenazate (ACRAMITE) on European red mite (ERM) nymphs on apple leaves.

Treatment[1]	Rate (a.i./ha)	Number of ERM nymphs per leaf					
		10 July 3 days[2]	14 July 7 Days[2]	21 July 14 days[2]	28 July 21 days[2]	4 August 28 days[2]	11 August 35 days[2]
ACRAMITE 50WS	425 g	0.2 b[3]	1.7 b	0.4 b	1.0 b	0.04 b	0.56 bc
ACRAMITE 50WS	567.5 g	0.2 b	1.6 b	1.2 b	0.8 b	0.08 b	0.72 b
ENVIDOR 240 SC	180 g	0.0 b	0.1 b	0.2 b	0.4 b	0.04 b	0.08 c
CONTROL	-	57.4 a	28.0 a	53.3 a	27.1 a	1.36 a	2.20 a

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 3. Effect of bifenazate (ACRAMITE) on European red mite (ERM) adults on apple leaves.

Treatment[1]	Rate (a.i./ha)	Number of ERM adults per leaf					
		10 July 3 days[2]	14 July 7 Days[2]	21 July 14 days[2]	28 July 21 days[2]	4 August 28 days[2]	11 August 35 days[2]
ACRAMITE 50WS	425 g	0.04 b[3]	0.00 b	0.04 b	0.08 b	0.00 b	0.16 ab
ACRAMITE 50WS	567.5 g	0.16 b	0.12 b	0.04 b	0.12 b	0.12 b	0.16 ab
ENVIDOR 240 SC	180 g	1.00 b	0.32 b	0.08 b	0.16 b	0.04 b	0.00 b
CONTROL	-	9.96 a	14.76 a	4.92 a	2.94 a	1.04 a	0.52 a

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 4. Effect of bifenazate (ACRAMITE) on predators (*Amblyseius* sp.) on apple leaves.

Treatment[1]	Rate (a.i./ha)	Number of predators (*Amblyseius* sp.) per leaf					
		10 July 3 days[2]	14 July 7 Days[2]	21 July 14 days[2]	28 July 21 days[2]	4 August 28 days[2]	11 August 35 days[2]
ACRAMITE 50WS	425 g	0.30 a[3]	0.88 a	0.40 a	0.72 b	0.36 b	0.12 b
ACRAMITE 50WS	567.5 g	0.16 a	0.92 a	0.72 a	0.60 b	0.32 b	0.36 b
ENVIDOR 240 SC	180 g	0.30 a	0.92 a	0.16 a	0.44 b	0.08 b	0.00 b
CONTROL	-	0.72 a	1.32 a	1.44 a	3.30 a	1.08 a	0.92 a

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 5. Effect of bifenazate (ACRAMITE) on apple rust mites (ARM) on apple leaves.

Treatment[1]	Rate (a.i./ha)	Number of ARM per leaf					
		10 July 3 days[2]	14 July 7 Days[2]	21 July 14 days[2]	28 July 21 days[2]	4 August 28 days[2]	11 August 35 days[2]
ACRAMITE 50WS	425 g	1.98 a[3]	3.56 a	4.24 ab	6.50 ab	0.92 a	3.36 ab
ACRAMITE 50WS	567.5 g	1.41 a	7.68 a	19.48 a	7.64 ab	1.72 a	4.72 a
ENVIDOR 240 SC	180 g	0.16 a	0.24 a	1.92 b	0.76 b	0.36 a	0.12 b
CONTROL	-	4.08 a	12.36 a	14.88 a	11.40 a	1.12 a	1.48 ab

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 6. Effect of bifenazate (ACRAMITE) on fruit weight.

Treatment[1]	Rate (a.i./ha)	Weight of 50 apples (g)
		27 August (51 days)[2]
ACRAMITE 50WS	425 g	5627.5 a[3]
ACRAMITE 50WS	567.5 g	5683.5 a
ENVIDOR 240 SC	180 g	5421.3 a
CONTROL	-	5330.0 a

[1] Applied 7 July.
[2] Number of days after the application (7 July).
[3] Mean of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

2008 PMR REPORT # 03 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Apple (*Malus domestica* Borkh.) cv. Empire
PESTS: Mullein leaf bug (*Campylomma verbasci* Meyer), Plum curculio (*Conotrachelus nenuphar* Herbst), Tarnished plant bug (*Lygus lineolaris* Palisot de Beauvois), White apple leafhopper (*Typhlocyba pomaria* McAtee)

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TITLE: **ASSESSMENT OF CLOTHIANIDIN (V-10170 50 WDG) TO CONTROL EARLY SEASON INSECT PESTS OF 'EMPIRE' APPLES, 2008**

MATERIALS: CALYPSO 480 SC (thiacloprid), V-10170 50 WDG (clothianidin).

METHODS: The trial was conducted on eight-year-old 'Empire' apple trees in an AAFC research orchard in Jordan Station, Ontario. The trees were spaced 4.6 m apart between rows and 2.4 m apart within rows. Two rates of V-10170 50 WDG (52.5 g a.i./ha and 105 g a.i./ha) were compared to a single rate of CALYPSO 480 SC (140 g a.i./ha) and an unsprayed control; the application occurred on 28 May (timed for petal fall). Each treatment was replicated four times and each replicate had two trees. The trial was arranged according to a randomised complete block design. The insecticides were applied in 1000 L of water per hectare with a SOLO 450 backpack sprayer. Assessments for mullein leaf bugs (MB) and spring feeding caterpillars (SFC - includes oblique banded leafroller, lesser apple worm, etc) occurred on 2 June (5 days after the application of 28 May) by tapping three limbs per tree over a 45 cm x 45 cm tapping tray; numbers of MB and SFC were recorded. Assessments for mullein leaf bugs (MB) and white apple leafhoppers (WALH) occurred on 10 June, 23 June, and 9 July (13, 26 and 42 days, respectively, after the application of 28 May) by tapping three limbs per tree over a 45 cm x 45 cm tapping tray; numbers of MB and WALH were recorded for each assessment. On 12 June (15 days after application of 28 May), 50 immature fruit per replicate were harvested and assessed for damage by MB, plum curculio (PC), SFC, and tarnished plant bug (TPB); the percentage of fruit damage by MB, PC, SFC, and TPB was recorded. On 9 July (42 days after the application of 28 May), 50 immature fruit per replicate were harvested; the percentage of fruit damage by MB, PC and TPB was recorded. On 21 August (85 days after application of 28 May), 50 fruit per replicate were harvested, weighed and assessed for MB, PC and TPB damage; the percentage of fruit damage by MB, PC, and TPB was recorded. Data were analysed using analysis of variance and means separated with a Tukey test at the 0.05 significance level. Data are expressed as numbers of MB and WALH, and % MB, PC, SFC and TPB fruit damage.

RESULTS: Data are presented in Tables 1-7. No phytotoxic effects were observed in any plots at five, 13 or 26 days after treatment. Spring feeding caterpillar (SFC) data of 2 June; plum curculio (PC) data of 12 June, 9 July, and 21 August; and white apple leafhopper (WALH) data of 23 June were not homogeneous and were therefore transformed using log (x+1).

CONCLUSIONS: On 2 June (5 days after application of 28 May), there were no differences in the number of mullein leaf bugs (MB) among or between the treated plots and the control (Table 1). On 10 June (13 days after the application of 28 May), all treatments had significantly fewer MB compared to the control; the treatments were not significantly different from each other (Table 1). There were no MB found on 23 June or 9 July (26 and 42 days, respectively, after the application of 28 May) (Table 1). On 2 June (5 days after the application of 28 May), both of the V-10170 (52.5 g a.i./ha and 105 g a.i./ha) treatments had significantly fewer spring feeding caterpillars (SFC) than the control; the high rate of V-10170 (105 g a.i./ha) had significantly fewer SFC than the CALYPSO treatment. On 12 June (15 days after application of 28 May), there were no differences in fruit damage by SFC among or between the treatments and the control (Table 2). On 12 June, 9 July and 21 August (15, 42 and 85 days, respectively, after the application of 28 May), there were no differences in the percentage of damage to apples by MB among or between the treatments and the control (Table 3). On 12 June (15 days after the application of 28 May), all treatments had significantly fewer apples damaged by plum curculio (PC) than the control; there were differences among the treatments (Table 4). On 9 July (42 days after the application of 28 May), there were no differences in damage to apples by PC among or between the treatments and the control (Table 4). On 21 August (85 days after the application of 28 May), the CALYPSO and the low rate of V-10170 (52.5 g a.i./ha) treatments had significantly fewer apples damaged by PC than the control; there were no differences among the treatments (Table 4). On 12 June, 9 July and 21 August (15, 42 and 85 days, respectively, after the application of 28 May), there were no differences in fruit damage by tarnished plant bugs (TPB) among or between the treatments and the control (Table 5). Although the WALH numbers are higher on 9 July than previously observed, on 10 June, 23 June and 9 July (13, 26 and 42 days, respectively, after the application of 28 May), there were no differences in the numbers of white apple leafhoppers (WALH) among or between the treatments and the control (Table 6). On 21 August (85 days after the application of 28 May), there were no differences in the weight of 50 apples among or between the treatments and the control (Table 7).

Table 1. Effect of clothianidin (V-10170 50 WDG) on mullein leaf bugs (MB) on apple trees.

Treatment[1]	Rate (g a.i./ha)	Number of MB			
		2 June (5 days)[2]	10 June (13 days)[2]	23 June (26 days)[2]	9 July (42 days)[2]
V-10170 50 WDG	52.5	0.00 a[3]	0.00 b	0.00 a	0.00 a
V-10170 50 WDG	105	0.00 a	0.00 b	0.00 a	0.00 a
CALYPSO 480 SC	140	0.00 a	0.25 b	0.00 a	0.00 a
CONTROL	-	0.50 a	1.75 a	0.00 a	0.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 2. Effect of clothianidin (V-10170 50 WDG) on spring feeding caterpillars (SFC) and fruit damage by SFC on apple trees.

Treatment[1]	Rate (g a.i./ha)	Number of SFC	Percent apples damaged by SFC
		2 June (5 days)[2]	12 June (15 days)[2]
V-10170 50 WDG	52.5	0.75 bc[3]	0.50 a
V-10170 50 WDG	105	0.50 c	0.00 a
CALYPSO 480 SC	140	3.00 ab	0.00 a
CONTROL	-	5.00 a	2.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 3. Effect of clothianidin (V-10170 50 WDG) on apple fruit damage by mullein plant bug (MB).

Treatment[1]	Rate (g a.i./ha)	Percent apples damaged by MB		
		12 June (15 days)[2]	9 July (42 days)[2]	21 August (85 days)[2]
V-10170 50 WDG	52.5	0.00 a[3]	0.00 a	0.00 a
V-10170 50 WDG	105	0.00 a	0.00 a	0.00 a
CALYPSO 480 SC	140	0.00 a	0.00 a	0.00 a
CONTROL	-	0.50 a	0.00 a	0.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 4. Effect of clothianidin (V-10170 50 WDG) on apple fruit damage by plum curculio (PC).

Treatment[1]	Rate (g a.i./ha)	% apples damaged by PC		
		12 June (15 days)[2]	9 July (42 days)[2]	21August (85 days)[2]
V-10170 50 WDG	52.5	0.00 b[3]	5.50 a	2.00 b
V-10170 50 WDG	105	3.50 b	3.50 a	4.00 ab
CALYPSO 480 SC	140	0.50 b	2.00 a	0.50 b
CONTROL	-	23.00 a	17.00 a	23.50 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 5. Effect of clothianidin (V-10170 50 WDG) on apple fruit damage by tarnished plant bugs (TPB).

Treatment[1]	Rate (g a.i./ha)	Percent apples damaged by TPB		
		12 June (15 days)[2]	9 July (42 days)[2]	21 August (85 days)[2]
V-10170 50 WDG	52.5	1.00 a[3]	0.00 a	1.00 a
V-10170 50 WDG	105	0.00 a	0.00 a	2.00 a
CALYPSO 480 SC	140	0.00 a	0.00 a	1.00 a
CONTROL	-	0.00 a	0.00 a	5.50 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 6. Effect of clothianidin (V-10170 50 WDG) on white apple leafhoppers (WALH) on apple trees.

Treatment[1]	Rate (g a.i./ha)	Number of WALH		
		10 June (13 days)[2]	23 June (26 days)[2]	9 July (42 days)[2]
V-10170 50 WDG	52.5	3.25 a[3]	3.25 a	28.00 a
V-10170 50 WDG	105	1.00 a	1.50 a	17.25 a
CALYPSO 480 SC	140	2.75 a	2.00 a	19.25 a
CONTROL	-	3.50 a	8.50 a	25.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 7. Effect of clothianidin (V-10170 50 WDG) on apple fruit weight.

Treatment[1]	Rate (g a.i./ha)	Weight of 50 apples (g)
		21 August (85 days)[2]
V-10170 50 WDG	52.5	5035.0 a[3]
V-10170 50 WDG	105	5847.5 a
CALYPSO 480 SC	140	5380.0 a
CONTROL	-	5480.0 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

2008 PMR REPORT # 04 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Apples (*Malus domestica* Borkh.) cv. McIntosh
PESTS: Mullein leaf bug (*Campylomma verbasci* Meyer), Plum curculio (*Conotrachelus nenuphar* Herbst), Tarnished plant bug (*Lygus lineolaris* Palisot de Beauvois), White apple leafhopper (*Typhlocyba pomaria* McAtee)

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TITLE: ASSESSMENT OF CLOTHIANIDIN (V-10170 50 WDG) TO CONTROL EARLY SEASON INSECT PESTS OF 'MCINTOSH' APPLES, 2008

MATERIALS: CALYPSO 480 SC (thiacloprid), V-10170 50 WDG (clothianidin).

METHODS: The trial was conducted on eleven-year-old 'McIntosh' apple trees in an orchard on the AAFC research orchard in Jordan Station, Ontario. The trees were spaced 3.7 m apart between rows and 2.5 m apart within rows. Two rates of V-10170 50 WDG (52.5 g a.i./ha and 105 g a.i./ha) were compared to a single rate of CALYPSO 480 SC (140 g a.i./ha) and an unsprayed control; applications were timed for petal fall (May 28). Each treatment was replicated four times, with two trees per replicate. The trial was arranged according to a randomised complete block design. The insecticides were applied in 1000 L of water per hectare with a SOLO 450 backpack sprayer. Assessments for mullein leaf bugs (MB) occurred on 3 June (6 days after application) and for MB and white apple leafhoppers (WALH) on 10 June (13 days after application) by tapping three limbs per tree over a 45 cm x 45 cm tapping tray; numbers of each insect pest were recorded for each assessment. Fifty immature fruit per replicate were harvested on 13 June (16 days after application); fruit damage by MB, plum curculio (PC), spring feeding caterpillars (SFC - includes lesser apple worm and oblique banded leafroller) and tarnished plant bug (TPB) was recorded. Assessments for MB and WALH occurred on 23 June (26 days after application) and for WALH on 9 July (42 days after application) by tapping three limbs per tree over a 45 cm x 45 cm tapping tray; numbers of each insect pest were recorded for each assessment. Fifty immature fruit per replicate were harvested on 9 July (42 days after application); fruit damage by PC was recorded. On 26 August, 50 fruit per replicate were harvested, weighed and assessed for damage by MB, PC and TPB; fruit damage by MB, PC and TPB was recorded. Data were analysed using analysis of variance and means separated with a Tukey test at the 0.05 significance level. Data are expressed as numbers of MB and WALH, and % MB, PC, SFC and TPB fruit damage.

RESULTS: Data are presented in Tables 1, 2, 3, 4, 5 and 6. No phytotoxic effects were observed in any treatments at six, 13, 16 or 26 days after application. PC data of 13 June and 9 July; and WALH data of 23 June were not homogeneous and therefore were transformed using log (x+1).

CONCLUSIONS: On 3 June, 10 June and 23 June (6 days, 13 days and 26 days, respectively, after the

application of 28 May), there were no differences in numbers of mullein leaf bugs (MB) among and between the treatments and the control (Table 1). On 13 June and 26 August (16 days and 90 days, respectively, after the application of 28 May), there were no differences in the percentage of damage by MB to the fruit among and between the treatments and the control (Table 2). On 13 June (16 days after the application of 28 May), there were no significant differences in the percentage of damage by plum curculio (PC) to the fruit among and between the treatments and the control (Table 3). On 9 July and 26 August (42 and 90 days, respectively, after the application of 28 May), the low rate of V-10170 (52.5 g a.i./ha) treatment had a significantly lower percentage of apples damaged by PC compared to the control; the treatments were not significantly different from each other (Table 3). On 13 June (16 days after the application of 28 May), there were no differences in fruit damage by spring feeding caterpillars (SFC) and on 13 June and 26 August (16 and 90 days, respectively, after the application of 28 May), there were no significant differences in fruit damage by tarnished plant bugs (TPB) among and between the treatments and the control (Table 4). On 10 June (13 days after the application of 28 May), there were no significant differences in numbers of white apple leafhoppers (WALH) between the treatments and the control (Table 5). On 23 June (26 days after the application of 28 May), all treatments had significantly fewer WALH than the control; there were no differences among the treatments (Table 5). On 9 July (42 days after the application of 28 May), although the numbers of WALH were elevated (21-50 per treatment), the high rate of V-10170 (105 g a.i./ha) and CALYPSO had significantly fewer WALH than the control; there were no differences among the treatments (Table 5). On 26 August (90 days after the application of 28 May), there were no differences in the weight of 50 apples among and between the treatments and the control (Table 6).

Table 1. Effect of clothianidin (V-10170 50 WDG) on mullein leaf bugs (MB) on apple trees.

Treatment[1]	Rate (g a.i./ha)	Number of MB		
		3 June (6 days)[2]	10 June (13 days)[2]	23 June (26 days)[2]
V-10170 50 WDG	52.5	0.00 a[3]	0.00 a	0.00 a
V-10170 50 WDG	105	0.00 a	0.00 a	0.00 a
CALYPSO 480 SC	140	0.25 a	0.00 a	0.00 a
CONTROL	-	0.50 a	1.75 a	0.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 2. Effect of clothianidin (V-10170 50 WDG) on apple fruit damage by mullein plant bug (MB).

Treatment[1]	Rate (g a.i./ha)	Percent apples damaged by MB	
		13 June (16 days)[2]	26 August (90 days)[2]
V-10170 50 WDG	52.5	0.00 a[3]	0.00 a
V-10170 50 WDG	105	0.00 a	0.00 a
CALYPSO 480 SC	140	0.00 a	0.00 a
CONTROL	-	0.50 a	0.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 3. Effect of clothianidin (V-10170 WDG) on apple fruit damage by plum curculio (PC).

Treatment[1]	Rate (g a.i./ha)	Percent apples damaged by PC		
		13 June (16 days)[2]	9 July (42 days)[2]	26 August (90 days)[2]
V-10170 50 WDG	52.5	0.50 a[3]	1.75 b	0.50 b
V-10170 50 WDG	105	0.00 a	4.00 ab	1.00 ab
CALYPSO 480 SC	140	0.00 a	4.70 ab	1.50 ab
CONTROL	-	7.00 a	11.35 a	4.50 a

[1] Applied 28 May.
[2] Number of days after application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 4. Effect of clothianidin (V-10170 WDG) on apple fruit damage by spring feeding caterpillars (SFC) and tarnished plant bug (TPB).

Treatment[1]	Rate (g a.i./ha)	Percent apples damaged by SFC	Percent apples damaged by TPB	
		13 June (16 days)[2]	13 June (16 days)[2]	26 August (90 days)[2]
V-10170 50 WDG	52.5	0.50 a[3]	0.50 a	0.00 a
V-10170 50 WDG	105	0.00 a	0.00 a	0.00 a
CALYPSO 480 SC	140	0.00 a	1.00 a	0.00 a
CONTROL	-	1.00 a	0.50 a	3.50 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 5. Effect of clothianidin (V-10170 WDG) on white apple leafhoppers (WALH) on apple trees.

Treatment[1]	Rate (g a.i./ha)	Number of WALH		
		10 June (13 days)[2]	23 June (26 days)[2]	9 July (42 days)[2]
V-10170 50 WDG	52.5	1.25 a[3]	3.75 b	37.75 ab
V-10170 50 WDG	105	0.75 a	1.75 b	21.00 b
CALYPSO 480 SC	140	3.00 a	1.75 b	22.75 b
CONTROL	-	0.75 a	15.75 a	50.25 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Means of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 6. Effect of clothianidin (V-10170 WDG) on apple fruit weight.

Treatment[1]	Rate (g a.i./ha)	Weight of 50 apples (g)
		26 August (90 days)[2]
V-10170 50 WDG	52.5	6818.50 a[3]
V-10170 50 WDG	105	6381.25 a
CALYPSO 480 SC	140	6913.25 a
CONTROL	-	6565.00 a

[1] Applied 28 May.
[2] Number of days after the application (28 May).
[3] Mean of four replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

2008 PMR REPORT # 05 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Apple (*Malus domestica* Borkh.) cv. Idared
PEST: European apple sawfly (*Hoplocampa testudinea* Klug), Mullein leaf bug (*Campylomma verbasci* Meyer), Plum curculio (*Conotrachelus nenuphar* Herbst), Rosy apple aphid (*Dysaphis plantaginea* Passerini), Tarnished plant bug (*Lygus lineolaris* Palisot de Beauvois)

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TITLE: **ASSESSMENT OF APPLICATION TIMING OF SPINETORAM (DELEGATE WG) FOR CONTROL OF EARLY SEASON INSECT PESTS OF 'IDARED' APPLE, 2008**

MATERIALS: DELEGATE WG (spinetoram), GUTHION 50 WP (azinphos methyl), V-10170 50 WDG (clothianidin).

METHODS: The trial was conducted in a mature 'Idared' apple orchard in Waupoos, Ontario. The apple trees were spaced 6.0 m between rows and 4.2 m within rows. The trial compared different application timings of three insecticides; DELEGATE WG (105 g a.i./ha), GUTHION 50 WP (1100 g a.i./ha) and V-10170 50 WDG. Treatments include 1) DELEGATE WG - applied pre-bloom only, 2) DELEGATE WG - applied post-bloom only, 3) DELEGATE WG - applied both pre-bloom and post-bloom, 4) GUTHION 50 WP - applied pre-bloom only, 5) GUTHION 50 WP - applied post-bloom only, 6) GUTHION 50 WP - applied both pre-bloom and post-bloom, 7) V-10170 50 WDG - applied post-bloom only, and 8) an unsprayed control. Each treatment was replicated four times and each replicate had a single tree. The trial was arranged according to a randomized complete block design. The insecticides were applied in 1000 L of water per hectare with a SOLO backpack sprayer. The pre-bloom applications occurred on 8 May and the post-bloom applications occurred on 29 May (21 days after the first application of 8 May). On apple fruit, primary European apple sawfly (EAS) damage and secondary EAS damage was assessed. The primary EAS damage is caused by a short period of feeding by first-instar larvae, and is characterized by a spiral scar on mature fruit. Fruit exhibiting primary EAS damage may

fall prior to harvest, depending on the severity of the damage. The secondary EAS damage is caused by extensive feeding by the developing larvae characterized by an entry/exit hole as larvae move from fruit to fruit; due to the extent of the damage, fruit exhibiting secondary EAS damage usually drop prior to harvest. Fruit damage data by EAS on a given assessment date is the total of both types of damage. On 20 May (12 days after the first application of 8 May), 10 fruit/flower clusters per replicate were harvested and assessed for damage by European apple sawfly (EAS), mullein leaf bug (MB), plum curculio (PC), spring feeding caterpillars (SFC - includes lesser apple worm, oblique banded leafroller, etc.) and tarnished plant bug (TPB) and 10 terminals were harvested and assessed for damage by SFC. On 27 May (19 days after the first application of 8 May); on 5 June (seven days after the second application of 29 May); and on 12 June (12 days after the second application of 29 May), 50 immature fruit per replicate were harvested and assessed for damage caused by EAS, MB, PC, SFC and TPB and 10 terminals per replicate were harvested and examined for damage caused by SFC. On 29 September (123 days after the second application of 29 May), 50 fruit per replicate were harvested, weighed and examined for damage caused by EAS, MB, PC, rosy apple aphid (RAA), SFC, and TPB. Data were expressed as percent fruit damage and percent terminal damage and analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1-8. There were no phytotoxic effects observed in any treatments 12 or 19 days after the first application of 8 May or seven or 14 days after the second application of 29 May. SFC terminal damage data; TPB fruit damage data of 12 June; and PC fruit damage data of 29 September was not homogeneous and were therefore transformed using log (x+1).

CONCLUSIONS: On 20 May (12 days after the first application of 8 May) and 27 May (20 days after the first application of 8 May), there were no fruit found with EAS damage. On 5 June (seven days after the second application of 29 May), all treatments except DELEGATE pre-bloom and DELEGATE pre-bloom + post-bloom had significantly fewer fruit damaged by EAS than the controls; the V-10170 post-bloom treatment had significantly fewer damaged fruit than the DELEGATE pre-bloom treatment. On 12 June (14 days after the second application of 29 May), all treatments except DELEGATE pre-bloom and GUTHION pre-bloom had significantly fewer fruit damaged by EAS than the controls; the V-10170 post-bloom treatment had significantly fewer EAS damaged fruit than the DELEGATE pre-bloom and the GUTHION pre-bloom treatments. On 29 September (123 days after the second application of 29 May), there were no significant differences in fruit damage by EAS among or between the treatments and the control. The damage by EAS may have been reduced at harvest due to the fruit drop of the secondary EAS damage between 12 June and 29 September (Table 1).

There were no significant differences in damage to fruit by mullein leaf bug (MB) among or between the treatments and the control on any of the assessment dates (Table 2). There were no significant differences in damage to fruit by plum curculio (PC) among or between the treatments and the control on any of the assessment dates (Table 3). On 29 September (123 days after the application of 29 May), there were no significant differences in damage to fruit by rosy apple aphids (RAA) among or between the treatments and the control (Table 4). There were no significant differences in damage to fruit by spring feeding caterpillars (SFC) among or between the treatments and the control on any of the assessment dates (Table 5). There were no significant differences in damage to terminals by spring feeding caterpillars (SFC) among or between the treatments and the control on any of the assessment dates (Table 6). There were no significant differences in damage to fruit by tarnished plant bugs (TPB) among or between the treatments and the control on any of the assessment dates (Table 7). On 29 September (123 days after the application of 29 May), there were no significant differences in the weight of 50 apples among or between the treatments and the control (Table 8).

Table 1. Effect of spinetoram (DELEGATE) on fruit damage by European apple sawfly (EAS) on apple trees.

Treatment	Rate (a.i./ha)	Percent EAS apple fruit damage				
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]	29 Sept. (123 days)[5]
DELEGATE WG [1]	105 g	0.00 a[6]	0.00 a	9.50 ab	14.50 ab	3.50 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	5.50 bc	9.00 bcd	2.50 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	7.50 abc	8.50 bcd	2.00 a
GUTHION 50 WP [1]	1100 g	0.00 a	0.00 a	4.00 bc	10.50 abc	2.50 a
GUTHION 50 WP [2]	1100 g	0.00 a	0.00 a	3.00 bc	4.50 cd	4.50 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	3.50 bc	2.50 cd	2.00 a
V-10170 50 WDG [2]	105 g	0.00 a	0.00 a	0.50 c	1.50 d	2.00 a
CONTROL	-	0.00 a	0.00 a	13.50 a	18.00 a	2.00 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 2. Effect of spinetoram (DELEGATE) on fruit damage by mullein leaf bug (MB) on apple trees.

Treatment	Rate (a.i./ha)	Percent MB apple fruit damage				
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]	29 Sept. (123 days)[5]
DELEGATE WG [1]	105 g	0.00 a[6]	0.00 a	0.00 a	0.00 a	0.00 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	0.50 a	0.00 a	0.00 a
GUTHION 50 WP [1]	1100 g	0.00 a	0.00 a	1.00 a	0.00 a	0.00 a
GUTHION 50 WP [2]	1100 g	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	1.00 a	0.00 a	0.00 a
V-10170 50 WDG [2]	105 g	0.00 a	0.00 a	1.00 a	0.00 a	0.00 a
CONTROL	-	0.00 a	0.00 a	0.50 a	0.50 a	0.00 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 3. Effect of spinetoram (DELEGATE) on fruit damage by plum curculio (PC) on apple trees.

Treatment	Rate (a.i./ha)	Percent PC apple fruit damage				
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]	29 Sept. (123 days)[5]
DELEGATE WG [1]	105 g	0.00 a[6]	0.00 a	0.00 a	0.00 a	1.50 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	0.00 a	0.50 a	0.00 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	0.00 a	0.00 a	0.50 a
GUTHION 50 WP [1]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	4.00 a
GUTHION 50 WP [2]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	1.00 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	0.00 a
V-10170 50 WDG [2]	105 g	0.00 a	0.00 a	0.50 a	0.50 a	0.50 a
CONTROL	-	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 4. Effect of spinetoram (DELEGATE) on fruit damage by rosy apple aphid (RAA) on apple trees.

Treatment	Rate (a.i./ha)	Percent RAA apple fruit damage
		29 Sept. (123 days)[4]
DELEGATE WG [1]	105 g	2.00 a[5]
DELEGATE WG [2]	105 g	1.00 a
DELEGATE WG [3]	105 g	0.00 a
GUTHION 50 WP [1]	1100 g	0.50 a
GUTHION 50 WP [2]	1100 g	1.50 a
GUTHION 50 WP [3]	1100 g	3.00 a
V-10170 50 WDG [2]	105 g	0.50 a
CONTROL	-	2.00 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the second application (29 May).
[5] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 5. Effect of spinetoram (DELEGATE) on fruit damage by spring feeding caterpillars (SFC) on apple trees.

Treatment	Rate (a.i./ha)	Percent SFC apple fruit damage				
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]	29 Sept. (123 days)[5]
DELEGATE WG [1]	105 g	2.50 a[6]	0.00 a	0.50 a	1.00 a	2.00 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	5.50 a	0.50 a	2.00 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	4.00 a	0.50 a	1.00 a
GUTHION 50 WP [1]	1100 g	7.50 a	0.00 a	3.50 a	1.00 a	3.00 a
GUTHION 50 WP [2]	1100 g	7.50 a	0.00 a	1.00 a	1.50 a	3.50 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	2.00 a	1.00 a	3.00 a
V-10170 50 WDG [2]	105 g	2.50 a	0.00 a	6.00 a	0.50 a	3.50 a
CONTROL	-	2.50 a	0.00 a	2.00 a	1.00 a	5.50 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 6. Effect of spinetoram (DELEGATE) on terminal damage by spring feeding caterpillars (SFC) on apple trees.

Treatment	Rate (a.i./ha)	Percent SFC apple terminal damage			
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]
DELEGATE WG [1]	105 g	12.50 a[6]	0.00 a	0.00 a	10.00 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	2.50 a	7.50 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	2.50 a	5.00 a
GUTHION 50 WP [1]	1100 g	2.50 a	2.50 a	0.00 a	5.00 a
GUTHION 50 WP [2]	1100 g	10.00 a	0.00 a	0.00 a	0.00 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a
V-10170 50 WDG [2]	105 g	2.50 a	0.00 a	7.50 a	2.50 a
CONTROL	-	0.00 a	0.00 a	15.00 a	2.50 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 7. Effect of spinetoram (DELEGATE) on fruit damage by tarnished plant bug (TPB) on apple trees.

Treatment	Rate (a.i./ha)	Percent TPB apple fruit damage				
		20 May (12 days)[4]	27 May (19 days)[4]	5 June (7 days)[5]	12 June (14 days)[5]	29 Sept. (123 days)[5]
DELEGATE WG [1]	105 g	0.00 a[6]	0.00 a	0.00 a	0.50 a	2.00 a
DELEGATE WG [2]	105 g	0.00 a	0.00 a	0.00 a	0.50 a	4.00 a
DELEGATE WG [3]	105 g	0.00 a	0.00 a	0.00 a	0.00 a	1.50 a
GUTHION 50 WP [1]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	1.50 a
GUTHION 50 WP [2]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	4.00 a
GUTHION 50 WP [3]	1100 g	0.00 a	0.00 a	0.00 a	0.50 a	2.50 a
V-10170 50 WDG [2]	105 g	0.00 a	0.00 a	0.00 a	0.00 a	2.50 a
CONTROL	-	0.00 a	0.00 a	0.00 a	2.00 a	1.00 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the first application (8 May).
[5] Number of days after the second application (29 May).
[6] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 8. Effect of spinetoram (DELEGATE) on apple fruit weight.

Treatment	Rate (a.i./ha)	Weight of 50 apples (g)
		29 Sept. (123 days)[4]
DELEGATE WG [1]	105 g	8375 a[5]
DELEGATE WG [2]	105 g	8063 a
DELEGATE WG [3]	105 g	8625 a
GUTHION 50 WP [1]	1100 g	8625 a
GUTHION 50 WP [2]	1100 g	8500 a
GUTHION 50 WP [3]	1100 g	8125 a
V-10170 50 WDG [2]	105 g	8313 a
CONTROL	-	8250 a

[1] Applied 8 May (pre-bloom only).
[2] Applied 29 May (post-bloom only).
[3] Applied 8 May and 29 May (both pre-bloom and post-bloom).
[4] Number of days after the second application (29 May).
[5] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

2008 PMR REPORT # 06 **SECTION A: TREE FRUIT -Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Apple (*Malus domestica* Borkh.) cv. Empire
PESTS: Oblique banded leafroller (*Choristoneura rosaceana* Harris), Plum curculio (*Conotrachelus nenuphar* Herbst), Tarnished plant bug (*Lygus lineolaris* Palisot de Beauvois)

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TITLE: ASSESSMENT OF NOVALURON (RIMON 10EC) FOR CONTROL OF OBLIQUE BANDED LEAFROLLER ON 'EMPIRE' APPLES, 2008

MATERIALS: DELEGATE WG (spinetoram), RIMON 10 EC (novaluron), SUCCESS 480 SC (spinosad).

METHODS: The trial was conducted on 'Empire' apple trees in a mature orchard in Simcoe, Ontario. The trees were spaced 7.8 m apart between rows and 4.9 m apart within rows. Two rates of RIMON 10 EC (140 ml a.i./ha and 230 ml a.i./ha) were compared to a single rate of DELEGATE WG (105 g a.i./ha), a single rate of SUCCESS 480 SC (87.4 g a.i./ha) and an unsprayed control; the treatments were applied on 23 May (timed for petal fall) and 6 June (fourteen days later). Each treatment was replicated five times and each replicate had a single tree. The trial was arranged according to a randomised complete block design. The insecticides were applied in 1000 L of water per hectare and applied with a SOLO 450 backpack sprayer. Twenty-five terminals per tree were harvested on 6 June (14 days after the first application of 23 May) and examined for the presence of oblique banded leafroller (OBLR) larvae and for terminals damaged by OBLR; the number of live OBLR and dead OBLR larvae, and the percentage of OBLR damaged terminals were recorded. On 20 June (14 days after the second application of 6 June), 25 terminals and 50 immature fruit were harvested per tree; the percentage of terminals damaged by OBLR was recorded and the percentage of fruit damaged by OBLR, plum curculio (PC) and tarnished plant bug (TPB) was recorded. Fifty immature fruit per tree were harvested on 6 August (61 days after the second application); the percentage of fruit damage per replicate by OBLR (includes damage caused by both generations of OBLR), PC and TPB was recorded. Fifty fruit per tree were harvested and weighed on 8 September (94 days after the second application); the weight and percent fruit damage by PC and TPB was recorded. Data were analysed using analysis of variance and means separated with a Tukey test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1, 2, 3, 4, 5, and 6. No phytotoxic effects were observed at 14 days after either application. PC data of 20 June, 6 August and 8 September; and OBLR data of 6 August were not homogeneous and therefore were transformed using arcsine (sqrt (x)).

CONCLUSIONS: On 6 June (14 days after the first application of 23 May), there were no significant

differences in the numbers of live or dead oblique banded leafroller (OBLR) larvae among or between the treatments and the control (Table 1). On 6 June (14 days after the first application of 23 May) and 20 June (14 days after the second application of 6 June), there were no significant differences in numbers of OBLR damaged terminals among or between the treatments and the control (Table 2). On 20 June (14 days after the first application of 6 June) and 6 August (61 days after the second application of 6 June), there were no significant differences in the percentage of OBLR damaged apples among or between the insecticide treatments and the control (Table 3). On 20 June (14 days after the second application), there were no significant differences in the percentage of apples damaged by plum curculio (PC) among or between the treatments and the control (Table 4). On 6 August (61days after the second application), all treatments, except the low rate of RIMON (140 ml a.i./ha), had significantly fewer apples damaged by PC compared to the control; there were no differences among or between the treatments (Table 4). On 8 September (94 days after the second application of 6 June), there were no significant differences in fruit damage by PC among or between the treatments and the control (Table 4). There were no significant differences in the percentage of tarnished plant bug (TPB) damaged apples among or between the insecticide treatments and the control at 14, 61 or 94 days after the second application of 6 June (Table 5). On 8 September (94 days after the second application of 6 June), the DELEGATE treatment had a significantly higher weight for fifty apples than the SUCCESS, the high rate of RIMON (230 ml a.i./ha) treatments and the control (Table 6).

Table 1. Effect of novaluron (RIMON) on oblique banded leafroller (OBLR) larvae on apple trees.

Treatment[1]	Rate (a.i./ha)	Number of OBLR larvae	
		6 June (14 days)[2]	
		# live larvae	# dead larvae
RIMON 10 EC	140 ml	0.00 a[3]	0.00 a
RIMON 10 EC	230 ml	0.00 a	0.20 a
DELEGATE WG	105 g	0.00 a	0.00 a
SUCCESS 480 SC	87.4 ml	0.00 a	0.20 a
CONTROL	-	0.20 a	0.00 a

[1] Applied 23 May and 6 June.
[2] Number of days after first application (23 May).
[3] Means of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 2. Effect of novaluron (RIMON) on terminal damage by oblique banded leafroller (OBLR) on apple trees.

Treatment[1]	Rate (a.i./ha)	Percent apple terminals damaged by OBLR	
		6 June (14 days)[2]	20 June (14 days)[3]
RIMON 10 EC	140 ml	2.40 a[4]	0.00 a
RIMON 10 EC	230 ml	0.80 a	0.00 a
DELEGATE WG	105 g	0.00 a	0.40 a
SUCCESS 480 SC	87.4 ml	1.60 a	0.00 a
CONTROL	-	1.60 a	0.00 a

[1] Applied 23 May and 6 June.
[2] Number of days after the first application (23 May).
[3] Number of days after the second application (6 June).
[4] Means of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 3. Effect of novaluron (RIMON) on fruit damage by oblique banded leafroller (OBLR) on apple fruit.

Treatment[1]	Rate (a.i./ha)	Percent apples damaged by OBLR	
		20 June (14 days)[2]	6 August (61 days)[2]
RIMON 10 EC	140 ml	0.00 a[3]	2.80 a
RIMON 10 EC	230 ml	0.40 a	4.80 a
DELEGATE WG	105 g	0.40 a	6.00 a
SUCCESS 480 SC	87.4 ml	0.40 a	3.20 a
CONTROL	-	0.40 a	10.00 a

[1] Applied 23 May and 6 June.
[2] Number of days after the second application (6 June).
[3] Means of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 4. Effect of novaluron (RIMON) on fruit damage by plum curculio (PC) on apple trees.

Treatment[1]	Rate (a.i./ha)	Percent apples damaged by PC		
		20 June (14 days)[2]	6 August (61 days)[2]	8 September (94 days)[2]
RIMON 10 EC	140 ml	1.60 a[3]	2.40 ab	2.00 a
RIMON 10 EC	230 ml	0.00 a	0.40 b	0.40 a
DELEGATE WG	105 g	0.40 a	0.40 b	0.00 a
SUCCESS 480 SC	87.4 ml	0.00 a	0.40 b	0.40 a
CONTROL	-	2.40 a	6.40 a	2.80 a

[1] Applied 23 May and 6 June.
[2] Number of days after the second application (6 June).
[3] Means of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 5. Effect of novaluron (RIMON) on fruit damage by tarnished plant bug (TPB) on apple trees.

Treatment[1]	Rate (a.i./ha)	Percent apples damaged by TPB		
		20 June (14 days)[2]	6 August (61 days)[2]	8 September (94 days)[2]
RIMON 10 EC	140 ml	1.20 a[3]	0.00 a	0.00 a
RIMON 10 EC	230 ml	0.00 a	0.00 a	0.40 a
DELEGATE WG	105 g	0.00 a	0.00 a	0.00 a
SUCCESS 480 SC	87.4 ml	0.00 a	0.40 a	0.40 a
CONTROL	-	1.20 a	1.20 a	0.80 a

[1] Applied 23 May and 6 June.
[2] Number of days after the second application (6 June).
[3] Means of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

Table 6. Effect of novaluron (RIMON) on fruit weight.

Treatment[1]	Rate (a.i./ha)	Weight of 50 apples (g)
		8 September (94 days)[2]
RIMON 10 EC	140 ml	5738.0 ab[3]
RIMON 10 EC	230 ml	5389.0 a
DELEGATE WG	105 g	6011.0 b
SUCCESS 480 SC	87.4 ml	5362.0 a
CONTROL	-	5443.0 a

[1] Applied 23 May and 6 June.
[2] Number of days after the second application (6 June).
[3] Mean of five replicates within a column followed by the same letter are not significantly different, $P<0.05$, Tukey test.

2008 PMR REPORT # 07 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Grape (*Vitis vinifera* L.) cv. Baco noir
PEST: Grape Berry Moth (*Endopiza viteana* Clemens)

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TITLE: ASSESSMENT OF SPINETORAM (DELEGATE WG) FOR CONTROL OF GRAPE BERRY MOTH ON 'BACO NOIR' GRAPES, 2008

MATERIALS: DELEGATE WG (spinetoram), GUTHION SOLUPAK 50 WP (azinphos-methyl), INTREPID 2F (methoxyfenozide), SUCCESS 480 SC (spinosad).

METHODS: The trial was conducted in a mature 'Baco noir' vineyard in Niagara-on-the-Lake, Ontario. Grapevines were spaced 3.0 m apart between rows and vines were 1.5 m apart within rows. Three rates of DELEGATE WG (70 g a.i./ha, 87.5 g a.i./ha, and 105 g a.i./ha) were compared to two rates of SUCCESS 480 SC (87.4 g a.i./ha and 140 g a.i./ha), a single rate of INTREPID 2F (144 g a.i./ha), a single rate of GUTHION SOLUPAK 50 WP (625 g a.i./ha), and an unsprayed control. Each treatment was replicated four times, each replicate had four to five vines. The trial was arranged according to a randomized complete block design. Prior to the first application of insecticides, all grape bunches infested with first generation grape berry moth (GBM) were removed from all vines in the trial. The first application was on 3 July (timed for first egg hatch of second generation GBM) and the second application was on 16 July (13 days later). The insecticides were applied in 1000 L of water per hectare with SOLO backpack sprayer. GBM damage was assessed by examining 50 bunches of immature grapes per replicate on 15 July (12 days after the first application) and 30 July (14 days after the second application); the percentage of GBM infested bunches were recorded. On 9 September (55 days after the second application), 50 grape bunches per replicate were harvested and weighed. Data were analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Table 1. The grape berry moth (GBM) damage data of 15 July was not homogeneous and therefore was transformed using square root (x + 0.5). No phytotoxic effects were observed in any of the treatments four days and seven days after the first application of 3 July or five and eight days after the second application of 16 July. The vineyard in which this trial was conducted is considered to have high GBM pressure.

CONCLUSIONS: On 15 July (12 days after the first application), the percentage of grape berry moth (GBM) damaged bunches was significantly reduced in all treatments except the GUTHION treatment compared to the control; there appeared to be a rate affect with the DELEGATE treatments (Table 1). On 30 July, (14 days after the second application), all treatments except INTREPID and the low rate of SUCCESS (87.4 g a.i./ha) had significantly fewer GBM damaged bunches compared to the control

(Table 1). On 9 September (55 days after the second application), there were no significant differences in the weight of 50 bunches of grapes between and among the treatments and the control (Table 1).

Table 1. Effect of spinetoram (DELEGATE) on grape berry moth (GBM) on grape bunches and fruit weight.

Treatment[1]	Rate (g a.i./ha)	Percent GBM damaged grape bunches		Weight (g)
		15 July (12 days)[2]	30 July (14 days)[3]	9 September (55 days)[3]
DELEGATE WG	70	6.50 bc[4]	12.00 bc	3826.25 a
DELEGATE WG	87.5	4.00 bc	12.50 bc	3782.50 a
DELEGATE WG	105	2.00 c	11.00 c	3401.25 a
INTREPID 2F	144	9.00 b	23.00 ab	3951.25 a
SUCCESS 480 SC	87.4	6.00 bc	21.00 abc	3415.00 a
SUCCESS 480 SC	140	5.00 bc	17.50 bc	3637.50 a
GUTHION SOLUPAK 50 WP	625	10.00 ab	16.00 bc	3550.00 a
CONTROL	-	19.50 a	30.00 a	3227.50 a

[1] Applied 3 July and 16 July.
[2] Number of days after first application (3 July).
[3] Number of days after second application (16 July).
[4] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

2008 PMR REPORT # 08 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Grape (*Vitis vinifera* L.) cv. Foch
PEST: Grape Berry Moth (*Endopiza viteana* Clemens)

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TITLE: ASSESSMENT OF CONTROL OF GRAPE BERRY MOTH ON 'FOCH' GRAPES WITH FLUBENDIAMIDE (BELT 480 SC), 2008

MATERIALS: BELT 480 SC (flubendiamide), GUTHION SOLUPAK 50 WP (azinphos methyl).

METHODS: The trial was conducted in a mature 'Foch' vineyard in Grimsby, Ontario. Grapevines were spaced 3.0 m apart between rows and vines were 1.5 m apart within rows. Two rates of BELT 480 SC (105 g a.i./ha and 140 g a.i./ha) were compared to a single rate of GUTHION SOLUPAK 50 WP (1870 g a.i./ha), and an unsprayed control. Each treatment was replicated four times; each replicate had two to three vines. The trial was arranged according to a randomized complete block design. Prior to the first application of insecticides, all grape bunches infested with first generation grape berry moth (GBM) were removed from all of the vines in the trial. The first insecticide application occurred on 8 July (timed for peak egg hatch of second generation GBM) and the second application occurred on 23 July (15 days later). The insecticides were applied in 3000 L of water per hectare, and sprayed to runoff with a Rittenhouse truck-mounted sprayer equipped with a Spraying Systems handgun fitted with a D-6 orifice plate. GBM damage was assessed by examining 50 bunches of immature grapes per replicate per treatment on 22 July (14 days after the first application of 8 July) and 7 August (15 days after the second application of 23 July); the percentage of GBM infested bunches was recorded. Fifty bunches of grapes per replicate per treatment were harvested and weighed on 27 August (35 days after the second application of 23 July). Data were analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1 and 2. No phytotoxic effects were observed in any of the treatments nine days and 14 days after the first application or five and eight days after the second application. The vineyard in which this trial was conducted is considered to have high grape berry moth pressure.

CONCLUSIONS: On 22 July (14 days after the first application of 8 July), the percentage of grape berry moth (GBM) infested bunches found in all treatments was significantly reduced compared to the control; there were no differences among the insecticide treatments. On 7 August (15 days after the second application of 23 July), the percentage of grape berry moth (GBM) infested bunches found in all treatments was significantly reduced compared to the control; there were no differences among the

insecticide treatments (Table 1). On 27 August (35 days after the second application of 23 July), there were no differences in the weight of 50 bunches of grapes among or between the treatments and the control (Table 2). Heavy rainfall from late July through early August (84 mm from 23 July through 5 August - data from the Grimsby weather station monitored by Weather Innovations Inc.) may have washed off some of the pesticide residue and reduced the efficacy of the pesticide product resulting in elevated GBM damage in the 7 August rating.

Table 1. Effect of flubendiamide (BELT) on grape berry moth (GBM) on grape bunches.

Treatment[1]	Rate (g a.i./ha)	Percent GBM infested grape bunches	
		22 July (14 days)[2]	7 August (15 days)[3]
BELT 480 SC	105	18.50 b[4]	28.00 b
BELT 480 SC	140	11.00 b	30.00 b
GUTHION SOLUPAK 50 WP	1870	13.00 b	23.50 b
CONTROL	-	36.00 a	47.00 a

[1] Applied 8 July and 23 July.
[2] Number of days after the first application (8 July).
[3] Number of days after the second application (23 July).
[4] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

Table 2. Effect of flubendiamide (BELT) on fruit weight.

Treatment[1]	Rate (g a.i./ha)	Weight of 50 grape bunches (g)
		27 August (35 days)[2]
BELT 480 SC	105	3030.75 a[3]
BELT 480 SC	140	2812.50 a
GUTHION SOLUPAK 50 WP	1870	2633.00 a
CONTROL	-	2977.25 a

[1] Applied 8 July and 23 July.
[2] Number of days after the second application (23 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

2008 PMR REPORT # 09 **SECTION A: TREE FRUIT - Insect Pests**
STUDY DATA BASE #: T.1206.QM

CROP: Grapes (*Vitis vinifera* L.) cv. Baco noir
PEST: Grape Berry Moth (*Endopiza viteana* Clemens)

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TITLE: ASSESSMENT OF CONTROL OF GRAPE BERRY MOTH ON 'BACO NOIR' GRAPES WITH FLUBENDIAMIDE (BELT 480 SC), 2008

MATERIALS: BELT 480 SC (flubendiamide), GUTHION SOLUPAK 50 WP (azinphos methyl).

METHODS: The trial was conducted in a mature 'Baco noir' vineyard in Niagara-on-the-Lake, Ontario. Grapevines were spaced 3.0 m apart between rows and vines were 1.5 m apart within rows. Two rates of BELT 480 SC (105 g a.i./ha and 140 g a.i./ha) were compared to a single rate of GUTHION SOLUPAK 50 WP (1870 g a.i./ha), and an unsprayed control. Each treatment was replicated four times; each replicate had four to five vines. The trial was arranged according to a randomized complete block design. Prior to the first application of insecticides, all grape bunches infested with first generation grape berry moth (GBM) were removed from all of the vines in the trial. The first insecticide application occurred on 8 July (timed for peak egg hatch of second generation GBM) and the second application occurred on 23 July (15 days later). The insecticides were applied in 3000 L of water per hectare, and sprayed to runoff with a Rittenhouse truck-mounted sprayer equipped with a Spraying Systems handgun fitted with a D-6 orifice plate. GBM damage was assessed by examining 50 immature bunches of grapes per replicate per treatment on 22 July (14 days after the first application of 8 July) and 7 August (15 days after the second application of 23 July); the percentage of GBM infested bunches was recorded. Fifty bunches of grapes per replicate per treatment were harvested and weighed on 29 August (37 days after the second application of 23 July). Data were analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1 and 2. No phytotoxic effects were observed in any of the treatments nine days and 14 days after the first application or five and eight days after the second application. The vineyard in which this trial was conducted is considered to have high grape berry moth pressure.

CONCLUSIONS: On 22 July (14 days after the first application of 8 July), the percentage of grape berry moth (GBM) infested bunches found in all treatments was significantly reduced compared to the control; there were no differences among the treatments (Table 1). On 7 August (15 days after the second application of 23 July), the high rate of BELT (140 g a.i./ha) and GUTHION treatments had significantly fewer GBM infested bunches compared to the control; there were no differences among the treatments

(Table 1). On 29 August (37 days after the second application of 23 July), there were no differences in the weight of 50 bunches of grapes among or between the treatments and the control (Table 2). Heavy rainfall from late July through early August (54.7 mm from 23 July through 5 August - data from the Virgil weather station monitored by Weather Innovations Inc.) may have washed off some of the pesticide residue and reduced the efficacy of the pesticide product resulting in elevated GBM damage in the 7 August rating.

Table 1. Effect of flubendiamide (BELT) on grape berry moth (GBM) on grape bunches.

Treatment[1]	Rate (g a.i./ha)	Percent GBM infested grape bunches	
		22 July (14 days)[2]	7 August (15 days)[3]
BELT 480 SC	105	7.00 b[4]	29.00 ab
BELT 480 SC	140	7.00 b	25.50 b
GUTHION SOLUPAK 50 WP	1870	10.50 b	24.50 b
CONTROL	-	22.50 a	37.50 a

[1] Applied 8 July and 23 July.
[2] Number of days after the first application (8 July).
[3] Number of days after the second application (23 July).
[4] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

Table 2. Effect of Flubendiamide (BELT) on fruit weight.

Treatment[1]	Rate (g a.i./ha)	Weight of 50 grape bunches (g)
		29 August (37 days)[2]
BELT 480 SC	105	3596.75 a[3]
BELT 480 SC	140	3722.25 a
GUTHION SOLUPAK 50 WP	1870	3414.50 a
CONTROL	-	3258.00 a

[1] Applied 8 July and 23 July.
[2] Number of days after the second application (23 July).
[3] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

2008 PMR REPORT # 10 **SECTION A: TREE FRUIT-Insect Pests**
STUDY DATA BASE #:T.1206.QM

CROP: Pear (*Pyrus communis* L.) cv. Bartlett
PESTS: Pear Psylla (*Psylla pyricola* Foerster)

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TITLE: ASSESSMENT OF DIFFERENT TIMINGS OF SPINETORAM (DELEGATE WG) FOR CONTROL OF PEAR PSYLLA ON 'BARTLETT' PEAR, 2008

MATERIALS: DELEGATE WG (spinetoram), GUTHION SOLUPAK 50 WP (azinphos-methyl).

METHODS: The trial was conducted in an established pear orchard in Grimsby, Ontario; 'Bartlett' pear trees were spaced 4.2 m apart between rows and 3.5 m apart within rows. Each treatment was replicated four times and each replicate had two trees. The trial was arranged according to a randomized complete block design. The trial compared two applications of DELEGATE WG (105 g a.i./ha) timed for green tip and pink to a single application of DELEGATE WG (105 g a.i./ha) timed for green tip, a single application of DELEGATE WG (105 g a.i./ha) timed for pink, a single application of GUTHION SOLUPAK 50 WP (1100 g a.i./ha) timed for pink and an untreated control. Insecticides were applied 23 April (for the treatments timed for green tip) and 5 May (for the treatments timed for pink). The insecticides were applied in 1000 L of water per hectare, and applied with a SOLO backpack sprayer. On 12 May, 20 May, 27 May, and 9 June (seven, 15, 22, and 35 days, respectively, after the second application of 5 May), ten healthy leaf clusters per replicate were harvested; the leaf clusters were examined under a stereo-microscope and the number of pear psylla (PP) eggs and live PP nymphs were counted and recorded. Dead PP nymphs were counted and recorded on 20 May and 27 May (15 and 22 days, respectively, after the second application of 5 May). Data were analyzed using analysis of variance and means were separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1 and 2. No phytotoxic effects were observed in any of the treatments at five, eight days or 12 days after the first application of 23 April or three, seven or 10 days after the second application of 5 May. Pear psylla (PP) egg count data and live PP nymph data of 12 May; and PP egg count data of 27 May were not homogeneous and therefore were transformed using log(x + 1). Attempts to transform non-homogeneous live PP nymph data of 20 May were unsuccessful, therefore original data is presented.

CONCLUSIONS: On 12 May and 20 May (seven and 15 days after the second application), there were no significant differences in the number of pear psylla (PP) eggs among or between the treatments and the control. On 27 May (22 days after the second application of 5 May), all treatments except the multiple application of DELEGATE (timed for both green tip and pink) had significantly fewer PP eggs than the control; there were no significant differences among the treatments. On 9 June (35 days after the second

application of 5 May), there were no significant differences in the number of PP eggs among or between the treatments and the control (Table 1).

On 12 May, 20 May and 27 May (seven, 15 and 22 days, respectively, after the second application of 5 May), there were no significant differences in the number of live PP nymphs among or between the treatments and the control. On 9 June (35 days after the second application of 5 May), the early DELEGATE treatment (timed for green tip) and the GUTHION treatment (timed for pink) had significantly fewer live PP nymphs than the control; there were no significant differences among the treatments (Table 2). On 20 May and 27 May (15 and 22 days after the second application of 5 May), there were no significant differences in the number of dead PP nymphs among or between the treatments and the control (data not shown as very few dead nymphs were found (approximately 1 dead nymph per replicate)).

Table 1. Effect of spinetoram (DELEGATE) on pear psylla (PP) eggs on pear leaves.

Treatment	Rate (g a.i./ha)	No. of PP eggs	No. of PP eggs	No. of PP eggs	No. of PP eggs
		12 May (7 days)[3]	20 May (15 days)[3]	27 May (22 days)[3]	9 June (35 days)[3]
DELEGATE WG (green tip)[1]	105	24.75 a[4]	7.50 a	0.75 b	13.00 a
DELEGATE WG (pink)[2]	105	20.50 a	2.25 a	1.00 b	5.50 a
DELEGATE WG (both)[1,2]	105	15.75 a	0.25 a	7.00 ab	15.25 a
GUTHION SOLUPAK 50 WP (pink)[2]	1100	9.00 a	10.50 a	1.00 b	20.00 a
CONTROL	-	52.00 a	29.25 a	22.75 a	14.00 a

[1] Applied 23 April.
[2] Applied 5 May.
[3] Number of days after the second application (5 May).
[4] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

Table 2. Effect of spinetoram (DELEGATE) on pear psylla (PP) nymphs on pear leaves.

Treatment	Rate (g a.i./ha)	No. of live PP nymphs	No. of live PP nymphs	No. of live PP nymphs	No. of live PP nymphs
		12 May (7 days)[3]	20 May (15 days)[3]	27 May (22 days)[3]	9 June (35 days)[3]
DELEGATE WG (green tip)[1]	105	3.50 a[4]	6.00 a	7.50 a	0.50 b
DELEGATE WG (pink)[2]	105	1.75 a	6.75 a	6.00 a	2.25 ab
DELEGATE WG (both)[1,2]	105	3.50 a	6.75 a	6.50 a	2.00 ab
GUTHION SOLUPAK 50 WP (pink)[2]	1100	2.75 a	11.50 a	10.00 a	1.50 b
CONTROL	-	3.50 a	11.00 a	20.25 a	6.75 a

[1] Applied 23 April.
[2] Applied 5 May.
[3] Number of days after the second application (5 May).
[4] Means of four replicates within a column followed by the same letter are not significantly different $P<0.05$, Tukey test.

2008 PMR REPORT # 11 **SECTION A : BERRIES - Insect Pests**

CROP: Strawberry (*Fragaria* x *ananassa*), cv. Jewel
PEST: Black vine weevil (BVW), *Otiorhynchus sulcatus* (F.)

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TITLE: **SMALL PLOT FIELD EVALUATION OF FOLIAR INSECTICIDES FOR CONTROL OF ADULT BLACK VINE WEEVIL IN STRAWBERRY, 2008**

MATERIALS: ACTARA 25 WG (thiamethoxam 25% [w/w]), DPX-HGW86 200 SC (cyazypyr 20% [w/w]), ALVERDE 240 SC (metaflumizone 22.0% [w/w]), MATADOR 120 EC (lambda-cyhalothrin 13.1% [w/w]), CAPTURE 2 EC (bifenthrin 25.1% [w/w])

METHODS: Three-row plots were established on 11 July in a block of strawberries planted in sandy loam soil (54.4% sand, 32.4% silt, 13.2% clay) near Campbelleville, ON (Latitude 43˚ 27' 26.16" N; Longitude 79˚ 56' 25.41" W) in May 2005. Barrier pitfall traps (BPFT) consisting of a 1 m x 15 cm barrier of fibreglass with a collection cup at each end of the barrier, first captured BVW in this field on 19 June. All treatments (Table 1) were replicated 4x in a Randomized Complete Block Design; a Block comprised a replicate of each treatment. Blocks, separated by a 1.5 m buffer, were located serially into the field. Individual plots measured 6 m long. Each plot within a Block was separated from the adjacent plot by a buffer row. A buffer, comprised of a single row along each side and a 1.5 m swath along each end, was also established around the entire experimental Block.

On 14 July, prior to treatment, 25 trifoliate leaves were randomly collected from each plot (ca. 8 trifoliate leaves/row), placed in labelled bags contained in coolers and returned to the laboratory where

"notches" characteristic of BVW-feeding were subsequently counted in each trifoliate leaf. On 14 July all treatments, including buffer treatments were applied in 200 L/ha at 205 kPa in a 1.2 m swath centred on each row, using a hand-held, CO_2-pressurized, R&D field-plot sprayer with a 0.6 m boom, fitted with three XR8002VS flat spray tips. All buffers were similarly treated with CAPTURE (450 ml/ha) immediately after completion of plot treatments. On 16 July, 2 days after treatment (DAT), in full darkness, BVW were collected from each plot by dragging a 37 cm sweep net just above the surface of the straw mulch through the foliage down the full length of each row. Collected BVW were placed in labelled, covered, foam cups contained in coolers and returned to the laboratory for counting. BVW were again collected and counted as described on 24 July, 10 DAT. A second set of 25 trifoliate leaves was collected from each plot as described, on 28 July, 14 DAT. Collected leaves were returned to the laboratory and feeding "notches" counted in "healthy", green growing leaves which comprised at least ⅔ of each sample. The number of BVW and the mean number of "notches"/leaf were determined for each plot. The significance of overall impact of treatments was determined by Analysis of Variance; significance of observed differences among individual treatment means was then determined using Student-Neuman-Keul's means separation test

OBSERVATIONS: No phytotoxicity was observed following any treatment. The BVW population was very high across the entire Block. By the time of application on 14 July, feeding damage was very heavy in all plots (Table 1). Due to favourable weather conditions post treatment, subsequent leaf development was quite rapid; many recently opened leaves were collected during the post treatment leaf assessment, 14 DAT.

RESULTS: Results are outlined in Table 1. On 14 July, immediately prior to treatment, BVW feeding damage was high in all plots. No significant differences in the number of feeding "notches"/leaf were recorded among any of the treatments (Table 1 - Pre Tmt.). By 2 DAT, relative to untreated plots, BVW numbers were significantly reduced in plots treated with any of the 3 higher rates of thiamethoxam (Tmts. 2-4), cyazypyr (Tmt. 5), metaflumizone (Tmt. 6) or bifenthrin (Tmt. 8). On 2 DAT, lowest BVW numbers were recorded in plots treated with metaflumizone (Table 1 - 2 DAT). By 10 DAT, while BVW numbers were still low in plots treated with metaflumizone or bifenthrin, numbers had greatly declined in untreated plots (Table 1 - 10 DAT). On that date, BVW numbers were significantly lower in plots treated with bifenthrin than in plots treated with cyazypyr or any rate of thiamethoxam but not lower than numbers recorded in untreated plots (Table 1 - 10 DAT). When leaves were again sampled 14 DAT, significantly fewer feeding "notches" were counted in "young" leaves from plots treated with bifenthrin or thiamethoxam @ 70.0 g a.i./ha (Tmt. 3) than in leaves from untreated plots (Table 1 - 14 DAT). Observed differences in feeding damage among treated plots were, however, not statistically significant on that date.

CONCLUSIONS: Under the conditions of this trial, application of any of the 3 higher rates of thiamethoxam (Tmts. 2-4), cyazypyr (Tmt. 5), metaflumizone (Tmt. 6) or bifenthrin (Tmt. 8) resulted in at least short term reductions in numbers of adult BVW in treated plots. Further investigation of the potential of these treatments is warranted. The applied rate of lambda-cyhalothrin, currently registered for control of clipper (bud) weevil, *Anthonomus signatus* Say, did not provide adequate control of BVW in this trial.

Table 1. Small plot field evaluation of foliar insecticides for management of black vine weevil, *Otiorhynchus sulcatus*, in strawberry, Campbelleville, ON, 2008.

Tmt No.	Treatment Applied		Rate Applied		Mean "Notches"/Leaf		Mean No. BVW/Plot	
	Insecticide	Formulation	g a.i./ha	Product/ha	Pre Tmt.	14 DAT[1]	2 DAT[1]	10 DAT[1]
1	thiamethoxam	ACTARA 25 WG	35.0	140.0 g	52.3 a[2]	3.0 ab	20.0 ab	10.8 ab
2	thiamethoxam	ACTARA 25 WG	52.5	210.0 g	67.2 a	3.4 ab	14.0 bc	12.5 ab
3	thiamethoxam	ACTARA 25 WG	70.0	280.0 g	59.3 a	2.6 b	8.0 bc	11.8 ab
4	thiamethoxam	ACTARA 25 WG	105.0	420.0 g	61.5 a	3.6 ab	7.5 bc	12.3 ab
5	cyazypyr	DPX-HGW86 200 SC	150.0	750.0 ml	60.8 a	3.1 ab	12.0 bc	18.5 a
6	metaflumizone	ALVERDE 240 SC	280.0	1,166.7 ml	67.4 a	1.9 b	1.5 c	2.3 bc
7	lambda-cyhalothrin	MATADOR 120 EC	12.5	104.0 ml	60.4 a	3.4 ab	21.0 ab	8.0 bc
8	bifenthrin	CAPTURE 2 EC	112.2	469.7 ml	49.0 a	3.3 ab	5.8 bc	0.8 c
9	no insecticide	CONTROL	---	---	56.0 a	4.9 a	31.8 a	5.8 bc

[1] Days after Treatment

[2] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and Student-Neuman-Keul's means separation test.

2008 PMR REPORT # 12 **SECTION B : VEGETABLE and SPECIAL CROPS - Insect Pests**

CROP: Cabbage (*Brassica oleracea* L. var. *capitata*), cv. Zerlina
PEST: Cabbage maggot (CM), *Delia radicum* (Linnaeus)

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TITLE: EVALUATION OF PLANTING TREATMENTS FOR CONTROL OF DAMAGE BY CABBAGE MAGGOT TO ROOTS OF CABBAGE TRANSPLANTS ON MINERAL SOIL, 2008

MATERIALS: ENTRUST 80 WP (spinosad 80% [w/w]), BOTANIGARD 22 WP (*Beauveria bassiana* Strain GHA 22% [w/w]), CAPTURE LFR (bifenthrin 17.15% [w/w]), PONCHO 600 FS (clothianidin 48% [w/w]), DPX-HGW86 200 SC (cyazypyr 20% [w/w]). DELEGATE 25 WG (spinetoram 25.0% [w/w]), PYRINEX 480 EC (chlorpyrifos 44.7% [w/w])

METHODS: Cabbage seedlings were grown singly in plastic propagation-plug trays each containing 10 rows of 20 plugs. On 11 June all treatments (Table 1) were hand planted in single 5 m row plots (1.0 m row spacing; 0.4 m plant spacing) in Embro loam (57.2% sand, 23.5% silt, 19.4% clay, 3.6% organic matter) on the SCPFRC-London Research Farm. All treatments were replicated 4x in a randomized complete block design with 1.5 m fallow buffers between blocks. The desired concentration of each control agent was applied in 100 ml of planting solution poured into individual planting holes. As soon as the planting solution had drained into the soil, a single seedling (BBCH growth stage 12-13) was established in each planting hole. On 01-02 July at BBCH 18-19, 15-20 CM eggs from an insecticide susceptible, laboratory-reared strain were carefully buried 1 cm deep, immediately adjacent to the stem of each of 8 successive plants in each plot. Each infested row length was delineated by dated, plastic stakes. On 24 July, all infested plants from each plot were carefully dug, soil washed from the roots and developing cabbage severed from the tap root 2-3 cm above ground level. All roots from each plot were placed in a labelled plastic bag and the damage caused by feeding CM subsequently assessed for each root using a semi quantitative rating scale where 0 = no root damage, 1 = less than 10% of the root surface with root maggot feeding channels, 2 = 11-25%, 3 = 26-50%, 4 = 51-75%, and 5 = 76-100% of the main root surface area damaged. (Dosdall, L. M., M. J. Herbut, and N. T. Cowle. 1994). For each plot, the % roots in each damage category was then calculated. Damage data were subjected to arcsin square root transformation prior to statistical analysis by analysis of variance (ANOVA); significance of differences among treatments means was determined using a Least Significant Difference (LSD) Range Test. Untransformed data are presented.

OBSERVATIONS: Application of the tested rate of LORSBAN 50 WP in the planting water seriously slowed subsequent growth of treated cabbaged seedlings. Treated plants were stunted; at the time of CM egg infestation, plants treated with LORSBAN 50 WP were at BBCH 14-16 while plants in all other treatments had reached at least BBCH 19. Cabbages had not recovered by the time of the final harvest

for root assessment.

Cabbage transplants had developed 2-3 pairs of leaves by the time of planting by which time transplants had become "plug-bound". While the resulting twisted roots did not slow plant growth, accurate assessment of CM-damage to roots was very difficult.

RESULTS: Experimental results are outlined in Table 1; due to the very low number of roots in these categories, data are not shown for Damage Ratings of 4 or 5. No clean roots (Rating 0) were recorded in untreated plots (Tmt. 10) or plots treated with either rate of spinosad alone (Tmt. 1, 2). At least 19% of roots in plots treated with either chlorpyrifos, the commercial standard (Tmt. 9) or B. bassiana (BB) alone (Tmt.3) showed no CM damage, a level of protection significantly higher than that recorded in plots treated with either rate of spinosad (Tmt. 1, 2). When criteria were relaxed to include cabbage roots with < 10% CM-damage (Rating 0 or 1), significantly more roots were recorded in these categories in plots treated with either chlorpyrifos (Tmt. 9), clothianidin (Tmt. 7) or cyazypyr (Tmt. 8) than in untreated plots (Tmt. 10). Conversely, at least 25% of the root showed CM-damage (Rating 3) in significantly fewer roots in plots treated with BB + the higher rate of spinosad (Tmt. 5), clothianidin (Tmt.7), cyazypyr (Tmt. 8) or the commercial standard, chlorpyrifos (Tmt. 9) than in untreated plots (Tmt. 10) or plots treated with either rate of spinosad alone (Tmt. 1, 2) or BB ± the lower rate of spinosad (Tmt. 3, 4).

CONCLUSIONS: Under the conditions of this trial, while addition of chlorpyrifos to the planting water effectively reduced CM damage to roots of cabbage plants, the observed phytotoxicity would more than eliminate any benefit of improved root protection. Addition of tested rates either clothianidin or cyazypyr to planting water had no impact on subsequent growth of cabbage and significantly reduced CM-damage to the roots of treated plants. Both insecticides warrant further investigation in this application. While no tested rate of the organically approved formulation of spinosad alone had any impact on CM-damage to cabbage roots, combination of the higher rate of spinosad with the entomopathogenic fungus, BB did reduce CM-damage. This combination might be of interest to organic growers and warrants further investigation.

REFERENCES:

Dosdall, L.M., M.J. Herbut, and N.T. Cowle. 1994. Susceptibilities of species and cultivars of canola and mustard to infestation by root maggots (Delia spp.) (Diptera: Anthomyiidae). The Canadian Entomologist 126: 251-260.

Table 1. Effect of planting treatments on root damage due to cabbage maggot attacking cabbage transplants on mineral soil, London, ON, 2008.

Tmt No.	Treatment Applied		Rate/1000 Plants		Mean % Roots with Indicated Damage Rating[1]				
	Insecticide	Formulation	g a.i.	Product	0	1	2	3	0 + 1
1	spinosad	ENTRUST 80 W	6.0	7.5 g	0.0 c	27.2 3	51.8 a	21.0 ab	27.2 c
2	spinosad	ENTRUST 80 W	12.0	15.0 g	0.0 c	46.4 bc	23.2 a	30.4 a	46.4 bc
3	*B. bassiana*	BOTANIGARD 22 WP	25.0	113.6 g	19.6 ab	39.7 bc	22.6 a	14.9 b	59.4 abc
4	spinosad + *B. bassiana*	ENTRUST 80 W + BOTANIGARD 22 WP	6.0 + 25.0	7.5 g + 113.6 g	3.6 bc	46.4 abc	28.6 a	21.5 ab	50.0 bc
5	spinosad + *B. bassiana*	ENTRUST 80 W + BOTANIGARD 22 WP	12.0 + 25.0	15.0 g + 113.6 g	10.7 bc	34.8 c	54.5 a	0.0 c	45.5 bc
6	bifenthrin	CAPTURE LFR	6.0	33.3 ml	10.7 abc	49.1 abc	33.0 a	7.2 bc	59.8 abc
7	clothianidin	PONCHO 600 FS	12.0	19.8 ml	12.5 abc	80.4 a	7.1 a	0.0 c	92.9 a
8	cyazypyr	DPX-HGW86 200 SC	35.0	175.0 ml	4.2 bc	73.2 ab	22.6 a	0.0 c	77.4 ab
9	chlorpyrifos	LORSBAN 50 WP	32.5	65.0 g	30.4 a	58.9 abc	10.7 a	1.1 c	89.3 a
10	no insecticide	CONTROL	---	---	0.0 c	39.3 c	42.3 a	18.5 ab	39.3 c

[1]Rating Scale: 0 = no root damage, 1 = less than 10% of the root surface with root maggot feeding channels, 2 = 11-25%, 3 = 26-50%, 4 = 51-75%, and 5 = 76-100% of the main root surface area damaged (Dosdall *et al.*, 1994).

[2] For each root damage rating category, means followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and a Least Significant Difference Range Test.

2008 PMR REPORT # 13 **SECTION B: VEGETABLES and SPECIALTY CROPS – Insect pests**

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cv. Cellobunch
PESTS: Carrot rust fly (*Psila rosae* (Fabricius))
Carrot weevil (*Listronotus oregonensis* (LeConte))

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TITLE: **COMPARISON OF VARIOUS SEED TREATMENTS FOR CONTROL OF DAMAGE BY CARROT RUST FLY AND CARROT WEEVIL IN CARROTS, 2008**

MATERIALS: ENTRUST (spinosad 80%), CRUISER (thiamethoxam 47.6%), SEPRESTO 75WS (clothianidin 56.25% + imidacloprid 18.75%), THIRAM 42S (thiram 42%)

METHODS: The trial was conducted near the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.8, organic matter ≈ 45%). Carrots were direct seeded (75-80 seeds/m) onto raised beds using a push V-belt seeder on 28 May. A randomized complete block arrangement with four replicates per treatment was used. Each plot consisted of two rows, 86 cm apart and 5 m in length. All treatments included 250 mg ai THIRAM (fungicide) per 100 g of seed. At harvest on 7 November a 2.32 m yield sample was taken from each replicate. Carrots were washed in a small drum washer to reveal damage caused by both carrot rust fly and carrot weevil. Assessments were made by inspecting each carrot for damage and calculating the percentage of carrots damaged by either pest. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.7. Means separation was obtained using Fisher's Protected LSD test at $P = 0.05$ level of significance.

WEATHER: The air temperatures in 2008 were below the long term (10 year) average for May (10.7˚C), August (17.9˚C) and September (14.7˚C), average for July (20.4˚C) and above average for June (19.2˚C). The long term (10 year) average temperatures were: May 12.6˚C, June 18.4˚C, July 20.3˚C, August 19.2˚C, and September 15.7˚C. Monthly rainfall was below the long term (10 year) average for May (48 mm) and June (68 mm), above average for July (137 mm) and August (63 mm), and average for

September (82 mm). The long term (10 year) rainfall averages were: May 80 mm, June 76 mm, July 69 mm, August 56 mm and September 80 mm.

RESULTS: As presented in Table 1

CONCLUSIONS: Significant differences were found among the treatments in the percentage of carrots damaged by rust fly (Table 1). Carrot rust fly damage was high (42.3% in Check plots) in the trial. Damage in the best treatment was only 15%, a reduction in damage of nearly 65%. Carrots grown from seeds treated with either rate of CRUISER, ENTRUST at the high rate (7.5 g ai) and SEPRESTO at the high rate (11.25 g ai) had significantly less rust fly damage than the Check. There were no significant differences in rust fly damage to carrots grown from seeds treated with low (2.5 g ai) and medium (3.75 g ai) rates of ENTRUST, the low rate of SEPRESTO (5.63 g ai) and the untreated Check. No significant differences in the percentage of carrots damaged by carrot weevil were found among the treatments (Table 1). No significant differences in yield were found among the treatments (Table 1).

ACKNOWLEDGEMENT: Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program and the New York State Agricultural Experiment Station, Cornell University provided support to conduct field research as part of a larger US project on new chemistry seed treatments.

Table 1. Effects of seed treatments on damage to carrots by carrot rust fly and carrot weevil, Holland Marsh, Ontario 2008.

Treatment	Rate (g ai/100 g seed)	% Carrot Rust Fly Damage	% Carrot Weevil Damage	Marketable Yield (t/ha)
CRUISER	2.5	15.0 a[1]	1.2 ns[2]	62.4 ns
CRUISER	3.75	21.7 ab	0.6	63.9
ENTRUST	7.5	22.4 ab	2.1	63.4
SEPRESTO	11.25	25.8 abc	2.2	61.7
SEPRESTO	5.63	27.7 a-d	2.0	55.8
ENTRUST	3.75	32.6 bcd	0.5	51.2
ENTRUST	2.5	40.1 cd	0.9	49.6
Check	--	42.3 d	2.3	46.0

[1] Numbers followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

[2] Not significantly different, $P = 0.05$ Fisher's Protected LSD Test

2008 PMR REPORT # 14 **SECTION B: VEGETABLES and SPECIALTY CROPS – Insect pests**

CROPS: Cepa bunching onions (*Allium cepa*) cv. Arsenal
Green bunching onions (*Allium fistulosum* L.) cv. Parade
Shallots (*Allium cepa* L.) cv. Conservor
PEST: Onion maggot (*Delia antiqua* (Meigen))

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TITLE: **EVALUATION OF SEED TREATMENTS FOR CONTROL OF ONION MAGGOT DAMAGE IN CEPA AND FISTULOSUM BUNCHING ONIONS, AND SHALLOTS, 2008**

MATERIALS: ENTRUST (spinosad 80%), SEPRESTO 75WS (clothianidin 56.25% + imidacloprid 18.75%), RAXIL 2.6F (tebuconazole 28.3%), THIRAM 42S (thiram 42%)

METHODS: Seed treatments for cepa and fistulosum bunching onions and shallots were evaluated in field trials on organic soil (pH ≈6.6, organic matter ≈ 70.2%) naturally infested with *Delia antiqua* pupae at the Muck Crops Research Station, Holland Marsh, Ontario. Cepa bunching and shallot seeds were treated with RAXIL at 250 mg ai, and cepa bunching seeds were also treated with THIRAM 42S at 188 mg ai. These rates are per 100 g seed. Fistulosum bunching onions and shallot seeds were treated with fludioxonil and metalaxyl-M by the seed company. In separate trials for each allium type, treatments were replicated four times in a randomized complete block design. Each plot consisted of 4 rows (42 cm apart), 6 m in length. Trials were seeded on 6 May using a push cone seeder. Two or 3 (for shallots) random 2 m sections were staked out, and emergence counts were recorded on a weekly basis to determine initial plant stands prior to first assessment. Plants were visually examined in the field on a weekly basis for onion maggot (OM) or damage caused by other pests within the staked-out sections in June and July. Damaged plants were rogued out and the cause recorded. OM damage was recorded two weeks after the end of the first (7 July) and second generation peaks (11 August for fistulosum bunching onions and 19 August for cepa bunching onions) and at bulb maturity for shallots (19 September) by examining all onions pulled from a staked out 2 m length of row in each plot. On 11 August (fistulosum bunching onions) and 23

September (cepa bunching onions and shallots) a 2.32 m section of row was pulled to assess yield. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistics V.7. Mean separation was obtained using Fisher's Protected LSD test with *P*=0.05 level of significance.

WEATHER: The air temperatures in 2008 were below the long term (10 year) average for May (10.7˚C), August (17.9˚C) and September (14.7˚C), average for July (20.4˚C) and above average for June (19.2˚C). The long term (10 year) average temperatures were: May 12.6˚C, June 18.4˚C, July 20.3˚C, August 19.2˚C, and September 15.7˚C. Monthly rainfall was below the long term (10 year) average for May (48 mm) and June (68 mm), above average for July (137 mm) and August (63 mm), and average for September (82 mm). The long term (10 year) rainfall averages were: May 80 mm, June 76 mm, July 69 mm, August 56 mm and September 80 mm.

RESULTS: As presented in Tables 1, 2 & 3

CONCLUSIONS: Significant differences were found in OM losses for 1st and 2nd generation and total season assessments for cepa and fistulosum bunching onions and shallots (Tables 1, 2 & 3).
At the 1st generation assessment, cepa bunching onions grown from seeds treated with SEPRESTO at the high rate (3.77 g ai) had significantly lower OM losses than ENTRUST at the low rate (2.56 g ai) and the Check. Over the total season, cepa bunching onions grown from seeds treated with SEPRESTO or ENTRUST at any rate had significantly lower OM losses than the Check (Table 1). There were significant differences in yield among the treatments (Table 1). The yield of cepa bunching onions grown from seeds treated with any rate of SEPRESTO or ENTRUST was significantly higher than bunching onions harvested from the untreated Check.

At the 1st generation assessment, fistulosum bunching onions grown from seeds treated with either rate of SEPRESTO and the medium rate of ENTRUST (6.62 g ai) had significantly lower OM losses than onions grown from seeds treated with ENTRUST at the low rate (4.41 g ai) and from seeds not treated with insecticide. Over the total season, fistulosum bunching onions grown from seeds treated with any of the insecticidal seed treatments had significantly lower OM losses than the Check and there were no significant differences among the various treatments and rates (Table 2). Significantly more fistulosum bunching onions were harvested from seeds treated with any of the seed treatments than from the untreated Check (Table 3).

At the 1st generation assessment, shallots grown from seeds treated with SEPRESTO or ENTRUST at any rate had lower OM losses than shallots from the untreated Check. At the 2nd generation assessment, shallots grown from seeds treated with SEPRESTO at the high rate (6.48 g ai) had significantly lower OM losses than shallots grown from seeds treated with ENTRUST at the low rate (4.41 g ai) and shallots in the Check. At bulb maturity, shallots grown from seeds treated with the high rate of SEPRESTO (6.48 g ai) had significantly lower OM losses than from seeds treated with ENTRUST at the high rate (8.82 g ai) and from seeds in the untreated Check. Shallots grown from seeds treated with all rates of SEPRESTO and ENTRUST at the medium (6.62 g ai) and the low (4.41 g ai) rates had lower OM losses than shallots grown in the untreated Check plots (Table 3). There were no significant differences in yield among the treatments (Table 3).

ACKNOWLEDGMENT: Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program and the New York State Agricultural Experiment Station, Cornell University provided support to conduct field research as part of a larger US project on new chemistry seed treatments by an agreement with Cornell University, Department of Food Science and Technology, under Prime Agreement Award Number 2003-NY001 from the Rutgers, State University of New Jersey. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of Cornell University or those of

Rutgers, State University of New Jersey.

Table 1. Evaluation of seed treatments for control of onion maggot damage in cepa bunching onions, cv. Arsenal, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Treatments	Rate (g ai/100 g seed)	% Onion Maggot Losses		Yield	
		1st Generation	Total Season	t/ha	Wgt/bulb (g)
SEPRESTO[1]	3.77	5.0 a[1]	10.5 a	41.2 a	70.3 b
ENTRUST	5.13	13.0 ab	17.1 a	43.7 a	78.1 b
SEPRESTO	2.82	14.3 ab	23.6 a	42.0 a	59.4 b
ENTRUST	3.85	18.0 ab	12.4 a	48.3 a	71.2 b
ENTRUST	2.56	22.2 b	18.1 a	52.5 a	78.8 b
Check	--	70.0 c	64.1 b	13.1 b	160.7 a

[1] Active ingredients of SEPRESTO are clothianidin and imidacloprid
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

Table 2. Evaluation of seed treatments for control of onion maggot damage in fistulosum bunching onions, cv. Parade, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Treatment	Rate (g ai/100 g seed)	% Onion Maggot Losses		Yield[3] (kg/m)
		1st Generation	Total Season	
SEPRESTO[1]	4.85	0.6 a[2]	0.7 a	2.9 a
SEPRESTO	6.48	1.0 a	2.1 a	3.4 a
ENTRUST	6.62	1.3 a	3.3 a	3.2 a
ENTRUST	8.82	3.6 ab	5.6 a	3.3 a
ENTRUST	4.41	11.1 b	8.8 a	2.8 a
Check	--	25.9 c	27.2 b	1.3 b

[1] The active ingredients of SEPRESTO are clothianidin and imidacloprid.
[2] Numbers followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.
[3] Onions pulled on 11 August

Table 3. Evaluation of seed treatments for control of onion maggot damage in shallots, cv. Ambition, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Treatment	Rate (g ai/100 g seeds)	% Onion Maggot Losses			Yield (t/ha)	Wgt/bulb (g)
		1st Generation	2nd Generation	Bulb Maturity		
SEPRESTO [1]	6.48	1.4 a[2]	6.3 a	12.5 a	37.9 ns[3]	55.4 ns
SEPRESTO	4.85	6.1 a	13.5 ab	16.9 ab	33.7	50.4
ENTRUST	8.82	6.2 a	11.8 ab	23.7 bc	37.7	54.9
ENTRUST	4.41	7.7 a	25.6 b	20.6 ab	40.0	49.1
ENTRUST	6.62	9.8 a	9.3 ab	13.7 ab	40.1	53.1
Check	--	57.1 b	52.9 c	33.6 c	25.3	56.5

[1] The active ingredients of SEPRESTO are clothianidin and imidacloprid.

[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

[3] ns indicates no significant differences were found among the treatments

2008 PMR REPORT # 15 **SECTION B : VEGETABLE and SPECIAL CROPS - Insect Pests**

CROP: Radish (*Raphanus sativus*), cv. Altebelle
PEST: Cabbage maggot (CM), *Delia radicum* (Linnaeus)

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TITLE: **EVALUATION OF EXPERIMENTAL TREATMENTS FOR CONTROL OF DAMAGE BY CABBAGE MAGGOT TO RADISH ON MINERAL SOIL, 2008**

MATERIALS: PONCHO 600 FS (clothianidin 48% [w/w]), DPX-HGW86 600 FS (cyazypyr 60% [w/w]), DPX-HGW86 200 SC (cyazypyr 20% [w/w]), CAPTURE LFR (bifenthrin 17.15% [w/w]), DELEGATE 25 WG (spinetoram 25.0% [w/w]), PYRINEX 480 EC (chlorpyrifos 44.7% [w/w])

METHODS: On 13 May, radish seed (SD) treatments (Tmts. 1-3) were applied in the laboratory at SCPFRC-London by tumbling seed and insecticide formulation for each treatment together in a clean 2 lb plastic bag for 1-2 minutes until all seed was uniformly coated. Seed for all treatments (Table 1) was planted at the SCPFRC-London Research Farm on 13 May in 3-row microplots (2.25 m long x 0.9 m wide) filled with insecticide residue-free mineral soil (sandy loam - pH 6.5; 67% sand; 20% silt; 13% clay; 2.2% organic matter). All treatments were replicated three times in a randomized complete block design. In-furrow spray (IFS) treatments (Tmts. 4, 5, 7-11) were applied in a 3-5 cm band, centred over the seed in the open seed furrow, at 125 kPa in 5 L/100 m row, using a hand-held, CO_2-pressurized, R&D plot sprayer fitted with a single 4004E even flat spray tip. Tmt. 6 was applied on 26 May at BBCH growth stage 09-10 (BBCH 09-10) in a 5 cm band centred over the row, at 125 kPa in 5 L/ha using a hand-held, CO_2-pressurized, R&D plot sprayer fitted with a single 4004E even flat spray tip. On 06 June when radishes were at BBCH 12-13, a total of 250 CM eggs from an insecticide-susceptible, laboratory-reared strain were buried 1 cm deep adjacent to radish roots along a 1 m length of row in each plot. The infested row length was delineated by dated stakes and the infested row watered to optimize egg hatch and maggot survival. On 09 June (BBCH 13-14, 41-43) a 2nd 1 m length of row in each plot was similarly infested and labelled. All radishes from the 1st infested length of row of each plot were harvested on 23 June (BBCH 48-49) and from the 2nd length of row on 25 June (BBCH 49). Roots were washed, counted and inspected for CM damage. The percent roots > 1 cm diameter, showing any feeding damage was calculated for each plot. Mean % Reduction of CM-damage by each treatment was calculated for each infestation (See footnote 4, Table 1) Data were subjected to arcsin square root transformation prior to statistical analysis by analysis of variance (ANOVA); significance of differences among treatments means was determined using Student-Neuman-Keul's means separation test. Untransformed data are presented.

OBSERVATIONS: No phytotoxicity was observed following any treatment.

RESULTS: Experimental results are outlined in Table 1. For both infestations, CM damage to radish in untreated CONTROL plots exceeded 45%. For both infestations, CM damage to radish was significantly

reduced by at least 75% following IFS-application of chlorpyrifos (Tmt. 11), the current commercial standard for CM control in this crop. No experimental treatment significantly reduced CM-damage to radish in both infestations. Since mean % CM-damage was very similar in CONTROL plots for both infestations (Infestation 1 - 47.3%; Infestation 2 - 51.2%), in an effort to distinguish differences in efficacy among treatments, data for the 2 infestations were pooled to increase the number of observations for each treatment. In the pooled analysis, all tested treatments significantly reduced CM-damage to radish relative to CM-damage in plots receiving no insecticide. For the pooled data, even though CM-damage was lowest in plots receiving the commercial treatment (Tmt. 11), no treatment was statistically less effective than IFS-application of chlorpyrifos (Tmt. 11).

CONCLUSIONS: IFS-application of chlorpyrifos, currently registered and recommended for control of CM damage to radish, was the most effective management strategy in this experiment. Other treatments, especially SD-application of cyazypyr, also reduced CM damage to radish and warrant further investigation under field conditions.

Table 1. Effect of experimental treatments on damage due to cabbage maggot attacking radishes on mineral soil, London, ON, 2008.

Tmt No.	Treatment Applied	Method[1]	Rate/100 m row[2] (g a.i.)	Results for Indicated Infestation					
				Infestation 1		Infestation 2		Pooled Data	
				% Dam. Roots	% Dam. Reduction[4]	% Dam. Roots	% Dam. Reduction[4]	% Dam. Roots	% Dam. Reduction[4]
1	clothianidin	SD	30.13	11.9 ab[5]	74.8	26.6 ab[5]	48.1	19.2 bc[5]	61.1
2	cyazypyr	SD	50.03	11.7 ab	75.1	18.7 ab	63.4	15.2 bc	69.2
3	cyazypyr	SD	100.03	14.5 ab	69.4	6.5 b	87.3	10.5 bc	78.7
4	cyazypyr	IFS	2	11.2 ab	76.3	27.6 ab	46.1	19.4 bc	60.6
5	cyazypyr	IFS	2.5	19.4 ab	59	29.6 ab	42.2	24.5 bc	50.3
6	cyazypyr	BD	2.5	23.2 ab	51	34.1 ab	33.4	28.6 bc	42
7	bifenthrin	IFS	2.5	19.6 ab	58.5	37.6 a	26.6	28.6 bc	42
8	bifenthrin	IFS	3.4	25.7 ab	45.7	25.2 ab	50.9	25.5 bc	48.3
9	spinetoram	IFS	2	21.9 ab	53.8	20.6 ab	59.7	21.3 bc	56.8
10	spinetoram	IFS	2.5	8.2 ab	82.7	27.5 ab	46.3	17.8 bc	63.9
11	chlorpyrifos	IFS	4.08	8.5 b	81.9	10.6 b	79.3	9.6 c	80.5
12	no insecticide	---	---	47.3 a		51.2 a		49.3 a	

[1] Method of application: SD - seed dressing applied to seed prior to planting; IFS - in seed-furrow spray over seed; BD - banded drench application at BBCH 09-10.
[2] Amount/100 m row; 0.25 m row spacing.
[3] Amount/kg seed.
[4] Mean % Damage Reduction relative to % Damage for CONTROL plots:
% Damage Reduction = % Damage (Control) - % Damage (Tmt. x)/% Damage (Control) x 100%
[5] For each infestation, means followed by the same letter are not significantly different ($P > 0.05$) as determined using ANOVA and Student-Neuman-Keul's means separation test.

2008 PMR REPORT # 16 **SECTION B : VEGETABLE and SPECIAL CROPS - Insect Pests**

CROP: Rutabaga (*Brassica napus* L. var. *napobrassica*), cv. Laurentian
PEST: Cabbage maggot (CM), *Delia radicum* (Linnaeus)

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TITLE: SMALL PLOT FIELD EVALUATION OF TREATMENTS FOR CONTROL OF CABBAGE MAGGOT ATTACKING RUTABAGA IN MINERAL SOIL, 2008

MATERIALS: DPX-HGW86 200 sc (cyazypyr 20.0% [w/w]), DELEGATE WG (spinetoram 25% [w/w]), PONCHO 600 FS (clothianidin 48% [w/w]), CAPTURE LFR (bifenthrin 17.15% [w/w]), PYRINEX 480 EC (chlorpyrifos 44.7% [w/w]), MATADOR 120 EC (lambda-cyhalothrin 13.1% [w/w])

METHODS: A block of rutabagas (10 rows x 40 m) was seeded on 12 June on the SCPFRC-London Research Farm in 1.0 m row spacing, in Embro loam (57.2% sand, 23.5% silt, 19.4% clay, 3.6% organic matter). Single row, 5 m plots were established on 23 June. All treatments (Table 2) were replicated 4 times in a randomized complete block design. Replicate ranges were separated by 1.5 m untreated buffers from which all plants were removed. Drench insecticides were applied as shown in Table 1 in a 10-12 cm wide band centred on the row, using a hand-held, CO_2-pressurized, R&D plot sprayer with a single flat spray tip. Spray tip and drench volume were altered to accommodate growth of rutabagas throughout the season. MATADOR 120 EC (50 ml/ha) was applied to the entire block on 25 June to control a very high population of crucifer flea beetle, *Phyllotreta cruciferae* (Goeze). On 18 August leaves were trimmed to ca. 15 cm above the top of the roots to open the canopy and maximize application of Drench 4 to rutabaga roots and adjacent soil. On 22 September, 12 roots were randomly pulled from each plot, topped, placed in labelled containers and returned to the laboratory and rated for CM-feeding damage according to the rating scale developed by King and Forbes (1954) (See footnote 1, Table 2). Guard plants at either row end were not considered. An Infestation Index (I.I.) was then calculated for each plot by multiplying the appropriate factor by the % of roots in each category, adding products and dividing the sum by 4. Statistical significance of observed differences in impact of drench application on CM-injury was determined by analysis of variance (ANOVA). Significance of differences among treatments means was determined using Student-Neuman-Keul's means separation test. Mean % Reduction of CM-damage by each treatment was calculated (See footnote 2, Table 2). The % roots with a Feeding-Damage Rating of "clean" or "light" was determined for each plot and subjected to arcsine square root transformation prior to determination of statistical significance of treatment differences by ANOVA and Student-Neuman-Keul's means separation test. Untransformed data are presented in Table 2.

OBSERVATIONS: No significant phytotoxicity was observed following any application of any treatment.

RESULTS: Results are presented in Table 2. As the I.I. in untreated CONTROL plots was just below 50, CM-pressure was only moderate in this trial; indeed, an average of ca. 23% of rutabaga roots pulled from plots receiving no drench application of insecticide were given a rating of "clean" or "light". Nevertheless, scheduled application of 4 drenches of all rates of all tested insecticides significantly reduced the I.I. in treated plots relative to the I.I. recorded in CONTROL plots (Table 2 - Infest'n Index). While the % Reduction in I.I. (Table 2 - % Reduction) ranged from 37% following application of chlorpyrifos (Tmt. 8) to 69% following application of the higher rate of cyazypyr (Tmt. 2), observed differences among drench applications were not statistically significant. An average of 75% of roots in plots treated with the higher rate of cyazypyr (Tmt. 2) or clothianidin (Tmt. 6) received a rating of "clean" or "light" (Table 2 - % Clean + Light). Drench application of chlorpyrifos was the only treatment which did not significantly increase the % Clean + Light roots in treated plots relative to CONTROL plots.

CONCLUSIONS: Under the conditions of this trial, multiple, scheduled drench application of all tested insecticides resulted in significant reduction in CM feeding damage to rutabaga. While further investigation of all experimental treatments is warranted, special emphasis should be placed on cyazypyr which was tested for the first time this year. The relatively poor protection following multiple drench application of chlorpyrifos, the current commercial standard, was not expected and may indicate that development of some tolerance to chlorpyrifos in the local field CM population. The major rutabaga production area in Ontario, heavily infested with CM, is located ca. 25 km upwind and north of the test site.

Table 1. Application parameters for evaluation of treatments for control of damage by cabbage maggot, *Delia radicum*, attacking rutabaga in mineral soil in small plots, London, ON, 2008.

Drench Application No.	1	2	3	4
Date Applied	23 June	15 July	31 July	21 August
Volume Applied (L/100 m row)	7.5	10	15	20
Application Pressure (kPa)	150	205	205	205
Spray Tip (Spraying Systems Co.)	4006	XR11008VS	4010	4015
Plant Growth Stage	cotyledon	8-10 leaves	roots to 5 cm	roots 10-15 cm
BBCH Identification Key[1]	9	18-19	42-43	47-48

[1] Enz, M. and Ch. Dachler. 1997. Compendium of growth stage identification keys for mono- and dicotyledonous plants. Extended BBCH Scale. 2nd Ed. (Electronic version). ISBN 3-9520479-3-4.

Table 2. Field drench treatments for control of damage by cabbage maggot, *Delia radicum*, attacking rutabaga in mineral soil in small plots, London, ON, 2008.

Tmt. No.	Treatment Applied		Rate Applied / 100 m Row		Mean Treatment-Impact		
	Insecticide	Formulation	g a.i.	Product	Infest'n Index[1]	% Reduction[2]	% Clean + Light[3]
1	cyazypyr	DPX-HGW86 200 SC	2	10.0 ml	19.3 b[4]	60.7	70.8 a
2	cyazypyr	DPX-HGW86 200 SC	3	15.0 ml	15.1 b	69.2	75.0 a
3	spinetoram	DELEGATE WG	2	8.0 g	21.4 b	56.4	68.8 a
4	spinetoram	DELEGATE WG	3	12.0 g	21.4 b	56.3	65.6 a
5	clothianidin	PONCHO 600 FS	2	3.30 ml	28.7 b	41.5	62.6 a
6	clothianidin	PONCHO 600 FS	3	4.95 ml	15.6 b	68.1	75.0 a
7	bifenthrin	CAPTURE LFR	1.4	7.78 ml	23.5 b	52.2	66.7 a
8	chlorpyrifos	PYRINEX 480 EC	10	21.0 ml	30.7 b	37.3	50.0 ab
9	no insecticide	CONTROL	----[5]	----	49.0 a		22.9 b

[1] Infestation Index (I.I.) developed by King and Forbes (1954, J. Econ. Entomol. 47: 607) where harvested roots rated for feeding damage according to the following scale: **Clean** - factor of 0, no damage; **Light** - factor of 1, slight, superficial early feeding but fully healed; **Moderate** - factor of 2, marketable as Grade 2 after single trim just above tap root to remove single deep penetration, or moderate, healed surface injury affecting < 20% of surface that could be removed by peeling; **Severe** - factor of 4, unmarketable for table use, injury not removable by practical trimming; any extensive unhealed surface injury; maggot in root. Infestation Index was then calculated for each plot by multiplying appropriate factor by the % of roots in each category, adding products and dividing sum by 4.

[2] Mean % Reduction relative to Infestation Index (I.I.) for Untreated CONTROL plots.

% Reduction = I.I.(Control) - I.I.(Tmt.)/I.I.(Control) x 100%

[3] Mean % roots for each treatment with Feeding Damage rating of **Clean** or **Light**.

[4] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined by ANOVA and Student-Neuan-Keul's means separation test.

[5] No insecticide applied.

2008 PMR REPORT # 17 **SECTION C: POTATOES – Insect Pests**

CROP: Potato (*Solanum tuberosum* L.) cv. Kennebec
PEST: Colorado potato beetle, *Leptinotarsa decemlineata* Say

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TITLE: SURVEY FOR IMIDACLOPRID-RESISTANCE AND SUSCEPTIBILITY TO NEW PRODUCTS IN COLORADO POTATO BEETLE POPULATIONS IN CANADIAN POTATO FIELDS

MATERIALS: ADMIRE 240 F (imidacloprid 21.4 %), ACTARA 25 WG (thiamethoxam 25 %), PONCHO 600 FS (clothianidin 48 %), CORAGEN (chlorantraniliprole 18.4 %).

METHODS: Colorado potato beetle (CPB) adults or mature larvae were collected from 42 field sites in 7 Canadian provinces where imidacloprid or chlorantranilaprole control failure was reported. CPB were shipped in chilled containers overnight to AAFC London and placed on fresh foliage (cv. Kennebec). The F1 generation 2nd instar larvae were used in leaf dip bioassays. A 5 cm diameter disc was cut from fresh potato leaves and dipped into aqueous solutions of formulated insecticides prepared at the discriminating concentration (DC). Discs were allowed to dry and then 5, 2nd instar larvae were placed on each disc and held in a Petri plate. The LC_{95} for each compound was designated as the DC. The LC_{95} was determined with probit analyses of dose-response data from 48 h tests (imidacloprid and thiamethoxam) or 72 h tests (clothianidin and chlorantraniliprole) with an insecticide-susceptible CPB strain (AAFC, London ON) using the leaf dip bioassay and a range of 5 to 6 concentrations. Each field population was tested with a minimum of 60 larvae/DC.

RESULTS: As outlined in Table 1 and 2. Almost half (19 out of 42 or 45%) of the Canadian CPB populations surveyed had < 30% mortality at the imidacloprid DC (LC_{95}). Control (> 70% mortality) was still achieved in 29% of the CPB populations. Resistance to thiamethoxam was observed in 2 of the 39 populations tested or 5%. Control using thiamethoxam was achieved with 56% of the CPB populations. No resistance was observed with clothianidin or chlorantraniliprole and control was achieved in 76% and 90% of the CPB populations using the DCs for each insecticide respectively. Regression analyses of percent mortality for imidacloprid with the other 3 compounds indicated a moderate correlation with clothianidin (R^2=0.49) and thiamethoxam (R^2=0.37), but low correlation with chlorantraniliprole (R^2=0.06).

CONCLUSIONS: Insecticide-resistance is a growing concern for Canadian potato growers. For the past 14 years growers have relied heavily on foliar and soil treatments of imidacloprid. It appears that this reliance has led to resistance to imidacloprid in an increasing number of populations. While 2nd generation neonicotinoid insecticides are now registered for use in Canada our preliminary findings show a moderate positive correlation between imidacloprid with clothianidin and thiamethoxam CPB mortality. This observation raises concern over potential cross-resistance development among the 3 neonicotinoids

tested. Continued surveillance is required along with increased implementation of resistance management strategies to prevent further CPB control failures. Mortality of CPB exposed to chlorantraniliprole, the first registered member of a novel class of insecticide, had a low correlation with imidacloprid CPB mortality. The potential for cross-resistance may currently be less with this compound, but a resistance management strategy to extend its use is still warranted. Tables should be formatted as shown below in Table 1.

ACKNOWLEDGEMENTS: We greatly appreciate financial support by Bayer, DuPont and Syngenta. Technical assistance from A. Alhemzawi and J. Bull is gratefully acknowledged.

Table 1. Number of tested CPB populations in each province with < 30% mortality at the DC (LC_{95}) for 4 insecticides.

Province	Imidacloprid	Thiamethoxam	Clothianidin	Chlorantraniliprole
AB	0 / 1[1]	0 / 1	0 / 1	0 / 1
MB	0 / 1	0 / 1	0 / 1	0 / 1
ON	8 / 17	0* / 16	0* / 16	0* / 16
QC	6 / 7	2* / 5	0* / 4	0* / 4
NB	5 / 10	0 / 10	0 / 10	0 / 10
NS	0 / 2	0 / 2	0 / 2	0 / 2
PEI	0 / 4	0 / 4	0 / 4	0 / 4
Total	19 / 42	2 / 39	0 / 38	0 / 38

[1] No. resistant populations / Total Populations Tested

* Tests not fully completed for 1-2 populations

Table 2. Number of tested CPB populations in each province with > 70% mortality at the DC (LC_{95}) for 4 insecticides.

Province	Imidacloprid	Thiamethoxam	Clothianidin	Chlorantraniliprole
AB	1 / 1[1]	1 / 1	1 / 1	1 / 1
MB	1 / 1	1 / 1	1 / 1	1 / 1
ON	4 / 17	11* / 16	13* / 16	13* / 16
QC	0 / 7	0* / 5	2* / 4	4* / 4
NB	1 / 10	4 / 10	6 / 10	9 / 10
NS	1 / 2	1 / 2	2 / 2	2 / 2
PEI	4 / 4	4 / 4	4 / 4	4 / 4
Total	12 / 42	22 / 39	29 / 38	34 / 38

[1] No. susceptible populations / Total Populations Tested

* Tests not fully completed for1-2 populations

2008 PMR REPORT # 18 **SECTION C: POTATOES - Insect Pests**

CROP: Potato (*Solanum tuberosum*), cv. Chieftain
PEST: Wireworm (WW), *Melanotus* spp.

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TITLE: PLANTING TREATMENTS FOR CONTROL OF DAMAGE TO POTATO TUBERS BY FIELD WIREWORM, 2008

MATERIALS: PYRINEX 480 EC (chlorpyrifos 44.7% [w/w]), CAPTURE 2 EC (bifenthrin 25.1% [w/w]), ACTARA 240 SC (thiamethoxam 21.6% [w/w]), PONCHO 600 FS (clothianidin 48.1% [w/w]), THIMET 15 G (phorate 15% [w/w]), MAXIM PSP (fludioxonil 0.5% [w/w]), LOROX L (linuron 40.7% [w/w], BRAVO 500 (chlorothalonil 40.4% [w/w]), REASON 500 SC (fenamidone 44.4% [w/w]), SUPERMAN 13-4-7 (liquid fertilizer), IGNITE 15 SN (glufosinate ammonium 13.5% [w/w])

METHODS: Hard red, spring wheat, cv. Superb, for the trap and kill (T&K) treatment (Tmt. 1 - 170 seeds/m row) was commercially treated and received in April. Seed potatoes were hand cut on 07 May. On 08 May, using a hand-operated mist-applicator, seed dressings (SD) (Table 1, Tmts. 8, 9) were uniformly applied in 0.555 L/100 kg seed to cut seed potatoes contained in separate 50 lb clear plastic bags. Each bag was then closed and inverted 40 times to ensure even coating of all pieces. MAXIM PSP (500 g/100 kg seed) was then uniformly sprinkled over the top of the treated seed pieces in each bag which was then closed and again inverted 40 times to ensure even coating of all seed potatoes. Seed potatoes for all other treatments were similarly treated with MAXIM PSP only. After treatment, bags were opened and seed allowed to dry until planting.

On 09 May, single row plots were established in sandy loam soil near Rodney, Ontario (42° 33' 38.02" N; 81° 38' 47.58" W). Rows were planted on 1 m spacing. Individual plots measured 5 m long. With the exception of Tmt. 11, all treatments were replicated 4 times in a Randomized Complete Block design. To accommodate possible uneven WW distribution within the block, single untreated rows (Tmt. 11) were established so that every treated row was adjacent to an untreated row; each replicate range thus contained 5 untreated rows. Replicate ranges were separated by 1 m fallow walkways which were also located at either end of the entire block.

The in-furrow granular (IFG)(Tmt. 10) and T&K (Tmt. 1) treatments were hand applied in a 7-10 cm band in the bottom of the seed furrow before placement of seed pieces. Seed pieces were then hand

planted at 20 cm spacing (25 seed pieces/plot) in all plots. In-furrow spray (IFS) treatments (Tmts. 2-5, 8, 9) were applied in a 10-12 cm band over the seed pieces in the open seed furrow in 5 L/100 m row at 135 kPa, using a hand-held, CO_2-pressurized, R&D field-plot sprayer fitted with a single 8004EVS flat spray tip. Seed pieces were covered with soil, hilled to a height of ca. 10 cm and the hills lightly tamped to ensure good contact with soil. LOROX L (3.0 L/ha) was applied to the entire block on 29 May to control weeds. On 27 June when plants were just beginning to flower, very heavy hail + 50 mm rain caused severe damage and flooding to the entire block; plants in Ranges 1-2 were submerged for at least 24 h. To stimulate recovery of damaged plants, a tank mixture of BRAVO 500 + REASON 500 SC + SUPERMAN 13-4-7 (1.5 + 0.2 + 2.5 L/ha) was applied on 28 June and 04 July. Plots were subsequently hilled and weeds removed manually as required until harvest. IGNITE 15 SN (3.0 L/ha) was applied to the entire block on 20 August to speed desiccation of potato vines and weeds.

On 18 September, 132 days after planting, all potatoes except for 1 guard plant at each row end of each plot were carefully dug, placed in labelled jute bags and returned to the laboratory. All tubers were washed and allowed to dry prior to grading. During grading, the 50 largest tubers for each plot were measured, weighed and checked for WW feeding damage; where tuber numbers were limited, all tubers $\geq$ 15 mm diameter were examined. Damage was determined by counting numbers of blemishes (fresh WW feeding holes + healed WW feeding scars) on each tuber and then calculating the number of blemishes/tuber for each plot. The % WW-damaged tubers was also calculated for each plot. Since WW were present throughout the block, the mean number of blemishes/tuber and the mean % WW damaged tubers for all untreated rows in each replicate range was calculated and utilized for purposes of comparison of treatment effect. The observed impact of treatments on the number of blemishes/tuber was analysed by Analysis of Variance (ANOVA); significance of observed differences among treatment means was then determined using Student-Neuman-Keul's means separation test. Results are presented as the number of WW blemishes/10 tubers. The % WW-damaged tubers were subjected to arcsine square root transformation prior to determination of statistical significance by ANOVA and Student-Neuman-Keul's means separation test. Untransformed data are presented.

OBSERVATIONS: No significant phytotoxicity was observed following any planting treatment. Wheat plants growing from treated seed planted beneath potato seed pieces grew quickly, reaching 10-12 cm height by the time LOROX was applied; subsequent growth of wheat plants was severely stunted and wheat did not compete with growing potato plants. Potato plants did not recover well from hail and flooding damage on 27 June and yields were reduced, particularly in Ranges 1-2. Flooding also drowned 100's of earthworms in those Ranges.

RESULTS: Impact of planting treatments on WW-damage to harvested potato tubers is shown in Table 1. While WW-damage was significantly higher in Ranges 3-4 than in Ranges 1-2, across the entire block an average of nearly 16 WW blemishes/10 tubers was recorded in plots to which no insecticide was applied. The highest level of damage was recorded in plots in which seed potatoes were treated with the lower rate of clothianidin alone (Tmt. 6). Indeed, this treatment was the only plot in which the number of blemishes/tuber was significantly higher than the numbers recorded in other treatments. In spite of the lack of statistical significance, trends in damage were noted. WW-damage in plots receiving the commercial standard, phorate (Tmt. 10) and in plots treated with bifenthrin, either alone (Tmt. 3) or in combination with SD-application of clothianidin (Tmt. 8, 9) or IFS-application of thiamethoxam (Tmt. 5), tended to be lower than WW-damage in untreated plots or in plots treated with either thiamethoxam (Tmt. 4) or clothianidin (Tmt. 6, 7) alone. In the presence of bifenthrin the number of WW-blemishes/ tuber was reduced by at least 50% relative to WW-blemishes in untreated plots (Tmt. 11). The % WW-damaged tubers in plots treated with either phorate IFG (Tmt. 10) or the combination of bifenthrin IFS + SD-application of clothianidin (Tmts. 8, 9) was significantly less than the % WW-damaged tubers in

untreated plots (Tmt. 11) or plots planted with tubers treated with SD-application of clothianidin alone (Tmts. 6, 7). Less than 25% of tubers in plots receiving Tmts. 8, 9 or 10 were damaged by WW.

CONCLUSION: Under the difficult conditions of this experiment, IFS-application of bifenthrin alone or in combination, appeared to provide control of WW-damage to potatoes equal to that provided by phorate, the commercial standard. SD-application of clothianidin alone did not provide adequate, season long, protection of potato tubers.

Table 1. Impact of planting treatments on damage to potato tubers by wireworm, primarily *Melanotus* spp., on mineral soil, Ridgetown, ON, 2008.

Tmt. No.	Insecticides Applied	Method[1]	Rate Applied (g ai/100 m row)	Blemishes/10 Tubers		Damaged Tubers	
				Number	% Reduction[2]	% Damaged	% Reduction[2]
1	experimental	T & K	confidential	8.4 ab[3]	47.2	38.7 ab[3]	19.0
2	chlorpyrifos	IFS	10.4	10.0 ab	36.9	37.2 ab	22.1
3	bifenthrin	IFS	3.4	7.4 b	53.3	29.7 ab	37.8
4	thiamethoxam	IFS	1.06	13.8 ab	13.1	39.5 ab	17.4
5	thiamethoxam + bifenthrin	IFS	1.06 + 3.4	7.3 b	54.2	29.0 ab	39.3
6	clothianidin	SD	6.2[4]	19.0 a	xxx[5]	51.5 a	xxx[5]
7	clothianidin	SD	12.5[4]	14.3 ab	10.4	47.8 a	xxx[5]
8	clothianidin + bifenthrin	SD + IFS	6.2[4] + 3.4	4.3 b	73.1	22.2 b	53.6
9	clothianidin + bifenthrin	SD + IFS	12.5[4] + 3.4	5.6 b	64.5	24.7 b	48.4
10	phorate	IFG	32.25	5.3 b	66.9	24.2 b	49.4
11	no insecticide		---	15.9 ab	---	47.8 a	---

[1] Method of Application: T&K - Trap & Kill; SD - Seed Dressing; IFS - In Furrow Spray; IFG - In Furrow Granular

[2] Relative to values recorded in absence of insecticide.

[3] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and Student-Neuman-Keul's range test.

[4] Rate/100 kg seed potatoes; seed dressing applied to seed potatoes.

[5] No reduction relative to damage recorded in absence of insecticide.

2008 PMR REPORT # 19 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Corn, *Zea mays* (L.), Maizex cvs. MZ 535 (3200 CHU), MZ 424, MZ 424 HX (3050 CHU)
PEST: Black Cutworm *Agrotis ipsilon* (Hufnagel)

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TITLE: EVALUATION OF CHLORONICOTINYL SEED TREATMENTS ON CORN FOR CONTROL OF BLACK CUTWORM

MATERIALS: MAXIM XL (fludioxonil + metalaxyl-M, 229.59 + 87.66 g ai/L); DYNASTY 100 FS (azoxystrobin, 100 g ai/L); CRUISER 5 FS (thiamethoxam, 5 g ai/L); PONCHO 600 FS (clothianidin, 600 g ai/L); FORCE 3.0 G (tefluthrin, 3 % v/v); MAIZEX MZ 424 HX (HERCULEX 1 CRY 1F Bt).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. Seed weights were 276.5 for MZ 535, 213.5 g for MZ 424, and 276.9 for MZ 424 HX, respectively. The trial was replicated three times at Ridgetown, ON on clay loam soil. Trials were planted on 16 May, 13 June, and 11 July in a randomized complete block design with four replications. Plots were planted using a two-row cone-seeder at a rate of 8 seeds per m in 4 rows, spaced 0.76 m apart, and 4 m in length. FORCE 3.0 G was applied in-furrow at planting using a Noble® plot scale applicator. Galvanized steel enclosures were placed over 2 rows to a depth of 15 cm and plant stands were thinned to enclose 24 plants per enclosure. Enclosures were infested prior to the 3rd leaf stage on 6 June, 2 July, and 24 July, respectively, with 36 3-4th instar laboratory-reared black cutworm larvae (French Agricultural Research Inc, Lamberton, MN) placed at the base of the plants. A layer of straw was placed throughout the enclosed area to protect the larvae. Plots were fertilized and maintained according to provincial recommendations.

Plant populations were recorded by counting all plants in the interior two rows of each plot. Vigour of the entire plot was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Damage was recorded at approximately 3, 7 and 14 days after infestation (DAI) using the Guthrie rating scale (Tseng et al., 1984) (1 = no visible leaf injury, 2 = pinholes on several leaves, 3 = several shot holes with 1-2 lesions, 4 = several shot hole type injuries and a few lesions, 5 = lesions on several leaves, 6 = several lesions and portions of leaves eaten away, 7 = many leaves with lesions, portions of leaves eaten away, some leaf area dying, 8 = many portions of leaves eaten away, several leaf areas dying, 9 = whorl leaves almost or completely eaten away, 10 = plant dead or almost completely destroyed). Yield and test weight were evaluated from the earliest planted trial by hand- harvesting plants within the enclosures; yields were corrected to 15.5% moisture. In the second and third plantings, all plants within the enclosures were weighed to obtain fresh weight measurements.

The sampling date, crop stage and number of DAI are given in the data tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random variable. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. The α level for statistical significance was set at 0.05 for all analyses.

OBSERVATIONS: Black cutworm feeding was most severe in the first planting of this trial. Warmer weather and numerous rain events during subsequent infestations may have reduced cutworm activity.

RESULTS: Following infestations and emergence, no differences in plant population were detected among treatments in the first and third plantings (Table 1). Following infestation and emergence in the second planting, all insecticide treatments improved plant stand compared to fungicide alone, and plots treated with PONCHO had significantly higher populations than those with the low rate of CRUISER 5 FS (0.125 mg ai/seed), but no other differences were measured among treatments (Table 1). No differences in vigour were measured in the first and third plantings; all insecticide treated plots appeared more vigourous than fungicide only treated plots in the second planting (Table 1).

In the first planting, plots treated with FORCE and CRY 1F had significantly less cutworm feeding damage than the other treatments on all assessment dates (Table 2). No differences in damage ratings were measured among all other treatments during this trial (Table 2). The number of cut plants did not differ among treatments at 3 DAI (Table 2). As feeding progressed, FORCE and CRY 1F had fewer cut plants than all other treatments at 7 and 14 DAI (Table 2). At 14 DAI, the number of cut plants was significantly greater in all CRUISER 5 FS and PONCHO 600 FS treatments than the FORCE treatment, and greater in the lower two rates of CRUISER 5 FS (0.125 and 0.25 mg ai/seed) and PONCHO 600 FS than in CRY 1F (Table 2).

In the second planting, 2 DAI, damage was significantly lower in FORCE 3 G and CRY 1F treatments than in the low rate of CRUISER 5 FS (1.25 mg ai/seed) and the fungicide treatment alone, and significantly lower in the mid-rate treatment of CRUISER 5 FS (0.5 mg ai/seed) than in the fungicide treatment alone (Table 3). At 7 and 14 DAI, damage was significantly lower in plots treated with FORCE 3 G than in all other treatments except CRY 1F (Table 3). All treatments reduced damage compared to fungicide alone except for the low rate of CRUISER 5 FS (0.125 mg ai/seed) and PONCHO 600 FS at 14 DAI (Table 3). No differences were noted in the number of cut plants except at 7 DAI, when more cut plants were observed in untreated and PONCHO 600 FS treated plots than the others (Table 3).

In the third planting, FORCE and CRY 1F treated plots had the least amount of damage on all assessment dates (Table 4). At 14 DAI, PONCHO 600 FS treated plots had less damage than untreated or CRUISER 5 FS treated plots (Table 4). CRUISER 5 FS treated plots had more cut plants than any of the other plots at 14 DAI (Table 4).

In the first trial, the highest yields were harvested from CRY 1F and FORCE 3 G treated plots (Table 5). All other treatments yielded comparably to untreated plots (Table 5). In the second planting, fresh weight was significantly greater in plots with a mid rate of CRUISER 5 FS (0.25 mg ai/seed) or with CRY 1F than in plots with fungicide alone or with the lowest rate of CRUISER 5 FS (0.125 mg ai/seed) (Table 5). No differences occurred in fresh weight in the third planting (Table 5).

CONCLUSIONS: FORCE 3 G and CRY 1F consistently provided good protection against black cutworm in this study. Neonicotinoid seed treatments did not provide adequate control of black cutworm at the rates tested in this study. No consistent differences were observed among seed treatments.

REFERENCE:

Tseng, C.T., J. J. Tollefson, and W.D. Guthrie. 1984. Evaluation of Maize Single-Cross Hybrids and Inbred Lines for Resistance to 3rd-Instar Black Cutworm Larvae (Lepidoptera: Noctuidae). *J. Econ. Entomol*. 77(3): 565-568.

Table 1. Mean plant population and vigour of corn planted with seed and in-furrow applied insecticides for black cutworm control at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m^2)			Mean plant vigour (0-100%)[3]		
Sampling date (Crop stage)		1st Planting 2 June (VE)	2nd Planting 24 June (V1)	3rd Planting 21 July (V1)	1st Planting 2 June (VE)	2nd Planting 24 June (V1)	3rd Planting 21 July (V1)
MAXIM XL	3.5	8.0 a[4]	5.7 c	10.3 a	86.3 a	78.8 b	92.5 a
+ DYNASTY 100 FS	1.0						
MAXIM XL	3.5	8.8 a	9.2 b	9.9 a	86.3 a	90.0 a	95.0 a
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.125[1]						
MAXIM XL	3.5	8.9 a	9.8 ab	10.1 a	88.8 a	95.0 a	92.5 a
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.25[1]						
MAXIM XL	3.5	8.6 a	10.1 ab	10.5 a	88.8 a	92.5 a	92.5 a
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.5[1]						
MAXIM XL	3.5	7.6 a	10.0 ab	9.9 a	91.3 a	91.3 a	92.5 a
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	1.25[1]						
MAXIM XL	3.5	9.0 a	10.2 ab	10.1 a	88.8 a	95.0 a	95.0 a
+ DYNASTY 100 FS	1.0						
+ FORCE 3.0 G	37.5[2]						
MAXIM XL	3.5	8.6 a	10.4 a	9.7 a	93.8 a	93.8 a	92.5 a
+ DYNASTY 100 FS	1.0						
+ PONCHO 600 FS	0.25[1]						
MAXIM XL	3.5	7.6 a	10.1 ab	9.9 a	78.8 a	95.0 a	92.5 a
+ Cry 1F							
CV (proc glm)		20.6	7.2	4.0	8.7	5.5	4.8
se		0.866	0.374	0.202	3.750	2.461	2.165
Pr>F		0.861	<0.0001	0.237	0.261	0.002	0.952

[1] mg ai/seed.

[2] g per 100 m length of row applied in-furrow at planting.

[3] 0 = plants dead in plot and 100 = furthest developed plants in the trial.

[4] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 2. Mean damage ratings and percentage of cut plants per enclosure of corn planted with seed and in-furrow applied insecticides and infested with black cutworm, first planting at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean damage rating[3]			Mean percentage of cut plants		
No. days after infestation Sampling date (Crop stage)		3 DAI 9 June (V3)	7 DAI 13 June (V4)	14 DAI 20 June (V4)	3 DAI 9 June (V3)	7 DAI 13 June (V4)	14 DAI 20 June (V4)
MAXIM XL	3.5	5.0 b[4]	5.5 b	5.0 b	12.0 a	17.0 ab	21.3 abc
+ DYNASTY 100 FS	1.0						
MAXIM XL	3.5	5.6 b	6.6 b	6.6 b	13.8 a	30.8 b	40.0 c
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.125[1]						
MAXIM XL	3.5	4.8 b	5.6 b	5.5 b	9.3 a	30.0 b	32.5 c
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.25[1]						
MAXIM XL	3.5	5.5 b	6.2 b	5.8 b	13.8 a	33.8 b	28.8 bc
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	0.5[1]						
MAXIM XL	3.5	4.6 ab	6.0 b	6.0 b	6.5 a	28.5 b	29.8 bc
+ DYNASTY 100 FS	1.0						
+ CRUISER 5 FS	1.25[1]						
MAXIM XL	3.5	3.2 a	3.1 a	2.9 a	1.0 a	1.0 a	3.0 a
+ DYNASTY 100 FS	1.0						
+ FORCE 3.0 G	37.5[2]						
MAXIM XL	3.5	5.9 b	6.6 b	6.6 b	17.0 a	34.0 b	37.8 c
+ DYNASTY 100 FS	1.0						
+ PONCHO 600 FS	0.25[1]						
MAXIM XL	3.5	3.4 a	3.3 a	3.0 a	6.0 a	6.8 a	8.5 ab
+ Cry 1F							
CV (proc glm)		20.3	23.4	26.3	83.9	56.4	58.4
se		0.551	0.669	0.705	0.044	0.064	0.075
Pr>F		0.005	0.002	0.003	0.196	0.006	0.016

[1] mg ai/seed.
[2] g per 100 m length of row applied in-furrow at planting.
[3] Guthrie Scale (1-10) (Tseng et al., 1984).
[4] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 3. Mean damage ratings and percentage of cut plants per enclosure of corn planted with seed and in-furrow applied insecticides and infested with black cutworm, second planting at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean damage rating[3]			Mean percentage of cut plants		
No. days after infestation		2 DAI	7 DAI	14 DAI	2 DAI	7 DAI	14 DAI
Sampling date (Crop stage)		4 July (V3)	9 July (V4)	16 July (V8)	4 July (V3)	9 July (V4)	16 July (V8)
MAXIM XL + DYNASTY 100 FS	3.5 1.0	3.0 c[4]	4.8 d	4.9 d	0.0 a	0.1 b	0.1 a
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.125[1]	2.8 bc	4.0 cd	4.0 cd	0.0 a	0.0 a	0.0 a
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.25[1]	2.3 abc	3.4 bc	3.2 cb	0.0 a	0.0 a	0.1 a
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.5[1]	2.2 ab	3.6 c	3.4 cb	0.0 a	0.0 a	0.0 a
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 1.25[1]	2.3 abc	3.5 c	3.0 cb	0.0 a	0.0 a	0.1 a
MAXIM XL + DYNASTY 100 FS + FORCE 3.0 G	3.5 1.0 37.5[2]	1.6 a	1.9 a	1.7 a	0.0 a	0.0 a	0.1 a
MAXIM XL + DYNASTY 100 FS + PONCHO 600 FS	3.5 1.0 0.25[1]	2.3 abc	4.0 cd	3.8 bcd	0.0 a	0.1 b	0.1 a
MAXIM XL + Cry 1F	3.5	1.7 a	2.3 ab	2.6 ab	0.0 a	0.0 a	0.0 a
CV (proc glm)		23.9	21.5	25.7	0	109.7	130.9
se		0.279	0.395	0.529	0.006	0.015	0.031
Pr>F		0.016	0.0004	0.002	0.552	0.044	0.38

[1] mg ai/seed.

[2] g per 100 m length of row applied in-furrow at planting.

[3] Guthrie Scale (1-10) (Tseng et al., 1984).

[4] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 4. Mean damage ratings and percentage of cut plants per enclosure of corn planted with seed and in-furrow applied insecticides and infested with black cutworm, third planting at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean damage rating[3]			Mean percentage of cut plants	
No. days after infestation		4 DAI	7 DAI	14 DAI	7 DAI	14 DAI
Sampling date (Crop stage)		25 July (V4)	31 July (V4)	7 Aug (V5)	13 June (V4)	7 Aug (V5)
MAXIM XL + DYNASTY 100 FS	3.5 1.0	2.3 c[4]	3.0 c	3.8 cd	0.0 a	0.0 a
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.125[1]	2.4 c	3.3 c	4.0 cd	0.0 a	0.1 b
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.25[1]	2.4 c	3.4 c	4.5 c	0.0 a	0.1 b
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 0.5[1]	2.2 c	3.1 c	3.9 cd	0.0 a	0.1 b
MAXIM XL + DYNASTY 100 FS + CRUISER 5 FS	3.5 1.0 1.25[1]	2.4 c	2.9 c	3.5 cd	0.0 a	0.1 b
MAXIM XL + DYNASTY 100 FS + FORCE 3.0 G	3.5 1.0 37.5[2]	1.3 a	1.3 a	1.3 a	0.0 a	0.0 a
MAXIM XL + DYNASTY 100 FS + PONCHO 600 FS	3.5 1.0 0.25[1]	2.1 bc	2.7 bc	3.3 b	0.0 a	0.0 a
MAXIM XL + Cry 1F	3.5	1.4 ab	1.7 ab	2.2 a	0.0 a	0.0 a
CV (proc glm)		23.5	24	20.9	0	95.2
se		0.235	0.390	0.386	0.018	0.024
Pr>F		0.011	0.001	<0.0001	0.699	0.024

[1] mg ai/seed.
[2] g per 100 m length of row applied in-furrow at planting.
[3] Guthrie Scale (1-10) (Tseng et al., 1984).
[4] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 5. Mean test weight and yield and fresh weight of corn planted with seed and in-furrow applied insecticides and infested with black cutworm at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean test weight (kg/hL)	Mean yield (T/ha)	Fresh weight (kg)	
Sampling date (Stage)		1st Planting 6 Nov (R6)		2nd Planting 21 Jul (V9)	3rd Planting 12 Aug (V6)
MAXIM XL	3.5	70.2 a[3]	4.0 c	2.5 c	2.5 a
+ DYNASTY 100 FS	1.0				
MAXIM XL	3.5	68.8 a	4.6 bc	3.0 bc	3.0 a
+ DYNASTY 100 FS	1.0				
+ CRUISER 5 FS	0.125[1]				
MAXIM XL	3.5	68.5 a	4.5 bc	3.9 a	2.8 a
+ DYNASTY 100 FS	1.0				
+ CRUISER 5 FS	0.25[1]				
MAXIM XL	3.5	69.3 a	4.3 c	3.5 ab	2.9 a
+ DYNASTY 100 FS	1.0				
+ CRUISER 5 FS	0.5[1]				
MAXIM XL	3.5	69.6 a	4.6 bc	3.7 ab	3.0 a
+ DYNASTY 100 FS	1.0				
+ CRUISER 5 FS	1.25[1]				
MAXIM XL	3.5	69.6 a	6.0 ab	3.8 ab	2.8 a
+ DYNASTY 100 FS	1.0				
+ FORCE 3.0 G	37.5[2]				
MAXIM XL	3.5	69.5 a	4.3 bc	3.5 ab	2.9 a
+ DYNASTY 100 FS	1.0				
+ PONCHO 600 FS	0.25[1]				
MAXIM XL		71.6 a	6.7 a	4.0 a	2.9 a
+ Cry 1F					
CV (proc glm)		1.9	23.8	15.5	13.3
se		0.696	0.970	0.586	0.421
Pr>F		0.086	0.037	0.013	0.787

[1] mg ai/seed.
[2] g per 100 m length of row applied in-furrow at planting.
[3] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

2008 PMR REPORT # 20 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Corn, *Zea mays* (L.), Maizex cvs. MZ 535 (3200 CHU) (1st planting) and MZ 424 (3050 CHU) (2nd planting)

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TITLE: EVALUATION OF FUNGICIDE AND INSECTICIDE SEED TREATMENTS ON CORN UNDER STRESSFUL GROWING CONDITIONS

MATERIALS: CRUISER 5 FS (thiamethoxam, 47.6 %); PONCHO 600 SC (clothianidin, 600 g/L); MAXIM XL 324 FS (fludioxonil + metalaxyl-m, 229.59 g ai/L + 87.66 g ai/L); DYNASTY 100 FS (azoxystrobin, 100 g ai/L).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. The seed weights of cultivars MZ 535 and MZ 424 were 276.5 g/1000 seeds and 213.5 g per1000 seeds, respectively. The first trial was planted on 17 April and the second on 9 May on clay loam soil following a corn, soybean, spring wheat rotation at Ridgetown, ON, at a seeding rate of 20 seeds per metre using a 4 row John Deere Max Emerge planter outfitted with Almaco cone type seed delivery units. Plots were 4 rows, spaced 0.76 m apart and 10 m in length, placed in a randomized complete block design with four replications. The plots were fertilized and maintained according to provincial recommendations.

Plant population was assessed by counting all emerged plants within the two centre rows of each plot. Following a frost event in the first planted trial, the number of plants displaying frost injury symptoms in the centre two rows of each plot was recorded. Plant vigour was evaluated on each whole plot; vigour was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Plant height was measured on ten plants from the centre two rows of each plot. The interior two rows of each plot were harvested with a modified New Holland TR-89 combine to obtain yield and test weight measurements and all yields were corrected to 15.5% moisture. The date and plant stage at sampling are reported in the data tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random source of variance. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. The α level for statistical significance was set at 0.05 for all analyses.

OBSERVATIONS: The early planted trial was subjected to a frost event on 30 April and both trials experienced hail injury on 18 May.

RESULTS: In the trial planted on 19 April, no differences were measured in plant stand, frost injury, vigour, plant height, yield or test weight (Tables 1-3).

In the trial planted on 9 May, no differences were measured in plant stand at the VE stage; at V1 the fungicide alone treatment had more plants than CRUISER 5 FS alone (1.25 mg ai/seed) (Table 4). At the V2 stage, plant stands were higher in all plots treated with a fungicide application, except those treated with the low rate of CRUISER 5 FS (0.25 mg ai/seed) only (Table 4). Plots treated with fungicide only or with fungicide + PONCHO 600 SC (0.25 mg ai/seed) had significantly higher plant stands than plots treated with the high rates of both CRUISER 5 FS (1.25 mg ai/seed) and PONCHO 600 SC (1.25 mg ai/seed) only (Table 4). No differences in vigour, plant height, test weight or yield were found among treatments in both this trial (Tables 5 and 6).

CONCLUSIONS: The intention of planting a corn trial 17 April in south-western Ontario was to evaluate the effects of insecticide and fungicide seed treatments under stressful conditions, but in the absence of severe pest incidence. Although frost injury was evident following a frost event, stand loss did not occur, and no differences were observed among treatments in stand or vigour. No differences were found in plant height, yield, or test weight.

The trial planted on 9 May experienced cool, wet conditions during emergence, but no differences were measured in plant stand or vigour until the V2 stage when plots treated with an insecticide only treatment had lower plant populations suggesting some protection by the fungicide treatments to a pathogen. Again, no differences were measured in plant height, yield or test weight. Although some differences in growth were visible in the early vegetative stages of this trial when the crop was subjected to environmental stresses, these observations did not translate into yield benefits, indicating that the use of these seed treatments was not warranted in this trial.

Table 1. Mean plant population of corn planted on 17 April with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m^2)				
Sampling date (Crop stage)		29 April (VE)	6 May (VE)	15 May (V1)	26 May (V1)	2 June (V3)
Untreated	---	3.9 a[2]	9.4 a	9.7 a	9.9 a	9.9 a
CRUISER 5 FS	0.25[1]	5.4 a	9.2 a	9.8 a	9.6 a	9.8 a
CRUISER 5 FS	1.25[1]	3.6 a	9.2 a	9.5 a	9.6 a	10.0 a
PONCHO 600 SC	0.25[1]	4.2 a	9.5 a	9.9 a	9.8 a	10.1 a
PONCHO 600 SC	1.25[1]	5.2 a	9.8 a	9.7 a	9.7 a	10.1 a
MAXIM XL	3.5	4.6 a	9.5 a	9.7 a	9.8 a	10.2 a
+DYNASTY 100 FS	1.0					
MAXIM XL	3.5	4.7 a	9.2 a	9.6 a	9.7 a	10.0 a
+DYNASTY 100 FS	1.0					
+CRUISER 5 FS	0.25[1]					
MAXIM XL	3.5	3.6 a	9.6 a	9.7 a	9.7 a	10.1 a
+DYNASTY 100 FS	1.0					
+CRUISER 5 FS	1.25[1]					
MAXIM XL	3.5	4.8 a	9.1 a	9.6 a	9.8 a	9.8 a
+DYNASTY 100 FS	1.0					
+PONCHO 600 SC	0.25[1]					
MAXIM XL	3.5	5.2 a	9.5 a	9.7 a	9.9 a	10.0 a
+DYNASTY 100 FS	1.0					
+PONCHO 600 SC	1.25[1]					
CV (proc glm)		34.2	4.5	3.3	4.3	2.7
se		0.770	0.297	0.154	0.223	0.150
Pr > F		0.678	0.477	0.785	0.984	0.531

[1] mg ai/seed.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 2. Mean number of frost-injured plants and vigour of corn planted on 17 April with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	No. frost injured plants/m^2	Mean plant vigour (0-100%)[1]				
Sampling date (Crop stage)		2 May (VE)	6 May (VE)	15 May (V1)	26 May (V1)	2 June (V3)	11 July (V12)
Untreated	---	5.6 a[3]	85.0 a	88.8 a	87.5 a	92.5 a	88.8 a
CRUISER 5 FS	0.25[2]	6.2 a	75.0 a	93.8 a	87.5 a	95.0 a	91.3 a
CRUISER 5 FS	1.25[2]	5.1 a	80.0 a	91.3 a	87.5 a	93.8 a	91.3 a
PONCHO 600 SC	0.25[2]	5.6 a	82.5 a	88.8 a	91.3 a	96.3 a	88.8 a
PONCHO 600 SC	1.25[2]	6.5 a	81.3 a	92.5 a	91.3 a	93.8 a	90.0 a
MAXIM XL	3.5	5.8 a	86.3 a	95.0 a	86.3 a	93.8 a	86.3 a
+DYNASTY 100 FS	1.0						
MAXIM XL	3.5	5.7 a	88.8 a	93.8 a	86.3 a	95.0 a	90.0 a
+DYNASTY 100 FS	1.0						
+CRUISER 5 FS	0.25[2]						
MAXIM XL	3.5	4.9 a	90.0 a	91.3 a	90.0 a	92.5 a	87.5 a
+DYNASTY 100 FS	1.0						
+CRUISER 5 FS	1.25[2]						
MAXIM XL	3.5	6.1 a	90.0 a	90.0 a	92.5 a	96.3 a	91.3 a
+DYNASTY 100 FS	1.0						
+PONCHO 600 SC	0.25[2]						
MAXIM XL	3.5	6.0 a	86.3 a	90.0 a	88.8 a	95.0 a	93.8 a
+DYNASTY 100 FS	1.0						
+PONCHO 600 SC	1.25[2]						
CV (proc glm)		23.7	11.7	4.1	7.4	3.1	8.0
se		0.783	5.737	2.213	3.812	1.425	3.659
Pr > F		0.857	0.492	0.257	0.888	0.541	0.945

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.
[2] mg ai/seed.
[3] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 3. Mean height, test weight and yield of corn planted on 17 April with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant height (cm)	Mean test weight (kg/hL)	Mean plot yield (T/ha)
Sampling date (Crop stage)		11 July (V12)	15 October (R6)	
Untreated	---	198.5 a[2]	54.7 a	10.4 a
CRUISER 5 FS	0.25[1]	203.9 a	54.3 a	10.4 a
CRUISER 5 FS	1.25[1]	201.0 a	54.2 a	10.9 a
PONCHO 600 SC	0.25[1]	196.4 a	53.9 a	10.1 a
PONCHO 600 SC	1.25[1]	196.1 a	54.6 a	10.1 a
MAXIM XL	3.5	197.8 a	53.9 a	9.9 a
+DYNASTY 100 FS	1.0			
MAXIM XL	3.5	197.7 a	54.1 a	9.8 a
+DYNASTY 100 FS	1.0			
+CRUISER 5 FS	0.25[1]			
MAXIM XL	3.5	197.0 a	54.3 a	10.3 a
+DYNASTY 100 FS	1.0			
+CRUISER 5 FS	1.25[1]			
MAXIM XL	3.5	200.0 a	54.0 a	10.3 a
+DYNASTY 100 FS	1.0			
+PONCHO 600 SC	0.25[1]			
MAXIM XL	3.5	201.6 a	54.7 a	10.6 a
+DYNASTY 100 FS	1.0			
+PONCHO 600 SC	1.25[1]			
CV (proc glm)		5.6	1.4	6.9
se		5.792	0.379	0.403
Pr > F		0.991	0.702	0.520

[1] mg ai/seed.

[2] Means followed by the same letter do not significantly differ ($P \geq 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 4. Mean plant population of corn planted on 9 May with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m^2)			
Sampling date (Crop stage)		26 May (VE)	30 May (VE)	2 June (V1)	6 June (V2)
Untreated	---	1.3 a[2]	3.9 a	6.1 ab	6.6 bc
CRUISER 5 FS	0.25[1]	1.6 a	3.9 a	6.2 ab	6.8 abc
CRUISER 5 FS	1.25[1]	1.0 a	3.8 a	5.6 b	6.1 c
PONCHO 600 SC	0.25[1]	1.5 a	4.2 a	5.8 ab	6.5 bc
PONCHO 600 SC	1.25[1]	1.1 a	3.6 a	5.7 ab	6.1 c
MAXIM XL	3.5	2.3 a	5.1 a	7.6 a	8.2 a
+DYNASTY 100 FS	1.0				
MAXIM XL	3.5	1.9 a	4.5 a	7.0 ab	7.4 abc
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	0.25[1]				
MAXIM XL	3.5	1.5 a	4.4 a	6.8 ab	7.5 abc
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	1.25[1]				
MAXIM XL	3.5	1.8 a	4.6 a	7.4 ab	7.8 ab
+DYNASTY 100 FS	1.0				
+PONCHO 600 SC	0.25[1]				
MAXIM XL	3.5	1.6 a	4.3 a	6.7 ab	7.4 abc
+DYNASTY 100 FS	1.0				
+PONCHO 600 SC	1.25[1]				
CV (proc glm)		37.2	19.3	12.8	8.8
se		0.305	0.405	0.423	0.319
Pr > F		0.114	0.372	0.011	0.0004

[1] mg ai/seed.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 5. Mean plant vigour of corn planted on 9 May with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant vigour (0-100%)[1]			
Sampling date (Crop stage)		30 May (VE)	2 June (V1)	6 June (V2)	11 July (V10)
Untreated	---	88.8 a[3]	85.0 a	88.8 a	85.0 a
CRUISER 5 FS	0.25[2]	82.5 a	88.8 a	91.3 a	90.0 a
CRUISER 5 FS	1.25[2]	82.5 a	83.8 a	85.0 a	87.5 a
PONCHO 600 SC	0.25[2]	95.0 a	92.5 a	86.3 a	90.0 a
PONCHO 600 SC	1.25[2]	90.0 a	92.5 a	86.3 a	90.0 a
MAXIM XL +DYNASTY 100 FS	3.5 1.0	87.5 a	95.0 a	95.0 a	90.0 a
MAXIM XL +DYNASTY 100 FS +CRUISER 5 FS	3.5 1.0 0.25[2]	91.3 a	91.3 a	92.5 a	91.3 a
MAXIM XL +DYNASTY 100 FS +CRUISER 5 FS	3.5 1.0 1.25[2]	90.0 a	91.3 a	91.3 a	92.5 a
MAXIM XL +DYNASTY 100 FS +PONCHO 600 SC	3.5 1.0 0.25[2]	88.8 a	90.0 a	92.5 a	91.3 a
MAXIM XL +DYNASTY 100 FS +PONCHO 600 SC	3.5 1.0 1.25[2]	90.0 a	92.5 a	95.0 a	93.8 a
CV (proc glm)		8.6	5.9	6.4	7.3
se		3.63	2.739	2.804	3.362
Pr > F		0.400	0.126	0.143	0.821

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.

[2] mg ai/seed.

[3] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 6. Mean height, test weight and yield of corn planted on 9 May with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant height (cm)	Mean test weight (kg/hL)	Mean plot yield (T/ha)
Sampling date (Crop stage)		11 July (V10)	15 October (R6)	
Untreated	---	150.5 a[2]	52.7 a	9.3 a
CRUISER 5 FS	0.25[1]	162.7 a	53.6 a	9.7 a
CRUISER 5 FS	1.25[1]	162.0 a	53.7 a	9.6 a
PONCHO 600 SC	0.25[1]	158.0 a	53.2 a	9.9 a
PONCHO 600 SC	1.25[1]	162.0 a	53.2 a	9.8 a
MAXIM XL	3.5	162.8 a	53.3 a	9.5 a
+DYNASTY 100 FS	1.0			
MAXIM XL	3.5	165.0 a	53.3 a	9.9 a
+DYNASTY 100 FS	1.0			
+CRUISER 5 FS	0.25[1]			
MAXIM XL	3.5	165.4 a	53.4 a	10.0 a
+DYNASTY 100 FS	1.0			
+CRUISER 5 FS	1.25[1]			
MAXIM XL	3.5	160.3 a	53.1 a	9.9 a
+DYNASTY 100 FS	1.0			
+PONCHO 600 SC	0.25[1]			
MAXIM XL	3.5	167.5 a	53.6 a	9.3 a
+DYNASTY 100 FS	1.0			
+PONCHO 600 SC	1.25[1]			
CV (proc glm)		5.2	1.3	6.5
se		5.050	0.348	0.366
Pr > F		0.289	0.610	0.725

[1] mg ai/seed.

[2] Means followed by the same letter do not significantly differ ($P \geq 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

2008 PMR REPORT # 21 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Soybean, *Glycine max* (L.) Merr., Pride cv. PS 88 RR, Hyland cv. Rodney, Syngenta Seeds cv. NK S26-V6
PEST: Bean Leaf Beetle, *Cerotoma trifurcata* (Förster)

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TITLE: EVALUATION OF FOLIAR INSECTICIDES FOR CONTROL OF OVERWINTERING AND FIRST GENERATION BEAN LEAF BEETLES IN SOYBEANS

MATERIALS: ACTARA 25 WG (thiamethoxam, 25% v/v); MATADOR 120 EC (lambda-cyhalothrin, 120 g ai/L); ENDIGO A13623B (lambda-cyhalothrin 9.48% + thiamethoxam 12.60% v/v); CYGON 480 EC (dimethoate, 480 g ai/L).

METHODS: Soybean fields at Wyoming, Inwood, and Ridgetown, ON were identified with high populations of overwintering (F_0) and first generation (F_1) bean leaf beetles to evaluate the efficacy of foliar insecticides for their control. The F_0 generation was assessed at the Wyoming location where the cultivar PS 88 was planted on May 23. The F_1 generation was targeted at Inwood, ON with the cultivar Rodney, planted 29 May, and Ridgetown, ON, with the cultivar NK S26-V6, planted 26 May. All locations were clay loam soil. Trials were placed a minimum of 20 m from any field edge and plots 3 m wide and 10 m in length were staked in a randomized complete block design with four replications. Insecticide was applied using a handheld three-nozzle CO_2 precision sprayer (R&D Sprayers Inc.). The nozzle type was XR Teejet 11002 VS with a nozzle spacing of 50 cm. Insecticide was prepared in two-litre plastic pop bottles according to assigned rates with 0.600 L of distilled water or 200 L/ha. Two passes covered the plot at a height of 0.5 m from the ground 1at a walking speed of 0.5 m/s.

Assessments were made at approximately 0, 3, 7, and 14 days after application of insecticides. Vigour of the entire plot was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Bean leaf beetle populations were assessed by counting beetles captured in a sweep net following 10 sweeps taken while walking lengthwise through the centre of each plot. Percent defoliation was calculated by evaluating defoliation on the last fully expanded trifoliate on 20 plants per plot (Baute et al., 2002). A swath was harvested from the centre of each plot with a Hege plot combine and yields were corrected to 14.5% moisture. The date, number of days after application (DAA) and crop stage at sampling are presented in the data tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random source of variance. Tukey's HSD test was used for multiple

treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. The α level for statistical significance was set at 0.05 for all analyses.

OBSERVATIONS: Beetle counts at the Wyoming location were low likely due to completion of the overwintering generation by the time of the trial.

RESULTS: Plant vigour was not affected by foliar application at the Wyoming location (Table 1). No differences in beetle counts among treatments were observed 4 or 7 DAA (Table 2). At 14 DAA, beetle counts were significantly higher in plots treated with ACTARA 25WG and ENDIGO (23.3 g ai/ha). No differences in defoliation were observed in this trial (Table 3).

At the Ridgetown location, beetle counts were significantly lower in all treated plots 2 DAA (Table 4). At 7 DAA, beetle counts were still lower in all treated plots than untreated plots, but counts were lower in plots treated with any rate of MATADOR or ENDIGO compared to ACTARA or CYGON (Table 4). By 14 DAA, differences in beetle counts were no longer observable among treatments (Table 4).

At the Inwood location, beetle counts were significantly decreased in treated plots 3 DAA, being lowest in plots treated with the high rate of ENDIGO (45.5 g ai/ha) and highest in CYGON treated plots (Table 4). At 7 and 14 DAA, all treatments except CYGON had significantly fewer beetles than the untreated check (Table 4). On all three rating dates there were treatments that showed significantly fewer beetles than the CYGON treatment: plots treated with the high rate of ENDIGO (45.5 g ai/ha) 3 DAA, plots treated with both rates of MATADOR or the low and mid rates of ENDIGO (23.3 and 37.0 g ai/ha) at 7 DAA, and plots treated with all rates of MATADOR and ENDIGO at 14 DAA (Table 4).

No differences in defoliation were observed at the Ridgetown location (Table 5). At the Inwood location, no differences were measured 3 DAA. However, at 7 DAA, defoliation was significantly lower in plots treated with ACTARA, the high rate of MATADOR (28.0 g ai/ha) and the low rate of ENDIGO (23.3 g ai/ha) (Table 5). At 14 DAA, the least amount of defoliation was found in plots treated with the low rate of ENDIGO (23.3 g ai/ha) (Table 5). No significant differences were measured in yield at any location (Table 6).

CONCLUSIONS: Conclusions cannot be made about control of the overwintering generation of bean leaf beetles from this study due to very low numbers of beetles completing that generation at the time of the trial. All treatments provided good knockdown of first generation beetle populations 2-3 days after application; this effect was not as pronounced with CYGON. At 7 days after application, all rates of MATADOR and ENDIGO treatments provided better control than ACTARA and CYGON; no differences were measured among rates of MATADOR or ENDIGO. Only at the Inwood location, defoliation was assessed to be lower with both rates of MATADOR and the low and high rates of ENDIGO (23.3 g ai/ha and 45.4 g ai/ha) 14 days after application. The treatments did not affect vigour or yield.

REFERENCE:

Baute, T., A. Hayes, I. McDonald and K. Reid**.** 2002. Soybeans. Pg. 120. *In* T. Baute, A. Hayes, I. McDonald and K. Reid. Agronomy Guide to Field Crops. Ontario Ministry of Agriculture, Food and Rural Affairs. Toronto, ON.

Table 1. Mean plant vigour following application of foliar insecticides for control of overwintering (F_0) generation bean leaf beetles in soybeans at Wyoming, Ontario in 2008.

Treatment	Rate (g ai/ha)	Mean plant vigour (0-100%)[1]			
Sampling date (Stage)		20 June (V2) 0 DAA	25 June (V3) 4 DAA	30 June (V3) 7 DAA	7 July (V4) 14 DAA
Untreated	---	90.0	92.5 a[2]	91.3 a	90.0 a
ACTARA 25WG	26.0	90.0	91.3 a	87.5 a	85.0 a
MATADOR 120 EC	10.0	90.0	93.8 a	93.8 a	91.3 a
MATADOR 120 EC	28.0	90.0	93.8 a	91.3 a	92.5 a
ENDIGO A13623B	23.3	90.0	92.5 a	91.3 a	91.3 a
ENDIGO A13623B	37.0	90.0	93.8 a	92.5 a	89.5 a
ENDIGO A13623B	45.5	90.0	92.5 a	96.3 a	92.5 a
CYGON 480 EC	480.0	90.0	93.8 a	93.8 a	95.0 a
CV (proc glm)			4.7	5.3	6.1
se			2.089	2.526	2.740
Pr > F			0.982	0.407	0.378

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 2. Bean leaf beetle counts following application of foliar insecticides for control of overwintering (F_0) generation bean leaf beetles in soybeans at Wyoming, Ontario in 2008.

Treatment	Rate (g ai/ha)	Mean bean leaf beetle sweep counts[1]			
Sampling date (Stage)		20 June (V2) 0 DAA	25 June (V3) 4 DAA	30 June (V3) 7 DAA	7 July (V4) 14 DAA
Untreated	---	3.0	0.8 b[2]	1.5 a	0.0 a
ACTARA 25WG	26.0	4.5	0.0 a	0.5 a	1.3 c
MATADOR 120 EC	10.0	3.0	0.0 a	0.0 a	0.5 abc
MATADOR 120 EC	28.0	2.8	0.0 a	0.0 a	0.3 ab
ENDIGO A13623B	23.3	3.3	0.0 a	0.0 a	1.0 bc
ENDIGO A13623B	37.0	1.5	0.0 a	0.0 a	0.0 a
ENDIGO A13623B	45.5	3.8	0.0 a	0.0 a	0.0 a
CYGON 480 EC	480.0	3.0	0.0 a	0.0 a	0.3 ab
CV (proc glm)			342.9	294.4	131.2
se			0.042	0.075	0.074
Pr > F			0.036	0.085	0.029

[1] Sweep counts were assessed by counting beetles captured in a sweep net following 10 sweeps while walking lengthwise through the centre of each plot. Analyses derived from data transformed using $\log_{10}(y+1)$. Means reported are transformed back to the original scale.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD Test.

Table 3. Mean percent defoliation following application of foliar insecticides for control of overwintering (F_0) generation bean leaf beetles in soybeans at Wyoming, Ontario in 2008.

Treatment	Rate (g ai/ha)	Mean defoliation (%)[1]			
Sampling date (Stage)		20 June (V2) 0 DAA	25 June (V3) 2 DAA	30 June (V3) 7 DAA	7 July 14 DAA
Untreated	---	8.3	5.8 a[2]	2.0 a	1.7 a
ACTARA 25WG	26.0	7.3	4.8 a	1.3 a	1.4 a
MATADOR 120 EC	10.0	7.9	5.4 a	1.3 a	0.9 a
MATADOR 120 EC	28.0	7.8	6.1 a	0.8 a	1.0 a
ENDIGO A13623B	23.3	8.0	6.1 a	0.9 a	0.8 a
ENDIGO A13623B	37.0	7.1	4.6 a	1.6 a	1.3 a
ENDIGO A13623B	45.5	6.6	5.4 a	0.9 a	1.1 a
CYGON 480 EC	480.0	7.7	4.4 a	1.5 a	1.2 a
CV (proc glm)			11.4	32.6	22.0
se			0.013	0.025	0.012
Pr > F			0.287	0.153	0.389

[1] Mean percent defoliation was calculated by evaluating the last fully expanded trifoliate on 20 plants per plot. Analyses derived from data using arcsine square root transformation; means reported are transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 4. Bean leaf beetle counts following application of foliar insecticides for control of first (F_1) generation bean leaf beetles in soybeans at Ridgetown and Inwood, Ontario, in 2008.

Treatment	Rate (g ai/ha)	Mean bean leaf beetle sweep counts[1]			
Ridgetown (F_1)		13 August 0 DAA	15 August 2 DAA	20 August 7 DAA	27 August 14 DAA
Untreated	---	16.9	24.7 a[2,3]	17.8 a	2.0 a
ACTARA 25WG	26.0	16.1	0.3 b	4.8 b	4.3 a
MATADOR 120 EC	10.0	15.4	0.0 b	0.5 c	1.0 a
MATADOR 120 EC	28.0	17.0	0.3 b	0.5 c	0.3 a
ENDIGO A13623B	23.3	16.9	0.8 b	1.3 c	1.3 a
ENDIGO A13623B	37.0	16.0	0.8 b	0.3 c	0.5 a
ENDIGO A13623B	45.5	17.2	0.0 b	1.3 c	0.8 a
CYGON 480 EC	480.0	17.0	1.0 b	6.8 b	2.5 a
CV (proc glm)			81.3	34.3	91.8
se			0.093	0.090	0.136
Pr > F			<0.0001	<0.0001	0.230
Inwood (F_1)		15 August 0 DAA	18 August 3 DAA	21 August 7 DAA	28 August 14 DAA
Untreated	---	244.8	76.0 c	65.3 c	20.8 c
ACTARA 25WG	26.0	117.5	22.0 ab	28.0 ab	8.8 ab
MATADOR 120 EC	10.0	168.8	14.0 ab	14.5 a	1.5 a
MATADOR 120 EC	28.0	191.0	7.5 ab	10.8 a	0.0 a
ENDIGO A13623B	23.3	186.0	12.0 ab	16.8 a	1.3 a
ENDIGO A13623B	37.0	169.3	7.0 ab	17.5 a	0.3 a
ENDIGO A13623B	45.5	199.5	4.8 a	26.0 ab	0.0 a
CYGON 480 EC	480.0	191.8	28.3 b	45.5 bc	18.0 bc
CV (proc glm)			16.3	14.8	53.9
se			0.127	0.110	0.131
Pr > F			<0.0001	0.0004	<0.0001

[1] Sweep counts were assessed by counting beetles captured in a sweep net following 10 sweeps while walking lengthwise through the centre of each plot. Analyses derived from data transformed using $\log_{10}(y+1)$. Means reported are transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD Test.

[3] Outlier removed from analysis (trt 1, block 2).

Table 5. Mean percent defoliation following application of foliar insecticides for control of first (F_1) generation bean leaf beetles in soybeans at Ridgetown and Inwood, Ontario, in 2008.

Treatment	Rate (g ai/ha)	Mean defoliation (%)[1]			
Ridgetown (F_1)		13 August 0 DAA	15 August 2 DAA	20 August 7 DAA	27 August 14 DAA
Untreated	---	16.9	16.2 a[2]	15.4 a	17.8 a
ACTARA 25WG	26.0	16.1	17.5 a	13.1 a	16.4 a
MATADOR 120 EC	10.0	15.4	15.1 a	12.8 a	15.3 a
MATADOR 120 EC	28.0	17.0	15.4 a	13.4 a	14.2 a
ENDIGO A13623B	23.3	16.9	16.1 a	13.9 a	16.1 a
ENDIGO A13623B	37.0	16.0	15.8 a	12.8 a	16.4 a
ENDIGO A13623B	45.5	17.2	15.0 a	13.4 a	15.1 a
CYGON 480 EC	480.0	17.0	15.9 a	14.2 a	15.7 a
CV (proc glm)			6.1	6.9	6.3
se			0.013	0.013	0.013
Pr > F			0.611	0.477	0.295
Inwood (F_1)		15 August 0 DAA	18 August 3 DAA	21 August 7 DAA	28 August 14 DAA
Untreated	---	24.2	29.1 a	34.8 b[3]	33.5 c
ACTARA 25WG	26.0	23.5	25.1 a	31.8 a	31.3 bc
MATADOR 120 EC	10.0	22.6	28.4 a	34.2 b	30.7 ab
MATADOR 120 EC	28.0	22.7	26.8 a	32.1 a	29.5 ab
ENDIGO A13623B	23.3	24.1	29.8 a	32.2 a	28.5 a
ENDIGO A13623B	37.0	24.9	28.1 a	33.3 ab	31.0 b
ENDIGO A13623B	45.5	24.8	27.6 a	33.7 ab	30.2 abc
CYGON 480 EC	480.0	24.0	29.3 a	34.1 b	31.3 bc
CV (proc glm)			4.0	2.2	3.1
se			0.012	0.014	0.016
Pr > F			0.063	0.030	0.021

[1] Mean percent defoliation was calculated by evaluating the last fully expanded trifoliate on 20 plants per plot. Analyses derived from data using arcsine square root transformation; means reported are transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD Test.

[3] Outlier removed from analysis (trt 5, block 4).

Table 6. Yield of soybeans treated with foliar applications of insecticides for control of overwintering (F_0) and first generation (F_1) bean leaf beetles in 2008.

Treatment	Rate (g ai/ha)	Mean yield (T/ha)		
		Wyoming 6 Oct (R6)	Ridgetown 23 Oct (R6)	Inwood 6 Oct (R6)
Untreated	---	3.0 a[1]	3.2 a	3.7 a
ACTARA 25WG	26.0	3.0 a	3.1 a	3.8 a
MATADOR 120 EC	10.0	3.0 a	3.1 a	3.6 a
MATADOR 120 EC	28.0	3.1 a	3.2 a	3.8 a
ENDIGO A13623B	23.3	2.9 a	3.4 a	3.7 a
ENDIGO A13623B	37.0	3.0 a	3.3 a	3.9 a
ENDIGO A13623B	45.5	3.2 a	3.1 a	4.3 a
CYGON 480 EC	480.0	3.0 a	3.5 a	3.7 a
CV (proc glm)		4.8	12.2	8.2
se		0.106	0.192	0.148
Pr > F		0.313	0.665	0.089

[1] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

2008 PMR REPORT # 22 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Soybean, *Glycine max* (L.) Merr., Hyland Seed cv. RR Respond
PEST: Seedcorn maggot, *Delia platura* (Meigen), Wireworm, *Melanotus* spp. (LeConte)

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TITLE: EVALUATION OF "STRESS SHIELD" FOR CONTROL OF SEEDCORN MAGGOT IN SOYBEANS

MATERIALS: VITAFLO 280 (carbathiin, 15.59%, thiram, 13.25%); CRUISER 5 FS (thiamethoxam, 47.6 %); STRESS SHIELD (imidacloprid, 600 g ai/L).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. The seed weight of RR Respond was 150.0 g/1000 seeds. The trial was planted on 5 May 2008 on sandy loam soil at Ridgetown, ON, at a seeding rate of 20 seeds per metre using a 2-row cone seeder. Cattle manure was broadcast on the plots 2 weeks before planting and the soil was disked shortly after manure application. Plots were 2 rows, spaced 0.76 m apart and 8 m in length, placed in a randomized complete block design with 4 replications. The plots were fertilized and maintained according to provincial recommendations.

Plant population and vigour were evaluated three times on each whole plot during early vegetative stages. Vigour was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). A one metre row length was destructively sampled from one row of each plot at VC stage to evaluate insect feeding damage using a rating scale of 1-4 (1 = no damage, 2 = some damage on cotyledons, 3 = seed emerged but feeding evident, and 4 = damaged and rotted seed). The soil within a 10 by 10 cm trench surrounding the seedlings was sifted through at the time of destructive sampling to exhume, identify, and count all soil inhabiting pests. The unsampled row of each plot was harvested and yields were corrected to 14.5% moisture. Dates and plant stages at sampling are presented in the tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random variable. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. The α level for statistical significance was set at 0.05 for all analyses.

OBSERVATIONS: Seedcorn maggot pupae and larvae were the predominant pest found in this trial. Some wireworm larvae and millipedes were found feeding on seedlings; very few European chafer larvae were found.

RESULTS: Plant stand was highest in plots treated with CRUISER 5 FS on all rating dates (Table 1). STRESS SHIELD treated plots had higher plant stands than untreated plots at the VC stage, but this was not observed at the V2 stage (Table 1). Plant vigour assessments showed the same trend on these rating dates in that CRUISER 5 FS treated plots looked best, STRESS SHIELD treated plots appeared more vigourous than untreated plots at the VC stage but not at V2 stage (Table 1).

Feeding damage was significantly reduced in CRUISER 5 FS treated plots at the VC stage (Table 2). CRUISER 5 FS treated plants had the greatest biomass; no differences in fresh weight existed among other treatments (Table 2). A greater number of seedcorn maggot larvae and pupae were recovered from STRESS SHIELD treated plots than the other plots; more wireworms were found in CRUISER 5 FS treated plots (Table 3). Yield was significantly greater in plots treated with CRUISER (Table 3).

CONCLUSIONS: CRUISER 5 FS provided better protection from seedcorn maggot feeding damage than STRESS SHIELD in this trial.

Table 1. Mean plant population and vigour of soybeans with seed applied insecticides for soil insect control at Ridgetown, Ontario in 2008.

Treatment	Rate (mL/100 kg seed)	Mean plant population (# plants/m^2)			Mean plant vigour (0-100%)[1]	
Sampling date (Crop stage)		26 May (VE)	2 June (VC)	18 June (V2)	2 June (VC)	18 June (V2)
Untreated	---	3.1 b[2]	4.6 c	12.1 b	78.8 c	72.5 b
VITAFLO-280	260.0	2.3 b	4.0 c	11.3 b	80.0 c	70.0 b
VITAFLO-280	260.0	3.2 b	6.3 b	14.5 b	90.0 b	75.0 b
+ STRESS SHIELD	260.0					
VITAFLO-280	260.0	6.9 a	11.3 a	26.4 a	100.0 a	100.0 a
+ CRUISER 5 F5	83.0					
CV (proc glm)		31.8	15.5	13.1	3.61	10.9
se		0.711	1.045	2.512	1.573	5.543
Pr > F		0.002	<0.0001	<0.0001	<0.0001	0.003

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 2. Percentage of plants per damage category resulting from destructive sampling of one metre row of soybean seedlings treated with insecticides at Ridgetown, Ontario in 2008.

Treatment	Rate (mL/100 kg seed)	Mean percentage of plants per damage category[1]				Mean damage rating	Mean fresh weight per plant (g)
Sampling Date (Crop stage)		3 June (VC)					
		1	2	3	4		
Untreated	---	19.2 a[2]	18.8 ab	7.9 a	59.1 ab	3.2 a	0.89 b
VITAFLO-280	260.0	13.0 a	8.7 b	7.6 a	71.8 b	3.4 a	0.77 b
VITAFLO-280	260.0	32.8 a	12.7 ab	4.4 a	53.0 ab	2.8 ab	0.96 b
+ STRESS SHIELD	260.0						
VITAFLO-280	260.0	34.8 a	29.6 a	3.7 a	28.6 a	2.2 b	1.22 a
+ CRUISER 5 F5	83.0						
CV (proc glm)		65.8	51.0	116.3	32.0	15.7	10.7
se		0.099	0.041	0.031	0.105	0.293	0.059
Pr > F		0.246	0.003	0.701	0.033	0.021	0.001

[1] 1 = no damage, 2 = some damage on cotyledons, 3 = seed emerged but feeding evident, 4 = damaged and rotted seed.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 3. Mean number of soil inhabiting pests found per metre by sifting through the soil around seedlings and yield of soybeans treated with insecticides at Ridgetown, Ontario in 2008.

Treatment	Rate (mL / 100 kg seed)	Mean no. of pests per metre row				Yield (T/ha)
Sampling date (Stage)		3 June (VC)				21 Oct (R8)
		SCM[1]	WWM	ECHF	Millipedes	
Untreated	---	7.0 b[2]	1.0 b	0.0 a	2.8 a	2.3 b
VITAFLO-280	260.0	5.3 b	1.3 b	0.3 a	5.8 a	2.2 b
VITAFLO-280	260.0	10.8 a	1.8 b	0.3 a	4.3 a	2.7 ab
+ STRESS SHIELD	260.0					
VITAFLO-280	260.0	5.8 b	4.3 a	0.3 a	4.0 a	3.8 a
+ CRUISER 5 F5	83.0					
CV (proc glm)		27.7	66.8	222.2	45.1	22.0
se		1.371	0.916	0.217	1.570	0.416
Pr > F		0.014	0.031	0.783	0.236	0.016

[1] SCM = seedcorn maggot *Delia platura* Meighen, WWM = wireworm *Melanotus* spp., ECHF = European Chafer *Rhizotrogus majalis* Razoumowsky.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

2008 PMR REPORT # 23 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS - Insects**

CROP: Soybean, *Glycine max* (L.) Merr., Hyland Seed cv. RR Respond
PEST: Wireworm, *Melanotus* spp. (LeConte)

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TITLE: EVALUATION OF "STRESS SHIELD" FOR CONTROL OF WIREWORM IN SOYBEANS

MATERIALS: VITAFLO-280 (carbathiin, 15.59%, thiram, 13.25%); CRUISER 5 FS (thiamethoxam, 5 g ai/L); STRESS SHIELD (imidacloprid, 600 g ai/L).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. The seed weight of RR Respond was 150.0 g/1000 seeds. The trial was planted on 6 May 2008 on sandy loam soil at Rodney, ON, at a seeding rate of 20 seeds per metre using a 2-row cone seeder. Plots were 2 rows, spaced 0.76 m apart and 8 m in length, placed in a randomized complete block design with 4 replications. The plots were fertilized and maintained according to provincial recommendations.

Plant population and vigour were evaluated three times on each whole plot during early vegetative stages. Vigour was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). A one metre row length was destructively sampled from one row of each plot at VC stage to evaluate insect feeding damage using a rating scale of 1-4 (1 = no damage, 2 = some damage on cotyledons, 3 = seed emerged but feeding evident, and 4 = damaged and rotted seed). The soil within a 10 by 10 cm trench surrounding the seedlings was sifted through at the time of destructive sampling to exhume, identify, and count all soil inhabiting pests. This trial was not harvested for yield due to hail damage. Dates and plant stages at sampling are presented in the data tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random variable. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. The α level for statistical significance was set at 0.05 for all analyses.

RESULTS: At all crop stages assessed, plant population and vigour were higher in both CRUISER 5 FS and STRESS SHIELD treatments than in those untreated or planted with VITAFLO-280 alone (Table 1).

Overall mean damage ratings were not significantly different among treatments (Table 2). However, analysis of the mean percentage of plants per damage category showed less damage on seedlings treated with CRUISER 5 FS or STRESS SHIELD (Table 2). Fewer wireworm larvae were exhumed from STRESS SHIELD treated plots than untreated ones, but no reduction in the incidence of seed corn maggot or millipedes can be attributed to any treatment in the trial (Table 3). The mean fresh weights of seedlings were higher in both CRUISER5 FS and STRESS SHIELD treatments than in those untreated or treated with VITAFLO-280 alone (Table 3).

CONCLUSIONS: STRESS SHIELD and CRUISER 5 FS were both effective in reducing feeding injury by wireworm in this trial. No differences were measured between these treatments in plant stand, vigour, the number of plants without damage, or fresh weight of plants.

Table 1. Mean plant population and vigour of soybeans with seed applied insecticides for soil insect control at Rodney, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m^2)			Mean plant vigour (0-100%)[1]		
Sampling date (Crop stage)		27 May (VE)	4 June (VC)	18 June (V2)	27 May (VE)	4 June[3] (VC)	18 July (V2)
Untreated	---	8.6 b[2]	10.0 b	10.7 b	77.5 b	68.6 b	65.0 b
VITAFLO-280	260.0	8.9 b	10.0 b	9.7 b	80.0 b	70.0 b	62.5 b
VITAFLO-280	260.0	17.2 a	19.2 a	19.3 a	96.3 a	97.5 a	96.3 a
+ STRESS SHIELD	260.0						
VITAFLO-280	260.0	16.2 a	19.5 a	20.1 a	95.0 a	97.5 a	92.5 a
+ CRUISER 5 F5	83.0						
CV		10.8	12.2	11.0	6.2	11.0	17.1
se		1.901	1.513	1.782	2.474	5.625	8.125
Pr > F		<0.0001	<0.0001	<0.0001	0.001	0.001	0.011

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 2. Percentage of plants per damage category resulting from destructive sampling of one metre row of soybeans seedlings treated with insecticides at Rodney, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean percentage of plants per damage category[1]				Mean damage rating
Sampling date (Stage)		4 June (VC)				
		1	2	3	4	
Untreated	---	22.0 b[2]	28.2 ab	4.1 b[3]	29.9 a	3.3 a
VITAFLO-280	260.0	29.2 b	30.4 b	0.0 a	40.4 a	3.5 a
VITAFLO-280 + STRESS SHIELD	260.0 260.0	77.7 a	9.6 a	4.5 b	8.2 a	1.8 a
VITAFLO-280 + CRUISER 5 F5	260.0 83.0	68.6 a	16.3 ab	0.0 a	15.1 a	2.2 a
CV		34.2	48.8	109.9	80.6	49.0
se		0.092	0.047	0.012	0.102	0.714
Pr > F		0.002	0.035	0.038	0.138	0.264

[1] 0 = no damage, 1 = some damage on cotyledons, 2 = seed emerged but feeding evident, 3 = damaged and rotted seed.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.
[3] An outlier removed from analysis (block 2).

Table 3. Mean number of soil-inhabiting pests found per metre row by sifting through the soil around seedlings treated with insecticides at Rodney, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean no. of pests per metre row			Mean fresh weight per plant (g)
Sampling date (Stage)		4 June (VC)			
		SCM[1]	WWM	Millipedes	
Untreated	---	0.8 a[2]	11.3 b	3.3 a	0.91 c
VITAFLO-280	260.0	0.0 a	7.5 ab	2.0 a	1.22 bc
VITAFLO-280 + STRESS SHIELD	260.0 260.0	0.8 a	4.5 a	6.3 a	1.57 ab
VITAFLO-280 + CRUISER 5 F5	260.0 83.0	0.5 a	6.5 ab	3.3 a	1.49 ab
CV		105.4	43.9	79.9	12.2
se		0.306	1.470	1.371	0.099
Pr > F		0.217	0.055	0.229	0.001

[1] SCM = seedcorn maggot *Delia platura* Meighen, WWM = wireworm *Melanotus* spp.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

2008 PMR REPORT # 24 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Soybean, *Glycine max* (L.) Merr., Hyland Seed cvs. HS24R45 (3200 CHU) (1st planting) and RR Razor (2nd planting) (2800 CHU)

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TITLE: EVALUATION OF INSECTICIDE AND FUNGICIDE SEED TREATMENTS ON SOYBEANS UNDER STRESSFUL PLANTING CONDITIONS

MATERIALS: CRUISER 5 FS (thiamethoxam, 47.6 %); GAUCHO 480 FS (imidacloprid, 480 g ai/L); APRON MAXX RFC (fludioxonil, 2.31% + metalaxyl-M and S-isomer, 3.46%); DYNASTY 100 FS (azoxystrobin, 100 g ai/L).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. The seed weights of HS24R45 and RR Razor were 172.0 and 207.0 g/1000 seeds, respectively. Trials were planted on 17 April and 9 May 2008 on clay loam soil following a corn, soybean, spring wheat rotation at Ridgetown, ON, at a seeding rate of 20 seeds per metre using a 4 row John Deere Max Emerge planter outfitted with Almaco cone type seed delivery units. Plots were 4 rows, spaced 0.76 m apart and 10 m in length, placed in a randomized complete block design with 4 replications. The plots were fertilized and maintained according to provincial recommendations.

Plant population was assessed by counting all emerged plants within the two centre rows of each plot. Following a frost event in the first planted trial, the number of plants displaying frost injury symptoms in the centre two rows of each plot was recorded. Plant vigour was evaluated on each whole plot; vigour was assessed using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Five plants per plot were destructively sampled at the V2 or V3 stage in the early and late planted trials, respectively; beginning 2 m into the plot and digging up every 5th plant. Destructively sampled plants were measured for above ground height and rated for *Rhizoctonia solani* root damage using a 1-7 rating scale (1 = no lesions, 2 = slight lesions, 3 = <1.0 cm lesion not encircling stem, 4 = < 1.0 cm lesion encircling stem, 5 = > 1.0 cm lesion encircling stem, 6 = severely girdled stem, 7 = dead plant) if symptoms were present. Root scanning was performed on the exhumed plants at Syngenta Crop Protection's Honeywood Research farm. Plants were washed, placed in a tray of water, scanned, and the root image analyzed using WinRHIZO Pro 2005b to measure root length, surface area, diameter, and volume. The number of root tips, forks, and crossing were also counted during analysis. The interior two rows of each plot were harvested with a modified New Holland TR-89 combine to obtain yield and

test weight measurements and all yields were corrected to 14.5% moisture. The dates and plant stages at sampling are reported in the data tables below.

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with blocks as a random source of variance. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and studentized residuals were calculated to test for outliers. If the assumptions of ANOVA were not met, the data was transformed using a $\log_{10}(x+1)$ transformation and statistics were reported from transformed data; means reported were transformed back to the original scale. The α level for statistical significance was set at 0.05 for all analyses. From the trial planted on 9 May, the 10th plot from each block was removed from all analyses due to herbicide drift injury.

OBSERVATIONS: The early planted trial was subjected to a frost event on 30 April and both trials experienced hail injury on 18 May. Neither soybean aphids nor bean leaf beetles, the two main soybean insect pests in south-western Ontario, were found to infest these trials.

RESULTS: In the trial planted on 17 April, no significant differences were measure in plant population during the early vegetative stages or in the number of injured plants following a frost event on 30 April (Table 1). At emergence, vigour was significantly higher in plots treated with APRON MAXX RFC + DYNASTY 100 FS alone than the untreated check (Table 2). At the VC stage, plots treated with APRON MAXX RFC + DYNASTY 100 FS alone appeared more vigourous than those treated with APRON MAXX RFC + DYNASTY 100 FS + GAUCHO 480 FS (125.0 g ai/100 kg seed) (Table 2). No differences in vigour were observed among treatments when assessed at the V1 or V2 stage (Table 2).

In the trial planted on 9 May, plant stands at emergence were greater in plots treated with the high rate of GAUCHO 480 FS (125.0 g ai/100 kg seed) in combination with APRON MAXX RFC + DYNASTY 100 FS than in plots treated with either rate of CRUISER 5 FS alone or APRON MAXX RFC + DYNASTY 100 FS alone; no other differences existed among treatments (Table 3). At the first assessment at the VC stage, the high rate of GAUCHO 480 FS (125.0 g ai/100 kg seed) in combination with APRON MAXX RFC and DYNASTY 100 FS had higher plant populations than the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) alone (Table 3). A week later, while plants were still at the VC stage, plots treated with the high rate of GAUCHO 480 FS (125.0 g ai/100 kg seed) in combination with APRON MAXX RFC + DYNASTY 100 FS had greater stands than the untreated plots, all plots treated with insecticide alone, excluding the low rate of GAUCHO 480 FS (62.5 g ai/100 kg seed), and plots treated with fungicide alone (Table 3). By the V1 stage, no differences in plant population were observed (Table 3).

Plant vigour did not differ among treatments planted on 9 May, except at the second VC assessment, where vigour appeared to be higher in GAUCHO 480 FS treated plots in combination with APRON MAXX RFC and DYNASTY 100 FS than in both the untreated check and the high rate of CRUISER alone (50.0 g ai/100 kg seed) (Table 3).

Following destructive sampling of V2 stage plants from the trial planted on 17 April, plant height did not differ among treatments other than plants treated with the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) alone were taller than those treated with the low rate of GAUCHO 480 FS (62.5 g ai/100 kg seed) alone (Table 4). No differences existed in plant height among treatments in the trial planted on 9 May when measured at the V3 stage (Table 4).

Rhizoctonia infection symptoms were observed in the trial planted on 19 April and injury ratings indicated that the addition of the fungicide treatment resulted in lower infection symptoms in plots treated with the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) (Table 4). *Rhizoctonia* infection was not observed in the later planted trial; therefore roots were not rated for injury.

Root scanning analysis of plants from the early planted trial did not reveal any differences in

total root length, root surface area, root diameter, root volume, or number of root crossings among treatments (Table 5). In this trial, plants treated with the combination of APRON MAXX RFC and DYNASTY 100 FS and GAUCHO 480 FS (125.0 g ai/100 kg seed) had more root tips than plants treated with GAUCHO 480 FS alone at this rate and more root forks than both rates of GAUCHO 480 FS alone or the untreated check (Table 5).

In the trial planted on 9 May, the total length and surface area of roots treated with the high rate of GAUCHO 480 FS (125.0 g ai/100 kg seed) alone was greater than plants treated with the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) alone and plots treated with APRON MAXX RFC + DYNASTY 100 FS + GAUCHO 480 FS (125.0 g ai/100 kg seed); the surface area of plots treated with APRON MAXX RFC + DYNASTY 100 FS + CRUISER 5 FS (30.0 g ai/100 kg seed) was also greater than these (Table 6). Root diameter did not differ among treatments (Table 6). Root volume was greater in plots treated with the low rate of CRUISER (30 g ai/100 kg seed) in combination with APRON MAXX RFC and DYNASTY 100 FS than with either rate of CRUISER 5 FS alone, the fungicide treatment alone, or with the high rate of GAUCHO 480 FS (125.0 g ai) in combination with APRON MAXX RFC and DYNASTY 100 FS (Table 6). Plants treated with GAUCHO 480 FS (125.0 g ai/100 kg seed), fungicide alone, or GAUCHO 480 FS (62.5 g ai/100 kg seed) + fungicide had more root tips than GAUCHO 480 FS (125.0 g ai/100 kg seed) + fungicide (Table 6). The number of root forks in plots treated with CRUISER 5 FS (50.0 g ai/100 kg seed) and GAUCHO 480 FS (125.0 g ai/100 kg seed) + fungicide was lower than those of plots treated with the low rate of CRUISER 5 FS (30.0 g ai/100 kg seed), high rate of GAUCHO 480 FS (125.0 g ai/100 kg seed) CRUISER 5 FS (30.0 g ai/100 kg seed) + fungicides and GAUCHO 480 FS (62.5 g ai/100 kg seed) + fungicide (Table 6). The number of root crossings in plots treated with the high rate of GAUCHO 480 FS (125 g ai/100 kg seed) was significantly greater than the high rate treatment of CRUISER 5 FS (50.0 g ai/100 kg seed), or than the high rate of GAUCHO 480 FS in combination with the fungicide treatments (Table 6).

No differences were measured in yield or seed moisture in either trial (Table 7).

CONCLUSIONS: The intention of planting a soybean trial 17 April in south-western Ontario was to evaluate the effects of insecticide and fungicide seed treatments under stressful conditions, but in the absence of severe pest incidence. Although this trial experienced both frost and hail, no treatment significantly mitigated the effects of these damaging events; plant stands in all treatments were similarly decimated. At emergence, plots treated with fungicide only appeared more vigourous than untreated plots, and at the VC stage, fungicide only treated plots appeared more vigourous than those treated with a combination of fungicide and GAUCHO 480 FS (125.0 g ai/100 kg seed); otherwise no differences in vigour were observed among treatments. Plant growth did not differ among treatments at the V2 stage; no differences were measured in root biomass and no differences were measured in above ground plant height except among insecticide only treated plots, those with CRUISER 5 FS at the high rate (50.0 g ai/100 kg seed) were taller than those treated with the low rate of GAUCHO 480 FS (62.5 g ai/100 kg seed). Infection by soil pathogens is a common risk to early planted soybeans at this location; the addition of fungicide treatments to the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) appeared to result in decreased *Rhizoctonia* infection and possibly more root proliferation on GAUCHO treated plants.

The second trial was planted on a typical planting date in south-western Ontario, but experienced a cool, wet spring. At emergence, plant densities treated with fungicide + GAUCHO 480 FS (125.0 g ai/100 kg seed) were higher than in fungicide only or CRUISER 5 FS only (either rate) treated plots, and higher than untreated, CRUISER 5 FS only (either rate), low rate of GAUCHO 480 FS only, and fungicide only at the VC stage. Fungicide + GAUCHO 480 FS (125.0 g ai/100 kg seed) plots appeared more vigourous than untreated and high rate CRUISER 5 FS plots at the VC stage, but by the V1 stage no differences were found among treatments in plant stand or vigour. At the V3 stage, no differences in above ground plant height were found. The combination of fungicide + GAUCHO 480 FS

(125.0 g ai/100 kg seed) and the high rate of CRUISER 5 FS (50.0 g ai/100 kg seed) alone tended to have decreased root growth in comparison to other treatments.

These trials experienced multiple environmental stresses by being planted under cool, wet conditions and encountering both frost and hail events. Some visible differences were observed in the early stages of these trials, but it is difficult to attribute any health effects to the treatments as our analyses did not show measurable differences in most cases. These trials were not subjected to any significant insect stresses and no yield benefits were achieved, suggesting that the use of these seed treatments was not warranted in these trials.

Table 1. Mean plant population and frost injury to soybeans planted on 17 April with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/ 100 kg seed)	Mean plant population (# plants/m^2)					Mean no. frost injured plants/m^2
Sampling date (Crop stage)		29 Apr (VE)	7 May (VE)	15 May (VC)	26 May (V1)	3 June (V2)	2 May (VE)
Untreated	---	12.2 a[1]	9.3 a	7.7 a	5.4 a	5.2 a	7.7 a
CRUISER 5 FS	30.0	11.5 a	11.1 a	8.4 a	5.1 a	5.6 a	6.1 a
CRUISER 5 FS	50.0	11.3 a	12.2 a	8.6 a	5.5 a	5.5 a	5.5 a
GAUCHO 480 FS	62.5	11.0 a	11.6 a	8.2 a	5.9 a	5.1 a	5.0 a
GAUCHO 480 FS	125.0	9.9 a	12.8 a	10.1 a	6.1 a	6.0 a	4.4 a
APRON MAXX RFC +DYNASTY 100 FS	6.25 1.0	12.3 a	12.9 a	10.7 a	7.5 a	7.5 a	5.5 a
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 30.0	10.1 a	12.9 a	11.2 a	7.4 a	7.2 a	4.6 a
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 50.0	10.7 a	11.8 a	8.6 a	6.4 a	6.0 a	5.2 a
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 62.5	11.1 a	11.8 a	7.0 a	5.1 a	5.3 a	5.3 a
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 125.0	11.2 a	11.6 a	7.4 a	5.4 a	5.4 a	4.6 a
CV (proc glm)		17.9	13.1	24.8	29.4	28.9	30.3
se		1.123	1.022	1.798	1.412	1.302	0.847
Pr > F		0.780	0.086	0.142	0.481	0.486	0.257

[1] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

Table 2. Mean plant vigour of soybeans planted on 17 April with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/ 100 kg seed)	Mean plant vigour (0-100%)[1]			
Sampling date (Crop stage)		7 May (VE)	15 May (VC)	26 May (V1)	3 June (V2)
Untreated	---	77.5 b	81.3 ab	83.8 a	82.5 a
CRUISER 5 FS	30.0	82.5 ab	82.5 ab	72.5 a	80.0 a
CRUISER 5 FS	50.0	90.0 ab	85.0 ab	80.0 a	85.0 a
GAUCHO 480 FS	62.5	82.5 ab	80.0 ab	78.8 a	81.3 a
GAUCHO 480 FS	125.0	87.5 ab	91.3 ab	80.0 a	85.0 a
APRON MAXX RFC	6.25	93.8 a	92.5 a	90.0 a	91.3 a
+DYNASTY 100 FS	1.0				
APRON MAXX RFC	6.25	80.0 ab	90.0 ab	91.3 a	91.3 a
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	30.0				
APRON MAXX RFC	6.25	83.8 ab	77.5 ab	81.3 a	87.5 a
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	50.0				
APRON MAXX RFC	6.25	88.8 ab	78.8 ab	76.3 a	83.8 a
+DYNASTY 100 FS	1.0				
+GAUCHO 480 FS	62.5				
APRON MAXX RFC	6.25	88.8 ab	73.8 b	80.0 a	85.0 a
+DYNASTY 100 FS	1.0				
+GAUCHO 480 FS	125.0				
CV (proc glm)		7.6	9.3	13.1	9.5
se		3.565	4.133	6.137	4.158
Pr > F		0.036	0.023	0.358	0.555

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 3. Mean plant population and vigour of soybeans planted on 9 May with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m^2)				Mean plant vigour (0-100%)[1]		
Sampling date (Crop stage)		26 May (VE)	30 May (VC)	2 June (VC)	6 June (V1)	30 May (VC)	2 June (VC)	6 June (V1)
Untreated	---	0.5 ab[2]	3.7 ab	9.6 b	11.6 a	87.5 a	80.0 b	90.0 a
CRUISER 5 FS	30.0	0.4 b	3.2 ab	9.0 b	11.8 a	85.0 a	83.8 ab	91.3 a
CRUISER 5 FS	50.0	0.3 b	2.8 b	9.4 b	10.2 a	80.0 a	80.0 b	83.8 a
GAUCHO 480 FS	62.5	0.8 ab	4.5 ab	10.9 ab	10.8 a	88.8 a	87.5 ab	87.5 a
GAUCHO 480 FS	125.0	0.5 ab	3.4 ab	9.0 b	10.2 a	83.8 a	83.8 ab	85.0 a
APRON MAXX RFC +DYNASTY 100 FS	6.25 1.0	0.3 b	3.0 ab	9.1 b	12.1 a	78.8 a	82.5 ab	88.8 a
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 30.0	0.9 ab	4.8 ab	10.7 ab	11.0 a	90.0 a	88.8 ab	92.5 a
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 50.0	0.6 ab	3.9 ab	10.2 ab	10.0 a	87.5 a	88.8 ab	86.3 a
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 62.5	0.6 ab	4.3 ab	11.2 ab	12.9 a	92.5 a	90.0 ab	92.5 a
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 125.0	1.0 a	5.6 a	12.8 a	12.7 a	91.3 a	96.3 a	90.0 a
CV (proc glm)		44.8	29.1	11.2	15.3	9.7	7.6	8.1
se		0.140	0.555	0.582	1.002	4.031	3.346	3.708
Pr > F		0.005	0.035	0.001	0.193	0.283	0.039	0.683

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 4. Mean plant height and *Rhizoctonia solani* damage assessed on 5 plants per plot treated with seed insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean plant height (cm)		Mean *R. solani* damage rating (1-7)[1]
Sampling date (Stage)		1st planting 10 June (V2)	2nd planting 25 June (V3)	1st planting 10 June (V2)
Untreated	---	7.8 ab[2]	25.4 a	2.9 ab
CRUISER 5 FS	30.0	8.5 ab	24.4 a	2.7 ab
CRUISER 5 FS	50.0	8.8 a	20.0 a	3.3 b
GAUCHO 480 FS	62.5	6.9 b	19.2 a	3.1 ab
GAUCHO 480 FS	125.0	7.7 ab	22.3 a	3.2 ab
APRON MAXX RFC +DYNASTY 100 FS	6.25 1.0	8.1 ab	21.3 a	1.7 ab
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 30.0	7.3 ab	25.7 a	2.2 ab
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 50.0	7.1 ab	25.3 a	1.7 a
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 62.5	7.1 ab	22.9 a	1.8 ab
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 125.0	8.2 ab	17.3 a	2.0 ab
CV (proc glm)		9.7	22.8	26.9
se		0.368	3.505	0.359
Pr > F		0.015	0.513	0.003

[1] 1 = no lesions, 2 = slight lesions, 3 = <1.0 cm lesion not encircling stem, 4 = < 1.0 cm lesion encircling stem, 5 = > 1.0 cm lesion encircling stem, 6 = severely girdled stem, 7 = dead plant.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 5. Results of root scanning analysis of five soybean roots per plot with insecticide and fungicide seed treatments planted on 17 April at Ridgetown, Ontario in 2008. Plants were sampled on 10 June at the V2 stage.

Treatment	Rate (g ai/100 kg seed)	Mean root length[1] (cm)	Mean surface area[1] (cm^2)	Mean root dia-meter[1] (mm)	Mean root volume[1] (cm^3)	Mean no. root tips	Mean no. root forks[1]	Mean no. root cross-ings[1]
Untreated	---	46.9 a[2]	15.2 a	1.07 a	0.40 a	82.5 ab	97.1 b	6.8 a
CRUISER 5 FS	30.0	66.9 a	19.9 a	1.00 a	0.48 a	114.3 ab	180.5 ab	13.7 a
CRUISER 5 FS	50.0	49.0 a	16.8 a	1.17 a	0.48 a	89.4 ab	103.0 ab	7.5 a
GAUCHO 480 FS	62.5	49.5 a	14.6 a	1.00 a	0.35 a	87.2 ab	97.1 b	8.8 a
GAUCHO 480 FS	125.0	49.5 a	15.1 a	1.01 a	0.38 a	70.3 b	98.6 b	9.0 a
APRON MAXX RFC	6.25	56.4 a	18.1 a	1.07 a	0.47 a	87.3 ab	115.3 ab	8.7 a
+DYNASTY 100 FS	1.0							
APRON MAXX RFC	6.25	52.5 a	16.4 a	1.05 a	0.42 a	85.1 ab	106.5 ab	9.5 a
+DYNASTY 100 FS	1.0							
+CRUISER 5 FS	30.0							
APRON MAXX RFC	6.25	61.0 a	17.9 a	0.97 a	0.43 a	103.3 ab	136.7 ab	12.7 a
+DYNASTY 100 FS	1.0							
+CRUISER 5 FS	50.0							
APRON MAXX RFC	6.25	47.3 a	15.3 a	1.14 a	0.42 a	79.2 ab	104.2 ab	11.4 a
+DYNASTY 100 FS	1.0							
+GAUCHO 480 FS	62.5							
APRON MAXX RFC	6.25	64.2 a	19.5 a	1.00 a	0.48 a	119.4 a	155.3 a	12.3 a
+DYNASTY 100 FS	1.0							
+GAUCHO 480 FS	125.0							
CV (proc glm)		12.0	12.9	14.0	31.0	10.1	12.8	37.5
se		0.047	0.035	0.012	0.011	0.048	0.057	0.078
Pr > F		0.182	0.177	0.082	0.100	0.007	0.015	0.092

[1] Data were transformed using $\log_{10}$ (x+1) transformation; statistical results are reported from transformed data, reported means have been transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 6. Results of root scanning analysis of five soybean roots per plot with insecticide and fungicide seed treatments planted on 9 May at Ridgetown, Ontario in 2008. Plants were sampled on 25 June at the V3 stage.

Treatment	Rate (g ai/100 kg seed)	Mean total length[1] (cm)	Mean surface area (cm^2)	Mean root dia-meter[1] (mm)	Mean root volume (cm^3)	Mean no. root tips[1]	Mean no. root forks	Mean no. root cross-ings[1]
Untreated	---	65.0 ab	24.5 ab	1.29 a	0.77 ab	194.3 ab	221.4 ab	13.0 ab
CRUISER 5 FS	30.0	62.7 ab	24.0 ab	1.34 a	0.76 ab	282.0 ab	235.8 a	12.2 ab
CRUISER 5 FS	50.0	48.0 b	19.0 b	1.49 a	0.66 b	290.0 ab	158.1 b	8.0 b
GAUCHO 480 FS	62.5	59.3 ab	20.1 ab	1.24 a	0.60 b	229.8 ab	216.4 ab	14.6 ab
GAUCHO 480 FS	125.0	80.4 a	28.3 a	1.20 a	0.82 ab	317.0 a	309.1 a	22.4 a
APRON MAXX RFC +DYNASTY 100 FS	6.25 1.0	62.1 ab	22.2 ab	1.40 a	0.69 b	414.6 a	220.2 ab	12.2 ab
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 30.0	67.9 ab	28.0 a	1.37 a	0.94 a	270.9 ab	245.5 a	10.2 ab
APRON MAXX RFC +DYNASTY 100 FS +CRUISER 5 FS	6.25 1.0 50.0	57.6 ab	22.7 ab	1.30 a	0.74 ab	215.4 ab	201.3 ab	11.0 ab
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 62.5	62.2 ab	23.9 ab	1.32 a	0.77 ab	328.3 a	224.0 a	12.5 ab
APRON MAXX RFC +DYNASTY 100 FS +GAUCHO 480 FS	6.25 1.0 125.0	47.4 b	18.6 b	1.49 a	0.62 b	212.8 b	164.6 b	9.4 b
CV (proc glm)		11.6	30.3	17.1	29.8	11.3	10.5	36.2
se		0.080	2.600	0.021	0.058	0.133	0.108	0.131
Pr > F		0.002	0.0001	0.298	0.001	0.001	<0.0001	0.005

[1] Data were transformed using $\log_{10}$ (x+1) transformation; statistical results are reported from transformed data, reported means have been transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 7. Mean moisture and yield of soybeans with seed applied insecticides and fungicides at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/100 kg seed)	Mean seed moisture (%)		Mean yield (T/ha)	
Sampling date (Stage)		1st planting 20 Oct (R6)	2nd planting 17 Oct (R6)	1st planting 20 Oct (R6)	2nd planting 17 Oct (R6)
Untreated	---	10.3 a[1]	11.8 a	2.3 a	3.0 a
CRUISER 5 FS	30.0	10.5 a	11.8 a	2.5 a	2.7 a
CRUISER 5 FS	50.0	10.3 a	11.8 a	2.6 a	2.6 a
GAUCHO 480 FS	62.5	10.3 a	11.9 a	2.4 a	2.7 a
GAUCHO 480 FS	125.0	10.4 a	11.8 a	2.7 a	2.6 a
APRON MAXX RFC	6.25	10.5 a	11.7 a	3.0 a	2.9 a
+DYNASTY 100 FS	1.0				
APRON MAXX RFC	6.25	10.5 a	11.6 a	2.7 a	3.0 a
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	30.0				
APRON MAXX RFC	6.25	10.4 a	11.9 a	2.8 a	2.9 a
+DYNASTY 100 FS	1.0				
+CRUISER 5 FS	50.0				
APRON MAXX RFC	6.25	10.3 a	11.7 a	2.7 a	2.8 a
+DYNASTY 100 FS	1.0				
+GAUCHO 480 FS	62.5				
APRON MAXX RFC	6.25	10.4 a	11.8 a	2.8 a	3.0 a
+DYNASTY 100 FS	1.0				
+GAUCHO 480 FS	125.0				
CV (proc glm)		1.3	2.2	12.6	7.3
se		0.068	0.131	0.210	0.131
Pr > F		0.047	0.774	0.265	0.109

[1] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.

2008 PMR REPORT # 25 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS – Insect Pests**

CROP: Spring wheat *Triticum aestivum* (L.), cv. Norwell.
PEST: European Chafer *Rhizotrogus majalis* (Razoumowsky).

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TITLE: EVALUATION OF CRUISER 5 FS FOR CONTROL OF EUROPEAN CHAFER IN SPRING WHEAT

MATERIALS: DIVIDEND XL RTA (difenoconazole, 3.37 % + metalaxyl-M and S-isomer, 0.27 %); CRUISER 5 FS (thiamethoxam, 47.6 %).

METHODS: Seed was treated in 500 g lots in individual plastic bags by applying a slurry of the material via syringe to each bag. The bag was inflated, and the seed was mixed for 1 min to ensure thorough seed coverage. The seed weight of Norwell was 30.6 g/1000 seeds. The trials were planted on 29 April and 1 May 2008 on sandy loam soil at two different locations at Ridgetown, ON, with a Wintersteiger cone type seed drill at a seeding rate of 86 seeds per metre metre row. Plots were 6 rows, spaced 0.18 m apart and 4 m in length, placed in a randomized complete block design with six replications. Following planting, two galvanized steel square enclosures (30 cm^2) were placed in each plot over two rows to a depth of 25 cm. On 30 April and 2 May, each enclosure was infested with either four or six third instar European chafer larvae collected from naturally infested turfgrass at the University of Guelph, Ridgetown campus. Larvae were placed in a trench approximately 12 cm deep between the two rows. Plots were fertilized and maintained according to provincial recommendations.

Plant populations were recorded by counting all plants within each enclosure. Vigour was assessed on plants within the enclosure using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Plants within the enclosures were destructively sampled at Z22 stage to evaluate insect feeding damage using a rating scale of 1-4 (1 = no damage, 2 = some damage on seedling root, 3 = seedling emerged but feeding evident, and 4 = damaged and rotted seedling). The soil surrounding the seedlings was sifted through at the time of destructive sampling to exhume, identify, and count all soil inhabiting pests. All plants were weighed following sampling to measure fresh weight. Sampling dates and the Zadok's stage at sampling are given in the tables below (Tottman, D.R. et al. 1979).

Data were analysed by analysis of variance in SAS v. 9.1 (SAS Institute, Cary, NC) using PROC MIXED with location and blocks as random variables. Tukey's HSD test was used for multiple treatment comparisons. To ensure that assumptions of ANOVA were met, PROC UNIVARIATE was used to test residuals. The Shapiro-Wilk statistic was used to test residuals for normal distribution and

studentized residuals were calculated to test for outliers. To analyze the data of percentage of plants per damage category, the arc sine square root transformation was used. The α level for statistical significance was set at 0.05 for all analyses.

RESULTS: No differences were measured in plant population among treatments infested with four larvae in this trial (Table 1). When enclosures were infested with six larvae, plant stand was significantly lower in untreated plots by the third assessment date; stand was not different between rates of CRUISER (Table 1). The vigour rating was significantly higher in enclosures infested with four larvae when treated with the high rate of CRUISER (50.0 g ai/ha) on the second and third assessments (Table 1). With six larvae, both rates of CRUISER were significantly more vigourous on the third assessment date (Table 1).

No differences were found in the percentage of plants per damage category in any plot, but with both four and six larvae per enclosure, plots treated with either rate of CRUISER had a significantly lower mean damage rating when destructively sampled (Table 2). No differences occurred in fresh weight per plant among treatments with four or six larvae (Table 2).

CONCLUSIONS: European chafer feeding damage was reduced in plots treated with either rate of CRUISER. The treatment effect was most obvious when enclosures were infested with six larvae rather than four in that plant stand was protected, plants appeared more vigourous, and the mean fresh weight per plant tended to be higher than in untreated enclosures. No consistent differences were measured between rates of CRUISER.

REFERENCE:

Tottman, D.R., R. J. Makepeace and H. Broad. 1979. An explanation of the decimal code for growth stages of cereals, with illustrations. *Annals of Applied Biology*. 93: 221-234.

Table 1. Mean plant population and vigour of spring wheat contained within 30 cm^2 enclosures infested with four or six European chafer larvae at two locations at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai / ha)	Mean plant population (# plants/enclosure)			Mean plant vigour (0-100%)[1]		
Infested with 4 larvae		15 May (Z12)	23 May (Z13)	30 May (Z21)	15 May (Z12)	23 May (Z13)	30 May (Z21)
DIVIDEND XL RTA	13.0	29.0 a[2]	24.3 a	21.2 a	90.4 a	86.7 b	78.3 b
DIVIDEND XL RTA + CRUISER 5 FS	13.0 30.0	27.9 a	26.4 a	24.8 a	92.9 a	91.3 b	90.4 ab
DIVIDEND XL RTA + CRUISER 5 FS	13.0 50.0	29.8 a	28.1 a	26.1 a	96.3 a	98.3 a	96.3 a
CV (proc glm)		30.7	34.1	34.5	6.5	6.2	16.3
se		2.416	3.588	4.440	1.706	2.477	4.218
Pr>F		0.855	0.552	0.307	0.074	0.0002	0.020
Infested with 6 larvae							
DIVIDEND XL RTA	13.0	28.3 a	22.4 a	14.5 b	93.8 a	86.3 a	81.7 b
DIVIDEND XL RTA + CRUISER 5 FS	13.0 30.0	31.3 a	28.7 a	26.3 a	92.9 a	92.1 a	91.7 a
DIVIDEND XL RTA + CRUISER 5 FS	13.0 50.0	28.3 a	27.9 a	24.9 a	92.1 a	93.8 a	95.0 a
CV (proc glm)		33.1	39.8	41.7	7.9	10.9	13.3
se		2.983	3.064	4.370	2.102	2.686	3.931
Pr>F		0.687	0.300	0.006	0.851	0.139	0.030

[1] 0 = plants dead in plot and 100 = furthest developed plants in the trial.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

Table 2. Damage ratings and fresh weight of spring wheat destructively sampled from within 30cm^2 enclosures infested with four or six European chafer larvae at two locations at Ridgetown, Ontario in 2008.

Treatment	Rate (g ai/ha)	Mean percentage of plants per damage category[1]				Mean damage rating[1]	Mean fresh weight per plant (g)
Infested with 4 larvae		1	2	3	4		
DIVIDEND XL RTA	13.0	73.1 a[2]	19.2 a	5.2 a	3.0 a	1.39 b	2.14 a
DIVIDEND XL RTA + CRUISER 5 FS	13.0 30.0	81.4 a	14.7 a	3.2 a	1.2 a	1.25 a	2.33 a
DIVIDEND XL RTA + CRUISER 5 FS	13.0 50.0	83.0 a	14.9 a	1.2 a	0.5 a	1.20 a	2.43 a
CV (proc glm)		16.1	50.0	142.4	169.6	15.9	25.7
se		0.070	0.076	0.050	0.051	0.060	0.158
Pr>F		0.089	0.692	0.288	0.142	0.028	0.371
Infested with 6 larvae							
DIVIDEND XL RTA	13.0	67.6 a[3]	23.1 a	1.8 a	4.5 a	1.45 b[3]	1.58 a
DIVIDEND XL RTA + CRUISER 5 FS	13.0 30.0	77.1 a	20.4 a	2.3 a	0.3 a	1.26 a	2.03 a
DIVIDEND XL RTA + CRUISER 5 FS	13.0 50.0	76.3 a	21.2 a	0.4 a	1.8 a	1.27 a	2.56 a
CV (proc glm)		16.2	43.8	174.6	172.5	13.6	85.7
se		0.060	0.087	0.040	0.065	0.061	0.473
Pr>F		0.090	0.990	0.196	0.110	0.008	0.351

[1] 1 = no damage, 2 = some damage on seedling root, 3 = seedling emerged but feeding evident, and 4 = damaged and rotted seedling. Analyses derived from data using arcsine square root transformation; means reported are transformed back to the original scale.

[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Tukey's HSD test.

[3] An outlier removed from analysis (block 6).

2008 PMR REPORT #26 **SECTION E: CEREALS, FORAGE CROPS and OILSEEDS - Insect Pests**

CROP: Spring wheat, *Triticum aestivum* L.
PEST: Wheat midge, *Sitodiplosis mosellana* (Géhin)

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TITLE: **WHEAT MIDGE DAMAGE TO FIVE SPRING WHEAT CULTIVARS AT VARIOUS SITES IN SASKATCHEWAN, 2008**

MATERIALS: Spring wheat cultivars AC BARRIE, 5602HR, GOODEVE VB, UNITY VB, WASKADA

METHODS: Five spring wheat cultivars were sown in plots on separate dates from May 5 to May 23 in 2008 at Kernen, Melfort, Outlook, Scott, Swift Current and Watrous, Saskatchewan. Plots ranged in size from 2.76 m^2 to 6 m^2 and were replicated three times in randomized block design. GOODEVE VB and UNITY VB are new varietal blends that have AC Intrepid and WASKADA, respectively, as 10% susceptible refuges. The 90% resistant seed component in these varietal blends contains the *Sm1* R-gene that confers resistance to the wheat midge. AC BARRIE is a widely grown cultivar with known high susceptibility to the wheat midge. WASKADA and 5602HR are recently released cultivars with levels of susceptibility that have not been quantified. Ten wheat spikes were randomly collected in each plot just before harvest. The seeds in each spike were counted and assessed individually for damage by the wheat midge. Seeds damaged by the midge were categorized as being either harvestable or not harvestable based on their weight. Previous studies have determined that damaged seed with weights below 7 mg are not retained in the grain when harvested by conventional machines. The harvestable undamaged and damaged seeds from the ten spikes in each plot were pooled and weighed. Yield losses (%) were calculated from the number of damaged seeds lost during harvest and the equivalent number of seeds lost based on the weight difference between damaged and undamaged seed in the grain. Seed damage (%) was measured as the percentage of damaged seed for all seed, and the grain damage (%) is the percentage of damaged seed in the grain. All data at each site were analyzed by Least Square Differences (P=0.05), which is the standard method to determine differences between cultivars.

RESULTS: As outlined in Tables 1 to 3.

CONCLUSIONS: Seed damage by the wheat midge to AC BARRIE was much higher at Watrous and Kernen than at the other four sites (Table 1). GOODEVE VB and UNITY VB both had significantly less seed damage and seed losses by the wheat midge at all sites than AC BARRIE (Table 1 and 3). WASKADA and 5602HR also had significantly lower seed damage and seed losses than AC BARRIE, except at Scott. Yield losses were higher at all sites for WASKADA and 5602HR than for one or both varietal blends, but results were significant only at Outlook or Watrous. Damaged seed in the grain will result in grade losses by the Canadian Grain Commission if levels exceed 2%, as determined by a visual bulk grain inspection, or 3.2% of all seeds, as determined in previous experiments from individual seed evaluation. AC BARRIE harvested at Watrous, Kernen, and Swift Current suffered grade losses, while GOODEVE VB, UNITY VB, and 5602HR grain had grade losses only at Watrous (Table 2). While GOODEVE VB and UNITY VB suffered the least amount of damage, they were most effective, compared to the other cultivars, when deployed at sites with high midge infestations. WASKADA and 5602HR also effectively reduced seed damage at all sites, but when midge infestations were high both cultivars did not reduce damage levels to below those necessary to prevent grade losses.

Table 1. Seed damage (%) by the wheat midge to five spring wheat cultivars at six sites in Saskatchewan, 2008

Cultivar	Kernen	Melfort	Outlook	Scott	Swift Current	Watrous	Mean
AC Barrie	28.9	2.8	6.9	5.0	6.7	43.1	15.6
5602HR	6.2	0.9	1.6	3.0	1.1	20.4	5.5
Goodeve VB	3.8	0.9	1.9	1.8	0.7	12.6	3.6
Unity VB	2.6	0.2	0.8	0.8	0.3	7.2	2.0
Waskada	8.9	0.5	3.3	3.0	0.1	11.2	4.5
LSD (P=0.05)	7.8	0.9	1.9	2.7	2.9	5.3	7.0

Table 2. Damaged seed (%) by the wheat midge in harvestable grain of five spring cultivars at six sites in Saskatchewan, 2008

Cultivar	Kernen	Melfort	Outlook	Scott	Swift Current	Watrous	Mean
AC Barrie	14.6	1.0	2.0	1.3	4.1	18.0	6.8
5602HR	2.6	0.3	0.1	0.8	0.5	5.2	1.6
Goodeve VB	2.5	0.5	1.6	1.3	0.3	9.2	2.6
Unity VB	2.2	0.2	0.7	0.6	0.3	6.4	1.7
Waskada	4.5	0	1.1	1.0	0.1	4.8	1.9
LSD (*P*=0.05)	5.0	0.6	1.0	1.5	0.8	6.1	3.1

Table 3. Yield losses (%) by the wheat midge to five spring wheat cultivars at six sites in Saskatchewan, 2008

Cultivar	Kernen	Melfort	Outlook	Scott	Swift Current	Watrous	Mean
AC Barrie	22.6	2.2	5.8	4.5	6.7	37.1	13.2
5602HR	5.0	0.8	1.1	2.5	1.1	18.2	4.8
Goodeve VB	2.2	0.7	1.1	0.9	0.7	7.9	2.3
Unity VB	1.3	0.1	0.2	0.5	0.3	3.8	1.0
Waskada	6.6	0.5	2.8	2.7	0.1	9.1	3.6
LSD (*P*=0.05)	5.9	0.9	1.7	2.3	2.6	3.0	6.2

2008 PMR REPORT # 27 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-T.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. Silken
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers)

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TITLE: **PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'SILKEN' APPLES, 2007-08**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil, and MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Silken' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*)and gray mold (*B. cinerea*) in wounded 'Silken' apples. Fruit were harvested on 05 September, 2007 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 07 September, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 10 September, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments, the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 170 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 ˚C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold incidence (Table 1) and gray mold incidence in 'Silken' apples (Table 2). Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of blue mold and gray mold for 170 days in cold storage and in the shelf-life study. As expected, MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium or Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Silken' apples, 2007-08.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						170 Days + Shelf-life at 7 Days
	29 Days	56 Days	84 Days	112 Days	142 Days	170 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	11.1 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	11.1 b	25.0 c
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench [1]	0.0 a	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
P. expansum 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
P. expansum 1 x 10^5 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	0.0 a	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Silken' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						170 Days + Shelf-life at 7 Days
	29 Days	56 Days	84 Days	112 Days	142 Days	170 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	0.0 a	0.0 a	0.0 a	2.8 a	19.4 b
Control 2 - wound and no inoculum	0.0 a	2.8 b	2.8 b	2.8 b	2.8 b	5.6 b	38.9 c
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench[1]	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
B. cinerea 1 x 10^4 conidia/ml	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
B. cinerea 1 x 10^5 conidia/ml	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g /L	0.00 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.00 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.00

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT# 28 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. Gala
PEST: Blue mold (*Penicillium expansum* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF BLUE MOLD WITH POSTHARVEST FUNGICIDES IN 'GALA' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Gala' apple fruit were harvested on September 11 2007 and treated on 13 and 14 of September, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. In each of the main treatments, 5 fungicide subtreatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control

without fungicide treatment were included. For the main treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *P. expansum* isolate PS-1R at a concentration of 1×10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Gala' apples were incubated in cold storage for up to 168 days. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for blue mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest blue mold incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments for up to 168 days. As expected, MERTECT was not effective against TBZ-resistant isolates of *Penicillium*. In the case of BIOSAVE, a higher disease incidence was observed in the fruit that was co-inoculated and then treated with or without 1-MCP than fruit treated with 1-MCP and then cotreated with fungicides. The results show that the timing of 1-MCP may have an effect on the control of postharvest diseases with BioSave. The results show that 1-MCP and CA storage conditions had neither a positive nor negative effect on the control of postharvest diseases of 'Gala' apples treated with SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L or VANGARD @ 0.8 g/L for up to 168 days, and in the subsequent shelf-life.

Table 1. Effect of 1-MCP on the control of postharvest blue mold (*Penicillium expansum)* with fungicides in 'Gala' apples, 2007-08.

Treatment	% Blue mold incidence in cold storage at 0.5 - 2 °C after						
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	168 Days + Shelf-life at 7 Days
Fruit co-treated with fungicide and inoculum but no 1-MCP							
Inoculum only	61.1 g[1,2]	100.0 g	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	11.1 c
BIOSAVE @ 1.59 g/L	5.6 b	5.6 b	5.6 b	54.6 c	72.2 c	77.7 d	94.4 e
MERTECT @ 1.15 g/L	55.6 h	66.1 e	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f
Fruit co-treated with fungicide and inoculum and then treated with 1-MCP							
Inoculum only	22.2 e	77.8 f	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
BIOSAVE @ 1.59 g/L	16.7 d	33.3 d	33.3 d	100.0 d	100.0 d	100.0 e	100.0 f
MERTECT @ 1.15 g/L	100.0 i	100.0 g	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum							
Inoculum only	27.8 f	100.0 g	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b	5.6 b
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	11.1 c	11.1 c	50.0 b	61.1 b	66.7 c	72.2 d
MERTECT @ 1.15 g/L	11.1 c	100.0 g	100.0 e	100.0 d	100.0 d	100.0 e	100.0 f

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 29 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. Gala
PEST: Gray mold (*Botrytis cinerea* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'GALA' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest gray mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Gala' apple fruit were harvested on September 11 2007 and treated on 13 and 14 September, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Gala' apples were incubated in cold storage for up to 168 days. In each of the main treatments, 5 fungicide subtreatments

(SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For the main treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *B. cinerea* isolate BC-34R at a concentration of 1×10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for gray mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest gray mold incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments for up to 168 days. As expected, MERTECT was not effective against TBZ-resistant isolates of *Botrytis*. In the case of BIOSAVE, a higher disease incidence was observed in the fruit that was treated with 1-MCP and then co-treated. The results show that 1-MCP had neither a positive nor negative effect on the control of postharvest diseases of ‘Gala’ apples treated with SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L or VANGARD @ 0.8 g/L for up to 168 days, and in the subsequent shelf-life.

Table 1. Effect of 1-MCP on the control of postharvest gray mold (*Botrytis cinerea)* with fungicides in 'Gala' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5 - 2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Fruit co-treated with fungicide and inoculum but no 1-MCP							
Inoculum only	0.0 a[1,2]	66.7 b	66.7 b	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	16.7 b
MERTECT @ 1.15 g/L	44.4 d	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Fruit co-treated with fungicide and inoculum then treated with 1-MCP							
Inoculum only	5.6 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	0.0 a	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum							
Inoculum only	0.0 a	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	0.0 a	0.0 a	11.1 b	11.1 b	33.3 b	55.6 c
MERTECT @ 1.15 g/L	11.1 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

[2] Data represent the mean of three replicates.

2008 PMR REPORT # 30 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. Gala
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers)

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TITLE: **PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'GALA' APPLES, 2007-08**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Gala' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'Gala' apples. Fruit were harvested on 10 September, 2007 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2˚C. On 17 September, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 19 September, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 170 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold (Table 1) and gray mold (Table 2) incidence in 'Gala' apples. Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of blue mold and gray mold for 170 days in cold storage and in the shelf-life study. As expected, MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium or Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Gala' apples, 2007-08.

	% Blue mold incidence in cold storage at 0.5-2 °C after						170 Days + Shelf-life at 7 Days
Treatment	28 Days	56 Days	86 Days	114 Days	142 Days	170 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 2 - wound and no inoculum	0.0 a	2.8 b	2.8 b	2.8 b	2.8 b	2.8 b	2.8 b
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench[1]	0.0 a	86.1 d	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	0.0 a	0.0 a	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
P. expansum 1 x 10^4 conidia/ml	91.7 c	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
P. expansum 1 x 10^5 conidia/ml	97.2 d	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	19.4 b	58.3 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Gala' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						170 Days + Shelf-life at 7 Days
	28 Days	56 Days	86 Days	114 Days	142 Days	170 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 2 - wound and no inoculum	0.0 a	11.1 c	11.1 b	11.1 b	11.1 b	11.1 b	11.1 b
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench [1]	2.8 b	100.0	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	8.3 c	8.3 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
B. cinerea 1 x 10^4 conidia/ml	19.4 f	58.3 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
B. cinerea 1 x 10^5 conidia/ml	13.9 e	61.1 f	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c
Fungicide efficacy							
SCHOLAR @ 0.6 g /L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15g /L	11.1 d	36.1 d	100.0 c	100.0 c	100.0 c	100.0 c	100.0

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT # 31 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. McIntosh
PEST: Blue mold (*Penicillium expansum* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF BLUE MOLD WITH POSTHARVEST FUNGICIDES IN 'MCINTOSH' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'McIntosh' apple fruit were harvested on September 05 2007 and treated on 05 and 06 of September, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. In each of the main treatments, 5 fungicide subtreatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control

without fungicide treatment were included. For the main treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *P. expansum* isolate PS-1R at a concentration of 1 x 10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'McIntosh' apples were incubated in cold storage for up to 140 days. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for blue mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest blue mold incidence. The test fungicide treatments PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L gave complete control with or without 1-MCP treatment for up to 168 days and SCHOLAR @ 1.2 g/L gave complete control for up to 112 days on apples that were first co-treated and then treated with 1-MCP. As expected, MERTECT was not effective against TBZ-resistant isolates of *Penicillium*. In the case of BIOSAVE, a higher disease incidence was observed in the fruit in the treatments. The results show that 1-MCP had neither a positive nor negative effect on the control of postharvest diseases of 'McIntosh' apples treated with SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, or VANGARD @ 0.8 g/L for up to 140 days of storage in air at 0.5-2 °C and in the subsequent shelf-life.

Table 1. Effect of 1-MCP on the control of postharvest blue mold (*Penicillium expansum)* with fungicides in 'McIntosh' apples, 2007-08.

Treatment	% Blue mold incidence in cold storage at 0.5 - 2 °C after					140 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 days	140 Days	
Fruit co-treated with fungicide and inoculum but no 1-MCP						
Inoculum only	88.9 f [1,2]	100.0 e	100.0 d	100.0 c	100.0 d	100.0 e
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	44.4 d
BIOSAVE @ 1.59 g/L	0.0 a	66.6 c	66.6 c	100.0 c	100.0 d	100.0 e
MERTECT @ 1.15 g/L	72.2 c	100.0 e	100.0 d	100.0 c	100.0 d	100.0 e
Fruit co-treated with fungicide and inoculum then treated with 1-MCP						
Inoculum only	83.3 e	100.0 e	100.0 d	100.0c	100.0 d	100.0 e
SCHOLAR @ 1.2 g/L	0.0 a	0.0a	0.0 a	0.0a	16.7 c	16.7 c
PENBOTEC @ 1.16 g/L	0.0 a	0.0a	0.0 a	0.0a	0.0a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0a	0.0 a	0.0a	0.0a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 g	100.0 e	100.0 d	100.0c	100.0 d	100.0 e
MERTECT @ 1.15 g/L	100.0 g	100.0 e	100.0 d	100.0c	100.0 d	100.0 e
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum						
Inoculum only	72.2 c	100.0 e	100.0 d	100.0c	100.0 d	100.0 e
SCHOLAR @ 1.2 g/L	0.0 a	5.6 b	5.6 b	5.6b	11.1 b	11.1 b
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	33.3 b	83.3 d	100.0 d	100.0 c	100.0 d	100.0 e
MERTECT @ 1.15 g/L	77.8 d	100.0 e	100.0 d	100.0 c	100.0 d	100.0 e

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

[2] Data represent the mean of three replicates.. Box 6000, 4902 Victoria Ave. N.

2008 PMR REPORT # 32 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. McIntosh
PEST: Gray mold (*Botrytis cinerea* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'MCINTOSH' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest gray mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'McIntosh' apple fruit were harvested on September 05, 2007 and treated on 05 and 06 September, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. In each of the main treatments, 5 fungicide subtreatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control

without fungicide treatment were included. For the main treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *B. cinerea* isolate BC-34R at a concentration of 1×10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'McIntosh' apples were incubated in cold storage for up to 140 days. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for gray mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest gray mold incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L , PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments for up to 140 days. SCHOLAR @ 1.2 g/L gave complete control. As expected, MERTECT was not effective against TBZ-resistant isolates of *Botrytis*. In the case of BIOSAVE, a higher disease incidence was observed in the fruit in all treatments. The results show that 1-MCP had neither a positive nor negative effect on the control of postharvest diseases of 'McIntosh' apples treated with SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, or VANGARD @ 0.8 g/L for up to 140 days, and in the subsequent shelf-life.

Table 1. Effect of 1-MCP on the control of postharvest gray mold (*Botrytis cinerea)* with fungicides in 'McIntosh' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5 - 2 °C after					140 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	
Fruit co-treated with fungicide and inoculum but no 1-MCP						
Inoculum only	100.0 b [1,2]	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
Fruit co-treated with fungicide and inoculum then treated with 1-MCP						
Inoculum only	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	5.6 b	5.6 b	5.6 b
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum						
Inoculum only	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 33 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Red Delicious
PEST: Blue mold (*Penicillium expansum* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF BLUE MOLD WITH POSTHARVEST FUNGICIDES IN 'RED DELICIOUS' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Red Delicious' apple fruit were harvested on October 10, 2007 and treated on 11 and 12 of October, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. In each of the main treatments, 5 fungicide subtreatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For the main

treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *P. expansum* isolate PS-1R at a concentration of 1×10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Red Delicious' apples were incubated in cold storage for up to 168 days. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for blue mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest blue mold incidence. The test fungicide treatments SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L, gave complete control with or without 1-MCP treatments for up to 175 days. As expected, MERTECT was not effective against TBZ-resistant isolates of *Penicillium*. In the case of BIOSAVE, a higher disease incidence was observed in the fruit that was co-inoculated and then treated with or without 1-MCP. The results show that 1-MCP had neither a positive nor negative effect on the control of postharvest diseases of 'Red Delicious' apples treated with SCHOLAR @ 1.2 g/L or PENBOTEC @ 1.16 g/L, for up to 168 days, and in the subsequent shelf-life after 175 days of storage in air at 0.5-2 °C.

Table 1. Effect of 1-MCP on the control of postharvest blue mold (*Penicillium expansum)* with fungicides in 'Red Delicious' apples, 2007-08.

Treatment	% Blue mold incidence in cold storage at 0.5 - 2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Fruit co-treated with ungicide and inoculum but no 1-MCP							
Inoculum only	100.0 c [1,2]	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
BIOSAVE @ 1.59 g/L	0.0 a	38.9 d	77.8 c	88.9 c	88.9 c	94.4 c	100.0 d
MERTECT @ 1.15 g/L	72.2 b	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d
Fruit co-treated with fungicide and inoculum and then treated with 1-MCP							
Inoculum only	100.0 c	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	33.3 c	55.6 b	55.6 b	61.1 b	66.7 b	77.8 c
MERTECT @ 1.15 g/L	100.0 c	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum							
Inoculum only	100.0 c	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
BIOSAVE @ 1.59 g/L	0.0 a	27.8 b	94.4 b	100.0 d	100.0 d	100.0 d	100.0 d
MERTECT @ 1.15 g/L	100.0 c	100.0 e	100.0 e	100.0 d	100.0 d	100.0 d	100.0 d

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 34 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Red Delicious
PEST: Gray mold (*Botrytis cinerea* Link)

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TITLE: **EFFECT OF SMARTFRESH (1-METHYLCYCLOPROPENE; 1-MCP) ON THE CONTROL OF GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'RED DELICIOUS' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) on the control of postharvest gray mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Red Delicious' apple fruit were harvested on October 10, 2007 and treated on 11 and 12 October, 2007. There were three main treatments: 1. Fruit were co-treated (co-treatment consists of co-treatment of fungicides along with the pathogen inoculum on the detached fruit) but no 1-MCP; 2. Fruit were co-treated and cooled overnight and then 1-MCP treated; 3. Fruit were cooled overnight, treated with 1-MCP for 24 hours and then apples were wounded, co-treated with fungicides and inoculum. In each of the main treatments, 5 fungicide subtreatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For the main

treatments 1 and 2, apples were placed in plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 4 hours of harvest, the apples were drop inoculated with the pathogen and the fungicides. For inoculum, thiabendazole-resistant *B. cinerea* isolate BC-34R at a concentration of 1 x 10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Red Delicious' apples were incubated in cold storage for up to 168 days. Apples in the experiment were evaluated for disease incidence at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days. After the shelf-life study, the fruit were again evaluated for gray mold incidence (percent infected apples). Fruit was considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Table 1.

CONCLUSIONS: The control had the highest gray mold incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L,and PENBOTEC @ 1.16 g/L) gave complete control with or without 1-MCP treatments for up to 112 days. As expected, MERTECT was not effective against TBZ-resistant isolates of *Botrytis*. In the case of BIOSAVE, at 28 days, a higher disease incidence was observed in the fruit that was co-inoculated and then treated with or without 1-MCP than the 1-MCP treated followed by co-inoculation. The results show that 1-MCP had neither a positive nor negative effect on the control of postharvest diseases of 'Red Delicious' apples treated with SCHOLAR @ 1.2 g/L or PENBOTEC @ 1.16 g/L, for up to 168 days, and in the subsequent shelf-life.

Table 1. Effect of 1-MCP on the control of postharvest gray mold (*Botrytis cinerea)* with fungicides in 'Red Delicious' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5 - 2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 days	140 Days	168 Days	
Fruit co-treated with fungicide and inoculum but no 1-MCP							
Inoculum only	100.0 e [1,2]	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
BIOSAVE @ 1.59 g/L	66.7 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
MERTECT @ 1.15 g/L	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Fruit co-treated with fungicide and inoculum then treated with 1-MCP							
Inoculum only	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
BIOSAVE @ 1.59 g/L	83.3 d	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
MERTECT @ 1.15 g/L	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
Fruit treated with 1-MCP and then co-treated with fungicide and inoculum							
Inoculum only	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d
SCHOLAR @ 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	5.6 b	5.6 b	38.9 b	77.8 b	77.8 b	77.8 b	77.8 c
MERTECT @ 1.15 g/L	100.0 e	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

[2] Data represent the mean of three replicates.

2008 PMR REPORT # 35 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Honey Crisp
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers)

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TITLE: PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'HONEY CRISP' APPLES, 2007-08

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil, and MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Honey Crisp' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'Honey Crisp' apples. Fruit were harvested on 14 September from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2˚C. On 09 October, the fruit were disinfested with a 1% bleach solution and rinsed in reverse osmosis water. On 16 October, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 175 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold incidence (Table 1) and gray mold (Table 2) incidence in 'Honey Crisp' apples. Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatment SCHOLAR gave complete control of blue mold for up to 140 days and then less than 3.0% incidence was observed for up to 175 days. PENBOTEC @ 1.16 g/L gave complete control of blue mold for up to 112 days and then less than 6.0% incidence was observed for up to 175 days. Shelf-life study had slightly higher blue mold incidence. Similarly, the test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of gray mold for up to 140 days and 2.8% incidence was observed in SCHOLAR treated apples up to 175 days. In the subsequent shelf-life study, PENBOTEC and SCHOLAR treated had 19.4% and 8.3%, respectively. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium or Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Honey Crisp' apples, 2007-08.

	% Blue mold incidence in cold storage at 0.5-2 °C after						175 Days + Shelf-life at 7 Days
Treatment	28 Days	56 Days	84 Days	112 Days	140 Days	175 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	0.0 a	16.7 c	33.3 d	33.3 d	38.9 d
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	11.1 b	22.2 c	27.7 c	30.6 c
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench [1]	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e	100.0 e	100.0 e
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e	100.0 e	100.0 e
P. expansum 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e	100.0 e	100.0 e
P. expansum 1 x 10^5 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e	100.0 e	100.0 e
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 a	5.6 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	5.6 b	11.1 b
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e	100.0 e	100.0 e

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Honey Crisp'apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						175 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	175 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	0.0 a	0.0 a	5.6 b	11.1 b	13.8 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	0.0 a	13.9 c	22.2 c	38.9 d
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench [1]	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d	100.0 e
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d	100.0 e
B. cinerea 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d	100.0 e
B. cinerea 1 x 10^5 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d	100.0 e
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 a	8.3 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 a	19.4 c
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d	100.0 e

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT # 36 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Ambrosia
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers)

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TITLE: **PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'AMBROSIA' APPLES, 2007-08**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil, and MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Ambrosia' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'Ambrosia' apples. Fruit were harvested on 24 September, 2007 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2˚C. On 24 October, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 24 October, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments, the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 168 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold incidence (Table 1) and gray mold (Table 2) incidence in 'Ambrosia' apples. Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of blue mold for up to 56 days and less than 6.0% incidence was observed for up to 168 days. Shelf-life study had slightly higher blue mold incidence. Similarly, the test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of gray mold for up to 84 days and 2.8% incidence was observed in SCHOLAR treated apples up to 168 days and in the subsequent shelf-life study. PENBOTEC gave less than 6% gray mold for up to 168 days and 13.9% in the shelf life study. As expected, MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium or Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Ambrosia' apples, 2007-08.

	% Blue mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
Treatment	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	0.0 a	2.8 b	2.8 b	5.6 b	8.3 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	11.1 c
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench [1]	61.1 b	69.4 b	100.0 c	100.0 d	100.0 d	100.0 c	100.0 d
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	80.6 c	100.0 c	100.0 c	100.0 d	100.0 d	100.0 c	100.0 d
P. expansum 1 x 10^4 conidia/ml	100.0 d	100.0 c	100.0 c	100.0 d	100.0 d	100.0 c	100.0 d
P. expansum 1 x 10^5 conidia/ml	100.0 d	100.0 c	100.0 c	100.0 d	100.0 d	100.0 c	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	2.8 b	5.6 c	5.6 c	5.6 b	5.6 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	5.6 c	5.6 b	11.1 c
MERTECT @ 1.15 g/L	80.6 c	100.0 c	100.0 c	100.0 d	100.0 d	100.0 c	100.0 d

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Ambrosia' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	2.8 b	5.6 b	5.6 b	5.6 b	11.1 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	2.8 a	2.8 a	13.8 c	38.9 d
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench [1]	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
B. cinerea 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
B. cinerea 1 x 10^5 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	2.8 a	2.8 a	2.8 a	2.8 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	5.6 b	5.6 b	5.6 b	13.9 c
MERTECT @ 1.15 g /L	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT # 37 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-E.1211.LK

CROP: Apples (*Malus domestica* Borkh.) cv. Golden Delicious
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers)

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TITLE: **PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'GOLDEN DELICIOUS' APPLES, 2007-08**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Golden Delicious' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'Golden Delicious' apples. Fruit were harvested on 15 October, 2007 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 05 November, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 07 November, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments, the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13˚C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 168 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold incidence (Table 1) and gray mold (Table 2) incidence in 'Golden Delicious apples. Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of blue mold and gray mold for 168 days in cold storage and in the shelf-life study. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium or Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Golden Delicious' apples, 2007-08.

	% Blue mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
Treatment	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	5.6 c	19.4 c	19.4 c	30.6 b	33.3 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	2.8 b	11.1 b	16.7 b	30.6 b	36.1 c
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench[1]	100.0 b	100.0 b	100.0 d	100.0 d	100.0 d	100.0 c	100.0 d
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 d	100.0 d	100.0 d	100.0 c	100.0 d
P. expansum 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 d	100.0 d	100.0 d	100.0 c	100.0 d
P. expansum 1 x 10^5 conidia/ml	100.0	100.0 b	100.0 d	100.0 d	100.0 d	100.0 c	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 d	100.0 d	100.0 d	100.0 c	100.0 d

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Golden Delicious' apples, 2007-08

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	5.6 c	16.7 c	22.2 c	44.4 c	50.0 c
Control 2 - wound and no inoculum	0.0 a	0.0 a	2.8 b	5.6 b	22.2 c	38.9 b	38.9 b
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench [1]	100.0	100.0 b	100.0 d	100.0 d	100.0 d	100.0 d	100.0 d
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	100.0 d	100.0 b	100.0 d	100.0 d	100.0 d	100.0 d	100.0 d
B. cinerea 1 x 10^4 conidia/ml	100.0 d	100.0 b	100.0 d	100.0 d	100.0 d	100.0 d	100.0 d
B. cinerea 1 x 10^5 conidia/ml	100.0 d	100.0 b	100.0 d	100.0 d	100.0 d	100.0 d	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g /L	72.2 b	100.0 b	100.0 d	100.0 d	100.0 d	100.0 d	100.0 d

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT # 38 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Fuji
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers**)**

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TITLE: **PATHOGENICITY OF *Penicillium expansum* AND *Botrytis cinerea* AND FUNGICIDE CONTROL OF BLUE MOLD AND GRAY MOLD IN 'FUJI' APPLES, 2007-08**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), MERTECT (45% Thiabendazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'Fuji' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT (45% Thiabendazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'Fuji' apples. Fruit were harvested on 22 October, 2007 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 20 November, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 21 November, the fruit were placed into plastic mesh bags and wounded by puncturing the apple once with a nail-like probe (5 mm diameter) to a depth of 4 mm. There were 3 controls: 1) Control 1, non-wounded fruit and no inoculum, 2) Control 2, wounded fruit and no inoculum and 3) Control 3, wounded fruit drenched with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at concentrations of 1×10^3, 1×10^4, and 1×10^5 conidia/ml. For the fungicide treatments the fruit were wounded and drop inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR @ 0.6 g/L, PENBOTEC @ 1.16 g/L or MERTECT @ 1.15 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 168 days and evaluated for blue mold or gray mold disease incidence (percent infected apples) at monthly intervals. After cold storage incubation, the fruit were moved to 20 °C, 85% RH and incubated for 7 days for the shelf-life study. The fruit were again evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The inoculated control had the highest blue mold incidence (Table 1) and gray mold (Table 2) incidence in 'Fuji' apples. Both thiabendazole-resistant *P. expansum* or *B. cinerea* were pathogenic on apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of blue mold for up to 168 days. Shelf-life study had slightly higher blue mold incidence in SCHOLAR treated apples and 0% incidence was observed in PENBOTEC treated apples. Similarly, the test fungicide treatments (SCHOLAR @ 1.2 g/L and PENBOTEC @ 1.16 g/L) gave complete control of gray mold for up to 168 days. In the subsequent shelf-life study, SCHOLAR had less than 20% blue mold and 6% gray mold incidence. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium* or *Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and postharvest control of blue mold with fungicides on 'Fuji' apples, 2007-08.

	% Blue mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
Treatment	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a [2,3]	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	8.3 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	2.8 b	2.8 b	8.3 b	11.1 c	41.7 d
Control 3 - *P. expansum* 1 x 10^4 conidia/ml drench [1]	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
P. expansum 1 x 10^4 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
P. expansum 1 x 10^5 conidia/ml	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	19.4 c
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g/L	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d	100.0 e

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

Table 2. Pathogenicity of *Botrytis cinerea* and postharvest control of gray mold with fungicides on 'Fuji' apples, 2007-08.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 Days + Shelf-life at 7 Days
	28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control 1 - no wound and no inoculum	0.0 a[2,3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
Control 2 - wound and no inoculum	0.0 a	0.0 a	0.0 a	0.0 a	16.7 b	19.4 b	55.6 c
Control 3 - *B. cinerea* 1 x 10^4 conidia/ml drench [1]	91.7 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	47.2 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
B. cinerea 1 x 10^4 conidia/ml	100.0 d	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
B. cinerea 1 x 10^5 conidia/ml	100.0 d	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d
Fungicide efficacy							
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
PENBOTEC @ 1.16 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
MERTECT @ 1.15 g /L	91.7 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 d

[1] Drench inoculation for this treatment only.
[2] Data represent the mean of three replicates.
[3] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.

2008 PMR REPORT # 39 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. McIntosh
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers.)

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TITLE: **EFFECT 1-MCP AND CA STORAGE CONDITION ON THE CONTROL OF BLUE MOLD AND GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'MCINTOSH' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) and controlled atmosphere storage (CA) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long- term storage for the apples was determined by the internal ethylene concentration and starch staining. 'McIntosh' apple fruits were harvested on 12 September, 2007. There were two main treatments: 1. Fruit were cooled overnight and then treated with 1-MCP and 2. Fruit were cooled overnight, and not treated with 1-MCP. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'McIntosh' apples were incubated in CA for 148 days. Then the apples were stored in CA storage for five months (12 September, 2007 to 07 February, 2008). Following the 148 day storage in CA, the fruit were wounded, co-treated with fungicides and inoculum. The apples were drop treated with the pathogen and the fungicides and incubated for 7 days at

20 °C.A total of 5 fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For inoculum, thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* isolate Bc-34R at a concentration of 1 x 10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. The fruit were evaluated for blue mold and gray mold incidence (percent infected apples) and fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The control and the MERTECT had the highest blue mold (Table 1) and gray mold (Table 2) incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments. In the case of BIOSAVE, higher disease incidence of blue and gray mold was observed. As expected, MERTECT was not effective against TBZ-resistant isolates of *Penicillium* or *Botrytis*. The results show that 1-MCP and CA storage conditions had neither a positive nor negative effect on the control of postharvest diseases of apples that were treated with SCHOLAR @1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L stored in CA prior to the testing.

Table 1. Control of postharvest blue mold (*Penicillium expansum*) with fungicides in 'McIntosh' apples stored in CA storage for five months and then co-treated with fungicides and inoculum, 2007-08.

	% Blue mold incidence after 7 Days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 b[1,2]	100.0 b
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	0.0 a	100.0 b
MERTECT @ 1.15 g/L	100.0 b	100.0 b

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

Table 2. Effect of control of postharvest gray mold (*Botrytis cinerea*) with fungicides in ‘‘McIntosh’ apples stored in CA storage for five months and then co-inoculated and treated with fungicides, 2007-08.

	% Gray mold incidence after 7 days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 c[1,2]	100.0 b
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	62.5 b	100.0 b
MERTECT @ 1.15 g/L	100.0 c	100.0 b

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 40 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Gala
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers.)

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TITLE: **EFFECT OF 1-MCP AND CA STORAGE CONDITION ON THE CONTROL OF BLUE MOLD AND GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'GALA' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) and controlled atmosphere storage (CA) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded apples. Optimum harvest time for long- term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Gala' apple fruits were harvested on 11 September, 2007. There were two main treatments: 1. Fruit were cooled overnight and then treated with 1-MCP and 2. Fruit were cooled overnight, and not treated with 1-MCP. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Gala' apples were incubated in CA storage for 188 days. Then the apples were stored in CA for six months (11 September, 2007 to 17 March, 2008). Following the 188 day storage in CA, the fruit were wounded, co-treated with fungicides and inoculum. The apples were drop treated with the pathogen and the fungicides and incubated for 7 days at 20 °C. A total of 5 fungicide

treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For inoculum, thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-8D at a concentration of 1 x 10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. The fruit were evaluated for blue mold and gray mold incidence (percent infected apples) and fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The control, TBZ and Biosave had the higher blue mold (Table 1) and gray mold (Table 2) incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments. As expected MERTECT was not effective against TBZ-resistant isolates of *Penicillium* or *Botrytis*. The results show that 1-MCP and CA storage conditions had neither a positive nor negative effect on the control of postharvest diseases of apples that were treated with SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L and stored in CA prior to the testing.

Table 1. Control of postharvest blue mold (*Penicillium expansum*) with fungicides in 'Gala' apples stored in CA storage for six months and then co-treated with fungicides and inoculum, 2007-08.

	% Blue mold incidence after 7 days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 c[1,2]	100.0 b
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	91.6 b	100.0 b
MERTECT @ 1.15 g/L	100.0 c	100.0 b

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

Table 2. Control of postharvest gray mold (*Botrytis cinerea*) with fungicides in 'Gala' apples stored in CA storage for six months and then co-inoculated and treated with fungicides, 2007-08.

	% Gray mold incidence after 7 days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 c [1,2]	100.0 c
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	85.8 b	75.0 b
MERTECT @ 1.15 g/L	100.0 c	100.0 c

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 41 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Empire
PEST: Blue mold (*Penicillium expansum* Link); Gray mold (*Botrytis cinerea* Pers.)

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TITLE: **EFFECT 1-MCP AND CA STORAGE CONDITION ON THE CONTROL OF BLUE MOLD AND GRAY MOLD WITH POSTHARVEST FUNGICIDES IN 'EMPIRE' APPLES, 2007-08**

MATERIALS: SmartFresh™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10), MERTECT (45% Thiabendazole).

METHODS: A trial was conducted to determine the effect of SMARTFRESH (1-methylcyclopropene; 1-MCP) and controlled atmosphere storage (CA) on the control of postharvest blue mold with postharvest fungicides, SCHOLAR 50 WG and PENBOTEC 400 SC, VANGARD 75 WG, BIOSAVE ESC10 and MERTECT in wounded 'Empire' apples. Optimum harvest time for long-term storage for the apples was determined by the internal ethylene concentration and starch staining. 'Empire' apple fruit were harvested on 10 October, 2007. There were two main treatments: 1. Fruit were cooled overnight and then treated with 1-MCP and 2. Fruit were cooled overnight, and not treated with 1-MCP. For 1-MCP treatment, 1 µl/ml of 1-MCP was used for 24 h at 0.5-2 °C. 'Empire' apples were incubated in CA storage for 183 Days. Then the apples were stored in CA for 6 months (10 October, 2007 to 10 April, 2008). Following the 183 days storage in CA, the fruit were wounded, co-treated with fungicides and inoculum. The apples were drop inoculated with the pathogen and the fungicides and incubated for 7 days at 20 °C. In each of the

main treatments, 5 fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, VANGARD @ 0.8 g/L, BIOSAVE @ 1.59 g/L, MERTECT @ 1.15 g/L) and a control without fungicide treatment were included. For inoculum, thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-8D at a concentration of 1 x 10^4 conidia/ml was used. Each treatment had 3 replicates with 6 fruit per replicate. The fruit were evaluated for blue mold and gray mold incidence (percent infected apples) and fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: The control had the highest blue mold (Table 1) and gray mold (Table 2) incidence. The test fungicide treatments (SCHOLAR @ 1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L) gave complete control with or without 1-MCP treatments. In the case of BIOSAVE, higher disease incidence of blue and gray mold was observed. As expected, MERTECT was not effective against TBZ-resistant isolates of *Penicillium* or *Botrytis*. The results show that 1-MCP and CA storage conditions had neither a positive nor negative effect on the control of postharvest diseases of apples that were treated with SCHOLAR @1.2 g/L, PENBOTEC @ 1.16 g/L, and VANGARD @ 0.8 g/L stored in CA prior to the testing.

Table 1. Control of postharvest blue mold (*Penicillium expansum*) with fungicides in 'Empire' apples stored in CA storage for six months and then co-treated with fungicides and inoculum, 2007-08.

	% Blue mold incidence after 7 days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 b[1,2]	100.0 b
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 b	100.0 b
MERTECT @ 1.15 g/L	100.0 b	100.0 b

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

Table 2. Control of postharvest gray mold (*Botrytis cinerea*) with fungicides in 'Empire' apples stored in CA storage for six months and then co-inoculated and treated with fungicides, 2007-08.

	% Gray mold incidence after 7 days at 20 °C	
Treatment	NO 1-MCP	1-MCP
Inoculum only	100.0 b[1,2]	100.0 b
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
VANGARD @ 0.8 g/L	0.0 a	0.0 a
BIOSAVE @ 1.59 g/L	100.0 b	100.0 b
MERTECT @ 1.15 g/L	100.0 b	100.0 b

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[2] Data represent the mean of three replicates.

2008 PMR REPORT # 42 **SECTION K: FRUIT – Diseases**
STUDY DATA BASE: WBSE-T.1210.4U

CROP: Apples (*Malus domestica* Borkh.) cv. Empire
PEST: Blue mold (*Penicillium expansum* Link.), Gray mold (*Botrytis cinerea* Pers.)

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TITLE: EFFECT OF PREHARVEST APPLICATION BOSCALID/PYRACLOSTROBIN (PRISTINE) AND PYRAMETHANIL (SCALA) FOR THE CONTROL OF POSTHARVEST BLUE AND GRAY MOLD IN 'EMPIRE' APPLES, 2007-08

MATERIALS: PRISTINE (boscalid 25.2% & pyraclostrobin 12.8%), SCALA SC (pyrimethanil 400 g ai/L), MERTECT (45 % flowable thiabendazole), SCHOLAR (50% fludioxonil).

METHODS: During the 2007 growing season a field trial was conducted at the Jordan Farm-AAFC, Jordan Station, ON. Apple cultivar 'EMPIRE' was maintained according to standard orchard practices at Jordan Farm, ON. The preharvest treatments include: an unsprayed control, preharvest field applications of PRISTINE (1.2 kg/ha) applied 7 days preharvest, and SCALA (pyrimethanil 800 g ai/ha) applied 14 days preharvest. Treatments were replicated 4 times with two trees per replicate, allocated in a completely randomized block design. The apple trees were sprayed with hand-operated gun sprayer at a pressure of 1034.25 kPa, 2.8-3 L of water per tree until runoff. Apples were harvested on September 20, 2007 and stored in cold storage at 0.5 - 2 °C. On September 25, 2007 apples were punctured once with a nail-tapered probe 5 mm deep and 4 mm wide at its base, placed in mesh bags and placed in plastic crates. Wounded fruit were then inoculated with 20 µl of conidial suspension ($1x10^4$ conidia/ml of water) of thiabendazole-resistant (TBZ – R) *P. expansum* isolate PS-1R or thiabendazole-resistant (TBZ R) *B. cinerea* isolate Bc-34R and placed back in cold storage at 0.5 - 2 ºC. Postharvest treatments include: (SCHOLAR @ 1.2 g/L and MERTECT @ 1.15 g/L). Twelve fruit were used for each treatment and each treatment had four replicates. After inoculation apples were evaluated for disease incidence once every 4 weeks. After 168 days (24 weeks) fruit were removed from cold storage and were placed in additional storage for a shelf-life study at 20 °C (85 % RH) for 6 days. The general linear model (GLM) procedures were used for the analysis of variance (ANOVA; SigmaStat 2.0 for Windows, SPSS Science, Chicago, Ill). Data recorded as percentage were subjected to arcsine square-root transformation before the ANOVA. All pair-wise multiple comparison procedures were determined with the Tukey test.

RESULTS: As outlined in Tables 1-2.

CONCLUSIONS: Effect on postharvest blue mold of apples (Table 1): Apples treated with preharvest application of PRISTINE or SCALA had no blue mold disease in either wounded or unwounded apples. When inoculum was introduced in the wounds of the PRISTINE treated apples, complete control was

observed up to 30 days and then disease increased to 25% at 56 days and 50% at 84 days and 64% at 140 days. Similarly in the SCALA treated apples, for the first 30 days the disease was completely controlled and 4.2%, 10.4%, 16.7%, 27.0%, 31.2% disease was observed after 56 days, 84 days, 112 days, 140 days, 168 days, respectively. When a combination of postharvest application of SCHOLAR was applied to apples that were treated with preharvest application of PRISTNE or SCALA, a complete control of blue mold was observed for up to 168 days in cold storage and in the subsequent one week shelf-life study. As expected, MERTECT treatment was not effective against TBZ-resistant *P. expansum*, on apples that were treated with preharvest application of SCALA or PRISTINE.

Effect on postharvest gray mold of apples (Table 2): Apples treated with preharvest application of PRISTINE or SCALA had no gray mold disease in either wounded or unwounded apples. When inoculum was introduced in the wounds of the PRISTINE treated apples, 10% gray mold disease incidence was observed at 30 days and increased up to 80% by 168 days. The combination of MERTECT on apples that were treated with preharvest application PRISTINE also showed similar trend. When a combination of postharvest application of SCHOLAR was applied to apples that were treated with preharvest application of PRISTINE or SCALA, a complete control of blue mold was observed for up to 168 days in cold storage and in the subsequent one week shelf-life study. Preharvest application of SCALA was effective (less than 4.2%) against gray mold over 168 days.

Table 1. Effect of preharvest applications of PRISTINE and SCALA alone or in combination with postharvest SCHOLAR and MERTECT on the development of postharvest blue mold in 'Empire' apples, 2007-2008.

Preharvest Application	Postharvest Treatment	Percent incidence of blue mold (*Penicillium expansum* TBZ-R) after						168 Days + 6 Days at 20 °C
		28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control	No Wound	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	2.8 b	8.3 b
Control	*Penicillium expansum* 1 x 10^4 conidia/ml	50.0 c	83.3 f	100.0 e	100.0 e	100.0 g	100.0 g	100.0 g
Control	*Penicillium expansum* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	6.3 c	12.5 c	12.5 c
Control	*Penicillium expansum* + MERTECT 1.15 g/L	100.0 d	100.0 g	100.0 e	100.0 a	100.0 g	100.0 g	100.0 g
PRISTINE	No wound	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PRISTINE	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b
PRISTINE	*Penicillium expansum* 1 x 10^4 conidia/ml	0.0 a	25.0 d	50.0 d	58.3 d	64.6 f	68.7 f	68.7 f
PRISTINE	*Penicillium expansum* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PRISTINE	*Penicillium expansum* + MERTECT 1.15 g/L	0.0 a	75.0 e	98.0 e	100.0 e	100.0 g	100.0 g	100.0 g
SCALA	No wound	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	*Penicillium expansum* 1 x 10^4 conidia/ml	0.0 a	4.2 b	10.4 b	16.7 b	27.0 d	31.2 d	31.2 d
SCALA	*Penicillium expansum* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	*Penicillium expansum* + MERTECT 1.15 g/L	8.3 b	20.8 c	37.5 c	50.0 c	58.3 e	60.4 e	60.4 e

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at P=0.05.

[2] Apples were inoculated with *P. expansum* immediately after harvest, stored at 0.5-2.0°C and evaluated for disease incidence at 28, 56, 84, 112, 140 and 168 days, then removed from cold storage and incubated for 6 days at 20°C.

Table 2. Effect of preharvest applications of PRISTINE and SCALA alone or in combination with postharvest SCHOLAR and MERTECT on the development of postharvest gray mold in 'Empire' apples, 2007-2008.

Preharvest Application	Postharvest Treatment	Percent incidence of gray mold (*Botrytis cinerea*-TBZ-R) after						168 Days + 6 Days at 20 °C
		28 Days	56 Days	84 Days	112 Days	140 Days	168 Days	
Control	No Wound	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	2.8 b	8.3 d
Control	*Botrytis cinerea* 1 x 10^4 conidia/ml	100.0 d	100.0 e	100.0 e	100.0 d	100.0 e	100.0 e	100.0 f
Control	*Botrytis cinerea* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	2.8 b
Control	*Botrytis cinerea* + MERTECT 1.15 g/L	100.0 d	100.0 e	100.0 e	100.0 d	100.0 e	100.0 e	100.0 f
PRISTINE	No wound	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PRISTINE	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
PRISTINE	*Botrytis cinerea* 1 x 10^4 conidia/ml	10.4 c	52.0 c	58.3 c	70.8 c	75.0 c	81.2 d	81.2 e
PRISTINE	*Botrytis cinerea* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 e	0.0 a	0.0 a
PRISTINE	*Botrytis cinerea* + MERTECT 1.15 g/L	6.3 b	62.5 d	70.8 d	70.8 c	70.8 d	75.0 c	81.3 e
SCALA	No wound	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	Wound only	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	*Botrytis cinerea* 1 x 10^4 conidia/ml	0.0 a	0.0 a	2.8 b	4.2 b	4.2 b	4.2 c	6.3 c
SCALA	*Botrytis cinerea* + SCHOLAR 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCALA	*Botrytis cinerea* + MERTECT 1.15 g/L	0.0 a	2.8 b	2.8 b	4.2 b	4.2 b	4.2 c	6.3 c

[1] Means within the column followed by the same letter are not significantly different according to the Tukey test at P=0.05.

[2] Apples were inoculated with *B. cinerea* immediately after harvest, stored at 0.5-2.0°C and evaluated for disease incidence at 28, 56, 84, 112, 140 and 168 days, then removed from cold storage and incubated for 6 days at 20°C.

2008 PMR REPORT # 43 **SECTION K: FRUIT - Diseases**

CROP: grape (*Vitis vinifera* L.), cv. Chardonnay
PEST: Powdery mildew, *Erysiphe necator* Schwein.

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TITLE: FUNGICIDES FOR CONTROL OF GRAPEVINE POWDERY MILDEW, 2008

MATERIALS: KUMULUS (sulphur 92%), SERENADE MAX (QST 713 strain *Bacillus subtilis* 14.6%), SERENADE ASO (QST 713 strain *Bacillus subtilis* 1.34 %), FLINT (trifloxystrobin 50%), NOVA (myclobutanil 40%), LANCE (boscalid, 70%)

METHODS: The experiment was conducted in a randomised complete block design in a 3-year-old research vineyard cv. Chardonnay, with a history of high disease pressure in Vineland Station, ON. Each plot consisted of 5 vines in a panel (8 m long) with row width of 3 m and treatments were replicated 4 times. Treatments were applied with a hydraulic tunnel sprayer at 690 kPa with 500 L/h until bloom and 1000 L/ha for the remainder of the season. Sprays were applied at: 1 = 13-20 cm shoots (05 June), 2 = 25-40 cm shoots (11 June), 3 = immediate pre-bloom (18 June), 4 = immediate post-bloom (27 June), 5 = fruit set (08 July), 6 = pea-sized berries (17 July), 7 = bunch close (28 July), 8 = véraison (15 August) and 9 = 2 wk post-véraison (30 August). The growing season in 2008 was very wet and cooler than average and disease pressure was very high. Precipitation in May, June, July, August and September was 47.4, 124, 103, 86 and 76.6 mm and mean daily temperatures were 12.2, 19.8, 21.6, 19.8 and 17.1˚C, respectively. Severity of powdery mildew was evaluated 11 Sep on 25 random leaves on the middle three vines per plot using the Barratt-Horsfall scale. Severity values were arsin sq root transformed and analysed using ANOVA (XLStat). Mean values were back-transformed for presentation.

RESULTS: As outlined in Table 1.

CONCLUSIONS: Powdery mildew was first noted in untreated plots on 01 August. All treatments significantly reduced the severity of powdery mildew. KUMULUS, the grower standard (KUMULUS, FLINT, NOVA, LANCE rotation) and SERENADE ASO following a half rate of KUMULUS (6.3 kg/ha) provided significantly better control of powdery mildew than SERENADE MAX, alone or following a full rate (12.6 kg/ha) of KUMULUS. No phytotoxicity was observed in any treatment.

Table 1. Mean severity of powdery mildew on upper and lower leaf surfaces and fruit of grapevine, 2008.

Product, rate/ha	Timing of application	Mean Severity of Powdery Mildew (% area)		
		Upper leaf surface	Lower Leaf Surface	Fruit
Serenade Max, 1.5 kg	1-9	14.9 c[1]	23.5 b	14.4 b
Kumulus, 12.6 kg Serenade Max, 1.5 kg	1-5 6-9	9.2 b	21.2 b	11.8 b
Kumulus, 6.3 kg Serenade ASO, 6 L	1-5 6-9	0.6 a	1.4 a	0.8 a
Kumulus, 12.6 kg	1-9	0.3 a	0 a	0.3 a
Kumulus, 12.6 kg Flint, 140 g Nova 40W, 200 g Lance WDG, 315 g	1,2,8,9 3,4 5 6,7	0.3 a	0.5 a	0.2 a
Unsprayed control	--	45.3 d	28.2 b	38.5 c

[1] Values in a column followed by the same letter are not significantly different according to the Student Newman Keul multiple range test ($P = 0.05$).

2008 PMR REPORT # 44 **SECTION K: FRUIT - Diseases**

CROP: grape (*Vitis vinifera* L.), cv. Chardonnay
PEST: Downy mildew, *Plasmopara viticola* (Berk. & M.A. Curtis) Berl. & De Toni

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TITLE: FUNGICIDES FOR CONTROL OF GRAPEVINE DOWNY MILDEW, 2008

MATERIALS: REASON (fenamidone 50%), ALIETTE (Fosetyl AL 80%), PRESIDIO (Fluopicolide 48%), MAESTRO 80 DF (captan 80%), CONFINE (Mono- and di-potassium salts of phosphorous acid, 45.8%), TIMOREX GOLD (tea tree oil *Melaleuca alternifolia* 23.8%)

METHODS: The experiment was conducted in a randomised complete block design in a 3-year-old research vineyard cv. Chardonnay, with a history of high disease pressure in Vineland Station, ON. Each plot consisted of 5 vines in a panel (8 m long) with row width of 3 m and treatments were replicated 4 times. Treatments were applied with a hydraulic tunnel sprayer at 690 kPa with 500 L/h until bloom and 1000 L/ha for the remainder of the season. Sprays were applied at: 1 = 13-20 cm shoots (05 June), 2 = 25-40 cm shoots (11 June), 3 = immediate pre-bloom (18 June), 4 = immediate post-bloom (27 June), 5 = fruit set (08 July), 6 = pea-sized berries (17 July), 7 = bunch close (28 July), 8 = véraison (15 August) and 9 = 2 wk post-véraison (30 August). Maintenance sprays of KUMULUS 80 DF were applied to all plots to control powdery mildew. Severity of downy mildew was evaluated on 30 July and 11 September on 25 random leaves on the middle three vines per plot using the Barratt-Horsfall scale. Severity values were arsin sq root transformed and analysed using ANOVA (XLStat). Means separations were obtained using Student Newman Keuls multiple range test at P=0.05 level of significance. Mean values were back-transformed for presentation. The growing season in 2008 was very wet and cooler than average and the disease pressure was very high. Precipitation in May, June, July, August and September was 47.4, 124, 103, 86 and 76.6 mm and mean daily temperatures were 12.2, 19.8, 21.6, 19.8 and 17.1˚C, respectively.

RESULTS: As outlined in Table 1.

CONCLUSIONS: Downy mildew was first noted on leaves in untreated plots on 23 June. No downy mildew was found on fruit. All treatments significantly reduced the severity of downy mildew at both assessment dates. ALIETTE was significantly more effective and comparable to the commercial standard, MAESTRO, when applied at 7-10 day intervals than at 21-day intervals. There was no difference in disease severity among ALIETTE, CONFINE, TIMOREX GOLD at the low rate and the rates of PRESIDIO, alone or tank-mixed or alternated with a full rate of MAESTRO and all provided control comparable to MAESTRO. The high rate of TIMOREX GOLD did not reduce disease severity as much as

the other treatments. A full-season program of MAESTRO provided excellent control of downy mildew. No phytotoxicity was observed in any treatment.

Table 1: Mean severity of downy mildew on grapevine leaves, 2008

		Severity of Downy Mildew (% area)	
Product, rate/ha	Timing of application[1]	30 Jul	11 Sep
Check	--	4.7 b[2]	67.0 d
REASON, 400 mL	1-9	0 a[100]	0.2 a[100]
ALIETTE, 3750 g	1-9	0 a[100]	1.4a [98]
ALIETTE, 3750 g	1,4,6,8	0.2 a[96]	13.2 b[83]
PRESIDIO, 105 mL	1-9	0 a[100]	1.4a [97]
PRESIDIO, 210 mL	1-9	0 a[100]	0.2 a[100]
PRESIDIO, 280L	1-9	0 a[100]	0.3 a[100
PRESIDIO, 210 g + CAPTAN 80 WDG, 2000 g	1-9	0 a[100]	0.4 a[99]
PRESIDIO, 280 mL + MAESTRO 80 DF, 2000 g	1-9	0 a[100]	0.3 a[99]
MAESTRO 80 DF alt MAESTRO 80 DF, 2000 g + PRESIDIO, 280 g	1,2,5,7,9 3,4,6,8	0 a[100]	0.5 a[99]
CONFINE 5 L	1-9	0 a[100]	2.1 a[100]
TIMOREX GOLD 2.5 L then TIMOREX GOLD 5 L	1-4 5-9	0 a[100]	3.7 a[94]
TIMOREX GOLD 5 L then TIMOREX GOLD 10 L	1-4 5-9	0 a[100]	32.7 [58]
MAESTRO 80 DF, 2000 g	1-9	0 a[100]	0 a[100]

[1] 1 = 13-20 cm shoots (05 June), 2 = 25-40 cm shoots (11 June), 3 = immediate pre-bloom (18 June), 4 = immediate post-bloom (27 June), 5 = fruit set (08 July), 6 = pea-sized berries (17 July), 7 = bunch close (28 July), 8 = véraison (15 August) and 9 = 2 wk post-véraison (30 August)2 Values in a column followed by the same letter are not significantly different according to the Student Newman Keuls multiple range test ($P = 0.05$). Percent reduction in disease severity from the unsprayed control is shown in brackets [ ].

2008 PMR REPORT # 45 **SECTION K: FRUIT – Diseases**
STUDY DATABASE: WBSE-T.1210.4U

CROP: Peaches (*Prunus persica*) cv. Redhaven
PEST: Gray mold (*Botrytis cinerea* Pers); Brown rot (*Monilinia fructicola* L)

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TITLE: **EVALUATION OF REDUCED RISK FUNGICIDES FOR THE POSTHARVEST CONTROL OF GRAY MOLD AND BROWN ROT IN 'REDHAVEN' PEACHES, 2007**

MATERIALS: SCHOLAR (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT 500SC (45% Thiabendazole, TBZ).

METHODS: SCHOLAR 50wp (fludioxonil) and PENBOTEC (pyrimethanil) were compared with MERTECT (thiabendazole, TBZ) for efficacy against gray mold caused by *Botrytis cinerea* and brown rot caused by *Monilinia fructicola.* Peaches at commercial maturity were harvested on August 09, 2007 from an orchard at Jordan Station, Ontario. All fruit were stored at 4 °C until used in the experimental treatments on August 10, 2007. Peaches were disinfested in 1% household bleach (5% sodium hypochlorite) and 0.01% Tween 20 (Fisher Scientific) for 4 min and rinsed in reverse osmosis water for 4 min. After disinfestation, 24 peaches were placed on a plastic packing insert (24 fruit master) contained in a plastic box. Each box represents a treatment replication. Four replicate trays with 12 fruit/replicate were prepared for each treatment. The peaches were punctured once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 45 minutes of wounding, peaches were inoculated with a 20 µl drop of thiabendazole-resistant *B. cinerea* BC-8dR or thiabendazole-resistant *M. fructicola* at a concentration of 1 x 10^4 conidia/ml and fruit were incubated at 13 °C for 6 hours. Then the fruit were treated with: control, 0.3, 0.6 and 1.2 g/L of SCHOLAR , 0.29, 0.58 and 1.16 g/L of PENBOTEC and a combination of SCHOLAR and PENBOTEC, and MERTECT at 1.15 g/L. The peaches were drop treated. Untreated control had no fungicides. The treatments were completely randomized. Peaches which were treated on August 10, 2007 were evaluated for disease incidence after 5 days of incubation at 20 °C. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: As outlined in Table 1.

CONCLUSIONS: Gary mold control. SCHOLAR at concentrations, 0.3, 0.6 and 1.2 g/L, PENBOTEC at the highest concentrations and combination of SCHOLAR and PENBOTEC gave 100% of control of gray mold after 5 days of storage at 20˚C. As expected, MERTECT was not effective against gray mold caused by thiabendazole-resistant *Botrytis*.

Brown rot control. While all three concentrations of SCHOLAR gave 100% control, PENBOTEC was not effective against brown rot. Some control was observed with MERTECT on brown rot caused by thiabendazole-resistant *M. fructicola*. Latent brown rot symptoms were observed on the fruit after 5 days of storage at 20 °C. SCHOLAR and PENBOTEC and the combination of the two fungicides significantly reduced gray mold but had no effect on the latent brown rot infections.

Table 1. Mean percent incidence of gray mold and brown rot after postharvest treatment of SCHOLAR (fludioxonil) and PENBOTEC on 'Redhaven' Peaches, 2007.

	% Disease incidence after 5 days at 20 °C	
Treatment	Gray mold (*Botrytis cinerea*)	Brown rot (*Monilinia fructicola*)
Inoculum only	100.0 d[1,2]	100.0 f
SCHOLAR @ 0.3 g/L	0.0 a	0.0 a
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
SCHOLAR @ 1.2g/L	0.0 a	0.0 a
PENBOTEC @ 0.29 g/L	83.3 c	95.8 e
PENBOTEC @ 0.58 g/L	12.5 b	91.6 d
PENBOTEC @ 1.16 g/L	0.0 a	16.7 b
SCHOLAR @ 0.3 g/L + PENBOTEC @ 0.29 g/L	0.0 a	0.0 a
SCHOLAR @ 0.6 g/L + PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
MERTECT @ 1.15 g/L	100.0 d	50.0 c

[1] Means within columns followed by the same letter are not significantly different using the Tukey test at $P = 0.05$.

[2] Data represent the mean of four replicates of 12 peaches per replicate. Each peach was wounded and inoculated with thiabendazole-sensitive *M. fructicola* and thiabendazole-resistant *B. cinerea* before treatment.

2008 PMR REPORT # 46 **SECTION K: FRUIT – Diseases**
STUDY DATABASE: WBSE-T.1210.4U

CROP: Peaches (*Prunus persica*) cv. Loring
PEST: Gray mold (*Botrytis cinerea* Pers) Brown rot (*Monilinia fructicola* L)

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TITLE: **EVALUATION OF REDUCED RISK FUNGICIDES FOR THE POSTHARVEST CONTROL OF GRAY MOLD AND BROWN ROT IN 'LORING' PEACHES, 2007**

MATERIALS: SCHOLAR (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) and MERTECT 500SC (45% Thiabendazole, TBZ)

METHODS: SCHOLAR 50wp (fludioxonil) and PENBOTEC (pyrimethanil) were compared with MERTECT (thiabendazole, TBZ) for efficacy against gray mold caused by *Botrytis cinerea* and brown rot caused by *Monilinia fructicola.* Peaches at commercial maturity were harvested on August 23, 2007 from an orchard at Jordan Station, Ontario. All fruit were stored at 4 °C until used in the experimental treatments on August 24, 2007. Peaches were disinfested in 1% household bleach (5% sodium hypochlorite) and 0.01% Tween 20 (Fisher Scientific) for 4 min and rinsed in reverse osmosis water for 4 min. After disinfestation, 24 peaches were placed on a plastic packing insert (24 fruit master) contained in a plastic box. Each box represents a treatment replication. Four replicate trays with 12 fruit/replicate were prepared for each treatment. The peaches were punctured once with a nail-like probe (5 mm diam.) to a depth of 4 mm. Within 45 minutes of wounding, peaches were inoculated with a 20 µl drop of thiabendazole-resistant *B. cinerea* BC-8dR or thiabendazole-resistant *M. Fructicola* at a concentration of 1 x 10^4 conidia/ml and fruit were incubated at 13 °C for 6 hours. Then the fruit were treated with: control, 0.3, 0.6 and 1.2 g/L of SCHOLAR , 0.29, 0.58 and 1.16 g/L of PENBOTEC and a combination of SCHOLAR and PENBOTEC, and MERTECT at 1.15 g/L. The peaches were drop treated. Untreated control had no fungicides. The treatments were completely randomized. Peaches which were treated on August 10, 2007 were evaluated for disease incidence after 5 days of incubation at 20 °C. Fruit were considered decayed when a lesion developed on the fruit. The data obtained were analyzed by analysis of variance using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: As outlined in Table 1.

CONCLUSIONS: Gary mold control. SCHOLAR at concentrations, 0.3, 0.6 and 1.2 g/L, PENBOTEC at the highest concentration and combination of SCHOLAR and PENBOTEC gave 100% of control of gray mold after 5 days of storage at 20˚C. As expected, MERTECT was not effective against gray mold caused by thiabendazole-resistant *Botrytis*.

Brown rot control. While all three concentrations of SCHOLAR gave 100% control, PENBOTEC was not effective against brown rot. Some control was observed with MERTECT on brown rot caused by thiabendazole-resistant *M. fructicola*. Latent brown rot symptoms were observed on the fruit after 5 days of storage at 20 °C. SCHOLAR and PENBOTEC and the combination of the two fungicides significantly reduced gray mold but had no effect on the latent brown rot infections.

Table 1. Mean percentage incidence of gray mold and brown rot after postharvest treatment of SCHOLAR (fludioxonil) and PENBOTEC on 'Loring' Peaches, 2007.

	% Disease incidence after 5 days at 20 °C	
Treatment	Gray mold (*Botrytis cinerea*)	Brown rot (*Monilinia fructicola*)
Inoculum only	100.0 d[1,2]	100.0 f
SCHOLAR @ 0.3 g/L	0.0 a	0.0 a
SCHOLAR @ 0.6 g/L	0.0 a	0.0 a
SCHOLAR @ 1.2g/L	0.0 a	0.0 a
PENBOTEC @ 0.29 g/L	4.2 b	66.7 d
PENBOTEC @ 0.58 g/L	12.5 c	83.3 e
PENBOTEC @ 1.16 g/L	0.0 a	41.7 b
SCHOLAR @ 0.3 g/L + PENBOTEC @ 0.29 g/L	0.0 a	0.0 a
SCHOLAR @ 0.6 g/L + PENBOTEC @ 0.58 g/L	0.0 a	0.0 a
MERTECT @ 1.15 g/L	100.0 d	45.8 c

[1] Means within columns followed by the same letter are not significantly different using the Tukey test at $P = 0.05$.

[2] Data represent the mean of four replicates of 12 peaches per replicate. Each peach was wounded and inoculated with thiabendazole-sensitive *M. fructicola* and thiabendazole-resistant *B. cinerea* before treatment.

2008 PMR REPORT # 47 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE #: T.1206.QM

CROP: Pear (*Pyrus communis* L.) cv. Bartlett
PEST: Pear scab (*Venturia pirina* Aderh)

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TITLE: **ASSESSMENT OF AE-C656948 500 SC AND AE-C656948 125 SC + AE-B100309 375 SC FOR CONTROL OF PEAR SCAB ON 'BARTLETT' PEARS, 2008**

MATERIALS: AE-C656948 500 SC, AE-C656948 125 SC + AE-B100309 375 SC, SCALA 400 SC (pyrimethanil).

METHODS: The trial was conducted to test the affect of fungicides on 'Bartlett' pears in an orchard in Grimsby, Ontario; the trees were spaced 4.2 m apart between rows and 3.5 m apart within rows. A single rate of AE-C656948 500 SC (150 g a.i./ha) was compared to a single rate of AE-C656948 125 SC + AE-B100309 375 SC (400 g a.i./ha), a single rate of SCALA 400 SC (300 g a.i./ha) and an unsprayed (no fungicide) control. Each treatment was replicated four times and each replicate had two trees. The trial was arranged according to a randomized complete block design. The first application occurred on 18 April (at swollen bud stage) followed by applications on 25 April, 5 May, 13 May, 28 May, 9 June, 24 June, 10 July, 29 July, 12 August and 22 August (7, 17, 25, 40, 52, 67, 82, 102, 116, and 126 days, respectively, after the first application). The fungicides were applied in 3000 L of water per hectare, and sprayed to runoff with a Rittenhouse truck-mounted sprayer equipped with a Spraying Systems handgun fitted with a D-6 orifice plate. Twenty-five immature fruit and 150 leaves per replicate were harvested and examined for pear scab (PS) infection on 16 June (7 days after the sixth application), 25 July (15 days after the eighth application), and 18 August (6 days after the tenth application); the number of PS infected fruit and leaves were recorded per replicate. On 4 September (13 days after the eleventh application), 50 mature fruit per replicate were harvested, weighed and examined for PS infection and 150 leaves were harvested and examined for PS infection; the number of PS infected fruit and leaves were recorded per replicate. To determine the disease severity of the fruit and leaves, each infected fruit and leaf was given a rating as follows: no infection = 0, pear scab lesion size between 0 mm and 2 mm in diameter = 1, pear scab lesion size between 2 mm and 5 mm in diameter = 2, pear scab lesion size between 5 mm and 10 mm in diameter = 3, pear scab lesion size between 10 mm and 20 mm in diameter = 4, and pear scab lesion size greater than 20 mm in diameter = 5. An average disease severity rating per replicate was determined by adding all of the individual scab ratings for each fruit or leaf per replicate and dividing by the number of harvested fruit (25 fruit per replicate for the 16 June, the 25 July and the 18 August assessments and 50 fruit per replicate for the 4 September assessment) or harvested leaves (150 leaves per replicate) in each replicate. Data were analyzed using analysis of variance and means separated with a Tukey Test at the 0.05 significance level.

RESULTS: Data are presented in Tables 1, 2, and 3. No phytotoxic effects were observed in any of the treatments during the growing season. The pear scab (PS) leaf disease incidence data of 25 July and 4 September; and the PS fruit disease incidence data of 18 August were not homogeneous and were therefore transformed using log (x+1). The PS leaf disease severity rating and the PS fruit disease severity rating data of 4 September were not homogeneous and were transformed using arcsine (sqrt (x)).

CONCLUSIONS: On 16 June (7 days after the sixth application of 9 June), there were no pear leaves found with pear scab (PS) in any of the treatments or the control. On 25 July (15 days after the eighth application of 10 July), only the AE-C656948 treatment had a significantly lower incidence of PS infected leaves compared to the control and there were no differences among the treatments. On 25 July (15 days after the eighth application of 10 July), there were no significant differences in the disease severity ratings of PS on pear leaves among or between the treatments or the control. On 18 August (6 days after the tenth application of 12 August), all treatments had a significantly lower incidence of PS infected leaves and a significantly lower disease severity rating of PS leaves compared to the control, there were no differences among the treatments. On 4 September (13 days after the eleventh application of 22 August), only the SCALA treatment had a significantly lower incidence of PS infected leaves compared to the control; there were no differences among the treatments. On 4 September (13 days after the eleventh application of 22 August), there were no significant differences in the disease severity rating of PS on pear leaves among or between the treatments or the control (Table 1).

On 16 June (7 days after the sixth application of 9 June), there were no pear fruit found with PS in any of the treatments or the control. There were no differences in the incidence or disease severity of PS infected fruit among or between the treatments and the control on 25 July (15 days after the eighth application of 10 July) or on 18 August (6 days after the tenth application of 12 August). On 4 September (13 days after the eleventh application of 22 August), both the AE-C656948 and the AE-C656948 + AE-B100309 treatments had a significantly lower incidence of PS on pear fruit than the control; there were no differences among the treatments. On 4 September (13 days after the eleventh application of 22 August), both the AE-C656948 and the AE-C656948 + AE-B100309 treatments had a significantly lower disease severity rating of PS on pear fruit than the SCALA treatment and the control (Table 2). There were no significant differences in the weight of 50 pear fruit on 4 September (13 days after the eleventh application of 22 August) (Table 3).

Table 1. Effect of AE-C656948 and AE-C656948 +AE-B100309 on pear scab (PS) disease incidence and PS disease severity on pear leaves.

Treatment[1]	Rate (a.i./ha)	Percent PS incidence and PS disease severity on pear leaves							
		16 June[2]		25 July[3]		18 August[4]		4 September[5]	
		% disease incidence	% disease severity	% disease incidence	% disease severity	% disease incidence	% disease severity	% disease incidence	% disease severity
AE-C656948 500 SC	150 g	0.00 a[6]	0.00 a	2.67 b	0.038 a	1.67 b	0.020 b	4.50 ab	0.065 a
AE-C656948 125 SC + AE-B100309 375 SC	400 g	0.00 a	0.00 a	4.17 ab	0.033 a	2.17 b	0.027 b	5.00 ab	0.065 a
SCALA 400 SC	300 g	0.00 a	0.00 a	4.00 ab	0.057 a	3.33 b	0.042 b	2.83 b	0.065 a
CONTROL (no fungicides)	-	0.00 a	0.00 a	8.83 a	0.063 a	7.33 a	0.123 a	11.67 a	0.187 a

[1] The fungicides were applied on 18 April, 25 April, 5 May, 13 May, 28 May, 9 June, 24 June, 10 July, 29 July, 12 August and 22 August.
[2] 7 days after the sixth application (9 June).
[3] 15 days after the eighth application (10 July).
[4] 6 days after the tenth application (12 August).
[5] 13 days after the eleventh application (22 August).
[6] Means of four replicates (sample size of 150 pear leaves per replicate) within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

Table 2. Effect of AE-C656948 and AE-C656948 + AE-B100309 on pear scab (PS) disease incidence and PS disease severity on pear fruit.

Treatment[1]	Rate (a.i./ha)	Percent PS disease incidence and PS disease severity on pear fruit							
		16 June[2]		25 July[3]		18 August[4]		4 September[5]	
		% disease incidence	% disease severity	% disease incidence	% disease severity	% disease incidence	% disease severity	% disease incidence	% disease severity
AE-C656948 500 SC	150 g	0.00 a[6]	0.00 a	1.00 a	0.002 a	1.00 a	0.007 a	9.50 b	0.037 b
AE-C656948 125 SC + AE-B100309 375 SC	400 g	0.00 a	0.00 a	2.00 a	0.008 a	1.00 a	0.003 a	11.00 b	0.042 b
SCALA 400 SC	300 g	0.00 a	0.00 a	2.00 a	0.012 a	1.00 a	0.005 a	20.50 ab	0.078 a
CONTROL (no fungicides)	-	0.00 a	0.00 a	4.00 a	0.013 a	9.00 a	0.030 a	34.50 a	0.155 a

[1] The fungicides were applied on 18 April, 25 April, 5 May, 13 May, 28 May, 9 June, 24 June, 10 July, 29 July, 12 August and 22 August.
[2] 7 days after the sixth application (9 June).
[3] 15 days after the eighth application (10 July).
[4] 6 days after the tenth application (12 August).
[5] 13 days after the eleventh application (22 August).
[6] Means of four replicates (sample size of 25 pear fruit per replicate on 16 June, 25 July and 18 August and 50 pear fruit on 4 September) within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

Table 3. Effect of AE-C656948 and AE-C656948 + AE-B100309 on pear fruit weight.

Treatment[1]	Rate (a.i./ha)	Weight of 50 fruit (g)
		4 September[2]
AE-C656948 500 SC	150 g	7074.25 a[3]
AE-C656948 125 SC + AE-B100309 375 SC	400 g	7104.00 a
SCALA 400 SC	300 g	7048.25 a
CONTROL (no fungicides)	-	6627.00 a

[1] The fungicides were applied on 18 April, 25 April, 5 May, 13 May, 28 May, 9 June, 24 June, 10 July, 29 July, 12 August and 22 August.
[2] 13 days after the eleventh application (22 August).
[3] Means of four replicates (sample size of 50 pear fruit per replicate) within a column followed by the same letter are not significantly different $P<0.05$, Tukey Test.

2008 PMR REPORT # 48 **SECTION L: VEGETABLES and SPECIALTY CROPS – Diseases**

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.)
PEST: Cavity spot (*Pythium intermedium* de Bary, *Pythium irregulare* Buisman, *Pythium sulcatum* Pratt & Mitchell, *Pythium sylvaticum* W.A. Campbell & J.W. Hendrix, *Pythium ultimum* Trow and *Pythium violae* Chesters & C.J. Hickman)

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TITLE: **EVALUATION OF DIFFERENT COLOURED CARROTS FOR SUSCEPTIBILITY TO CAVITY SPOT, 2008**

MATERIALS: Carrot breeding lines from the University of Wisconsin, carrot cultivars from Bejo Seeds Inc., Johnny's Selected Seeds, Seminis Vegetable Seeds, Alpha Seed, South Africa, Bountiful Gardens, Willits, CA, Garden City Seeds, Ellensburg, WA, Nunhems Vegetable Seeds, and red cultivars from India (supplier unknown)

METHODS: The trial was conducted on organic soil (pH ≈ 7.0, organic matter ≈ 48.0%) naturally infested with *Pythium* spp. near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block design with four replicates per treatment was used. Carrots were direct seeded (70-80 seeds/m) on raised beds using a push V-belt seeder on 2 June. Each replicate consisted of two rows, 86 cm apart, 6 m in length. On 25 August, a random sample of 25 carrots was removed from each treatment and assessed for cavity spot. A 50 carrot sample was harvested on 5 November, placed into cold storage and assessed for cavity spot on 4 and 5 December. On both assessment dates carrots were washed in a small drum washer, examined for cavity spot lesions and sorted into classes based on the size of the largest lesion (measured as horizontal length). The six classes were as follows: no disease; very light < 1mm; light 1-2 mm; medium 3-5 mm; heavy 6-10 mm; very heavy > 10 mm. Carrots were grouped by colour and by cultivar when assessed for disease incidence and severity. The disease severity index (DSI) was determined by the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

The air temperatures in 2008 were below the long term (10 year) average for May (10.7˚C), August (17.9˚C) and September (14.7˚C), average for July (20.4˚C) and above average for June (19.2˚C). The long term (10 year) average temperatures were: May 12.6˚C, June 18.4˚C, July 20.3˚C, August 19.2˚C, and September 15.7˚C. Monthly rainfall was below the long term (10 year) average for May (48 mm) and June (68 mm), above average for July (137 mm) and August (63 mm), and average for September (82 mm). The long term (10 year) rainfall averages were: May 80 mm, June 76 mm, July 69 mm, August 56 mm and September 80 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix 7. Means separation was obtained using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: As presented in Tables 1, 2 and 3

CONCLUSIONS: Cavity spot incidence was very high in 2008. Significant differences were found among cultivars for disease incidence and disease severity index on both assessment dates (Table 1). At the August assessment date, Purple Haze had a significantly lower severity of cavity spot than all other carrots except breeding line purple, and cultivars Belgian White, Purple Rain, and YaYa. At the December assessment date, cultivars Purple Haze and Purple Rain had significantly lower severity of cavity spot of all carrots except Amarillo Yellow, Belgian White and Yellowstone.
When carrots were grouped by colour, significant differences were found for disease incidence and disease severity on both assessment dates (Table 2). At the August and December assessment dates, the purple colour group had the lowest incidence of cavity spot than all other colour groups. At the August assessment date, the purple colour groups had lowest severity of cavity spot of all other colour groups and at the December assessment date the purple and yellow colour groups had a significantly lower severity of cavity spot than all other colour groups. At the December assessment date the red colour group had highest incidence and severity of cavity spot of all the colour groups.
When breeding line carrots were grouped together, significant differences were found for disease incidence and disease severity on both assessment dates (Table 3). At the August assessment date, breeding line purple had significantly less disease than white, yellow and dark orange and at the December assessment date, breeding lines purple and yellow had significantly less disease than red and dark orange. Carrot pigment may influence the susceptibility of carrots to cavity spot.

ACKNOWLEDGEMENT: Funding for this project was supplied by the OMAFRA/University of Guelph sustainable Production Systems Program

Table 1. Disease incidence and disease severity index (DSI) of cavity spot in different coloured carrots, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Cultivar	Source[1]	Colour	Disease Incidence (%)		DSI[2]	
			25 August	4 December	25 August	4 December
Proline red	I	red	70.6 a-d[3]	92.6 a	34.2 ab	65.9 a
Cosmic Purple	JSS	purple	68.3 a-e	85.9 ab	29.7 abc	46.8 bcd
White Satin	Bejo	white	70.7 a-d	85.2 ab	25.9 b-e	42.1 b-f
Atomic Red	JSS	red	61.4 a-f	85.0 ab	20.1 c-g	54.0 ab
Dragon	GCS	red	48.8 c-g	84.7 ab	23.7 c-f	47.9 bc
Dark orange	UW	orange	53.7 b-f	83.6 ab	19.5 d-g	42.2 b-f
Mello Yello	Bejo	yellow	77.6 ab	83.3 ab	29.1 a-d	38.1 c-g
Indian carrot	I	red	45.0 efg	83.1 ab	23.0 c-f	53.8 ab
Alpha	Alpha	orange	81.0 a	82.1 ab	34.7 ab	44.5 b-e
Red	UW	red	48.9 c-g	79.2 ab	21.8 c-f	51.5 b
Envy	Sem	orange	48.0 c-g	70.9 bc	20.5 c-g	31.2 f-i
White	UW	white	84.8 a	68.5 bcd	35.4 ab	30.4 f-i
Yaya	Bejo	orange	40.0 fgh	67.1 bcd	17.1 e-h	32.2 e-h
Crème de Lite	Nun	white	81.8 a	66.7 bcd	36.9 a	34.4 d-h
Cellobunch	Sem	orange	73.1 abc	65.7 c-f	23.0 c-f	26.9 g-j
Yellow	UW	yellow	74.4 ab	51.2 d-g	28.7 a-d	24.1 hij
Purple	UW	purple	25.6 gh	50.4 d-g	11.4 gh	27.4 g-j
Amarillo Yellow	BG	yellow	55.3 b-f	49.3 efg	18.8 efg	22.2 h-k
Belgian White	BG	white	39.7 fgh	45.2 fg	15.9 fgh	19.0 ijk
Yellowstone	GCS	yellow	54.2 b-f	42.1 gh	22.6 c-f	16.4 jkl
Purple Rain	Bejo	purple	46.3 d-g	23.0 hi	16.6 e-h	9.8 kl
Purple Haze	Bejo	purple	17.3 h	12.1 i	8.8 h	5.3 l

[1] Sources: Alpha = Alpha Seed, S.A, Bejo = Bejo Seeds Inc., BG = Bountiful Gardens, GCS = Garden City Seeds, JSS = Johnny's Selected Seeds, I = India, Nun = Nunhems Vegetable Seeds, Sem = Seminis Vegetable Seed, Stokes = Stokes Seed Ltd., UW = University of Wisconsin breeding lines

[2] Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

[3] Numbers in a column followed by the same letter were not significantly different at P=0.05, Fisher's Protected LSD Test.

Table 2. Disease incidence and severity (DSI) of cavity spot of different coloured carrots grouped by colour, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Colour[1]	Disease Incidence (%)		DSI[2]	
	25 August	4 December	25 August	4 December
Red	54.9 b[3]	85.5 a	24.5 ab	54.8 a
Orange	59.2 ab	73.9 b	23.0 b	35.4 b
White	69.3 a	66.4 b	28.5 a	31.5 b
Yellow	65.4 ab	56.5 c	24.8 ab	25.2 c
Purple	39.4 c	42.8 d	16.6 c	22.3 c

[1] Cultivars of similar colour were grouped for analysis

[2] Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

[3] Numbers in a column followed by the same letter were not significantly different at P=0.05, Fisher's Protected LSD Test.

Table 3. Disease incidence and severity (DSI) of cavity spot of various breeding lines from University of Wisconsin, grown near the Muck Crops Research Station, Holland Marsh, Ontario, 2008.

Breeding Line	Variety #	Disease Incidence (%)		DSI[2]	
		25 August	4 December	25 August	4 December
Dark Orange	101-23	53.7 b[1]	83.6 a	19.5 c	42.2 ab
Red	104-3	48.9 bc	79.2 a	21.8 bc	51.5 a
White	105-7	84.8 a	68.5 ab	35.4 a	30.4 bc
Yellow	102-1	74.4 ab	51.2 b	28.7 ab	24.1 c
Purple	106-3	25.6 c	50.4 b	11.4 d	27.4 bc

[1] Numbers in a column followed by the same letter were not significantly different at P = 0.05, Fisher's Protected LSD test.

[2] Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. carrots per sample})(\text{no. classes } -1)} \times 100$$

2008 PMR REPORT # 49 **SECTION L: VEGETABLES and SPECIALTY CROPS – Diseases**

CROP: Yellow cooking onions (*Allium cepa* L.) cv. Hamlet
PEST: Downy mildew (*Peronospora destructor* Berk. Casp. In Berk)

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TITLE: **COMPARISON OF VARIOUS ONION VARIETIES FOR RESISTANCE TO DOWNY MILDEW (*PERONOSPORA DESTRUCTOR*) IN ONIONS, 2008**

MATERIALS: Eight onion cultivars from various seed companies

METHODS: Onions of cultivars Tahoe, Yankee (Bejo Seeds Inc.), Hamlet, Ricochet, Fortress, Mars (Stokes Seeds), Nebula (Nunhems) and Stanley (Solar Seeds Inc.) were direct seeded (34 seeds/m) using a Stan Hay Precision seeder on 6 May, into organic soil (organic matter ≈ 48.0%, pH ≈ 7.2) near the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each experimental unit consisted of four rows, 42 cm apart, 5 m in length. Recommended control procedures for weeds and insects were followed. On 6 and 14 August, plants in two, 1 m sections of row per replicate were examined for downy mildew lesions and the numbers of lesions and plants were counted and recorded. On 21 August, all the plants in a randomly selected 1 m section of row per replicate were pulled, dead leaves counted and green leaves removed and individually assessed visually for downy mildew severity on a scale of 0 to 5 where 0 = no disease, 1 = <10% disease, 2 = 11 – 25% diseased, 2 = 26% - 50% diseased, 3 = 51 – 75% diseased, 4 = 51 = 75% diseased and 5 = >75% diseased. Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \text{ x100}$$

On 11 September a 4.64 m yield sample was taken from each replicate. The onions were weighed and graded for size on 19 November. The air temperatures in 2008 were below the long term (10 year) average for May (10.7˚C), August (17.9˚C) and September (14.7˚C), average for July (20.4˚C) and above average for June (19.2˚C). The long term (10 year) average temperatures were: May 12.6˚C, June 18.4˚C, July 20.3˚C, August 19.2˚C, and September 15.7˚C. Monthly rainfall was below the long term (10 year) average for May (48 mm) and June (68 mm), above average for July (137 mm) and August (63 mm), and average for September (82 mm). The long term (10 year) rainfall averages were: May 80 mm, June 76 mm, July 69 mm, August 56 mm and September 80 mm. Data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.7. Means separation was obtained by using Fisher's Protected LSD test at $P = 0.05$ level of significance.

RESULTS: As presented in Tables 1 & 2

CONCLUSIONS: Significant differences were found among the cultivars in percent healthy leaves, disease severity (Table 1), plant stand, yield and percent marketable (Table 2). Cultivar Yankee had the highest percent healthy leaves and the lowest DSI of all the cultivars. Cultivars Yankee, Mars and Nebula also had a significantly higher percentage of healthy leaves than cultivar Stanley. Yankee has been bred for mildew resistance; however, at both the 6 and 14 August in-field assessments, downy mildew lesions were found. The significant differences in yield may be a related to plant stand and differences in phenotype. Disease pressure was high in the trial as July and August were wetter than average.

Table 1. Downy mildew (DM) ratings and disease severity index (DSI) and percent healthy leaves on 22 August for various onion cultivars grown at the Muck crops Research Station, Holland Marsh, 2008.

Variety	DM Lesions/plant 6 August	DM Lesions/plant 14 August	% Healthy Leaves[2]	DSI[4]
Yankee	0.03 ns[1]	0.03 ns	100.0 a[3]	0.0 a
Mars	0.06	1.83	16.9 b	62.7 b
Nebula	0.03	1.93	15.7 b	68.2 b
Tahoe	0.20	2.56	12.9 bc	64.5 b
Hamlet	0.05	2.63	12.4 bc	69.9 b
Fortress	0.13	2.72	10.9 bc	64.7 b
Ricochet	0.11	3.14	10.8 bc	71.7 b
Stanley	0.09	3.23	5.9 c	62.9 b

[1] ns indicates that no significant differences were found among the treatments at P=0.05 according to Fisher's Protected LSD

[2] percentage of leaves assessed for DM severity

[3] Numbers followed by the same letter are not significantly different at P = 0.05, Fisher's Protected LSD test.

[4] Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \text{ x100}$$

Table 2. Yield data for various onion cultivars grown at the Muck Crops Research Station, Holland Marsh, 2008.

Variety	Yield (t/ha)	Plant Stand (Plants/m)	% Marketable
Stanley	57.0 a[1]	24.8 a	96.1 a
Nebula	53.5 ab	21.4 bc	96.8 a
Ricochet	51.3 ab	18.9 cd	97.6 a
Tahoe	46.2 abc	22.0 ab	94.8 a
Yankee	45.6 abc	15.3 e	96.6 a
Hamlet	41.5 bcd	18.1 de	95.5 a
Mars	35.6 cd	11.5 f	98.1 a
Fortress	33.3 d	17.2 de	90.4 b

[1] Numbers followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

2008 PMR REPORT # 50 **SECTION M: FIELD LEGUMES - Diseases**

CROP: Bean (*Phaseolus vulgaris* L.) cv. Winchester
PEST: Bacterial wilt **(***Curtobacterium flaccumfaciens* pv. *flaccumfaciens*, brown spot (*Pseudomonas syringae* pv. *syringae*), common blight (*Xanthomonas axonopodis* pv. *phaseoli*), and halo blight (*P. syringae* pv. *phaseolicola*)

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TITLE: EVALUATION OF AGRESS FOR CONTROL OF SEED-BORNE BACTERIA IN DRY BEAN, 2008

MATERIALS: AGRESS (oxysilver nitrate, Innovotech Inc., Edmonton, AB), APRON MAXX RTA (fludioxinil + metalaxyl, Syngenta Crop Protection, Guelph, ON), SECURE (seed coating polymer, BeckerUnderwood, Saskatoon, SK).

METHODS: Trials were conducted on the heavy Sutherland clay-loam soil of the AAFC Research Farm at Saskatoon SK (N 52˚ 09' W 106˚ 34') in 2008 to assess the impact of seed treatments on seed transmission and subsequent infection in bean by four seed-borne bacterial pathogens. A separate trial was conducted for each pathogen. The pathogens were *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* (bacterial wilt), *Pseudomonas syringae* pv. *phaseolicola* (halo blight); *P. syringae* pv. *syringae* (brown spot), and *Xanthomonas axonopodis* pv. *phaseoli* (common blight). Similar trials were conducted on field pea (*Pisum sativum*) cv. Camry inoculated with *Erwinia rhapontici* (pink seed) and *Pseudomonas syringae* pv. *pisi* (bacterial blight). However, no disease developed in these trials. The bean and pea trials were repeated at Brooks AB in 2008 but disease levels were low and highly variable, so the results are not presented.

Seed was coated with a concentrated (~10^8 cfu/mL) nutrient broth culture of the bacterial pathogen by adding 5-mL of bacterial culture per kilogram of seed drop-wise to seed tumbling in a rotating drum. The inoculated seed was air dried at room temperature and seed treatments were applied in a rotating drum as described above. There were seven seed treatments: Apron Maxx RTA; Apron Maxx RTA + 0.05 % Agress; Apron Maxx RTA+ 0.1 % Agress; Apron Maxx RTA + 1 % Agress; Secure + 0.1 % Agress; 0.1 % Agress (aq); and water applied as a nontreated control. Apron Maxx RTA and secure were applied at a rate of 3.25 mL kg^{-1}. Seed was air dried at room temperature, packaged and stored at about 8 ºC until planting.

Each study was arranged in a RCBD design with four replications. Each plot consisted of four rows, each 6-m long, with 0.3 m between rows and 1.2 m between blocks. There was a guard row of fababean (*Vicia faba*) between each plot. The plots were direct seeded to achieve 44 plants m^{-2} using a double-disc

drill seeder. The trials were seeded on 29 and 30 May. Weed control consisted of applying Edge (ethalfluralin, Dow AgroSciences Canada Inc., Calgary, AB) the previous fall according to label specifications, tillage in early spring to prepare the seed bed, hand tillage after seedling emergence, and hand roguing as needed. No irrigation was applied due to regular rainfall after planting.

Seedling emergence was counted 3-4 weeks after seeding on two 1-m-long sections within the two centre rows of each plot. Disease incidence was assessed by counting plants with symptoms (as described for emergence). Disease severity was assessed using the 0–11 Horsfall-Barratt scale (Horsfall and Barratt, 1945) on 10 plants per plot selected at random. The ratings were taken on 30 July–01 August and on 22, 26, and 28 August.

The trials were harvested on 24–25 September using a small-plot combine. Seed was air-dried, cleaned, and weighed to estimate yield. Analysis of variance (General Linear Model Procedure of SAS) was used for statistical analysis, with means separation using the Waller-Duncan K-ratio t test. Differences are significant at $P \leq 0.05$ unless specifically noted.

RESULTS: Seeding was delayed because conditions throughout May were so cool and dry that germination would have been slow and erratic. Instead, the trials were seeded into warm soil just before a major rain event, which resulted in rapid, uniform germination and establishment. Visible disease symptoms did not develop until the plants were flowering or even starting to pod, so disease assessments were delayed until late in the season.

Bacterial wilt – There were no differences in seedling emergence associated with treatment, no differences in wilt incidence at the first rating date, and only small differences in severity (both dates) and yield. However, both Agress and Apron Maxx reduced wilt incidence at the second rating date relative to the control (Table 1).

Brown spot –There were no differences in seedling emergence associated with treatment, and no differences in wilt incidence or severity at the first rating date. Both Agress and Apron Maxx treatments reduced the incidence of foliar symptoms at the second rating date relative to the control, but had only a small impact on severity and no impact on yield (Table 2).

Common blight –There were no differences in seedling emergence associated with treatment, and only small differences in wilt incidence and severity among treatments at the first rating date. Both Agress and Apron Maxx substantially reduced blight incidence at the second rating date relative to the control, but had only a small impact on severity and no impact on yield (Table 3).

Halo blight –There were no differences in seedling emergence associated with treatments, and only small differences in wilt incidence with no impact on severity at the first rating date. Both Agress and Apron Maxx reduced blight incidence at the second rating date relative to the control, but had no impact on severity. However, there was a 10% increase in yield associated with moderate to high rates of Agress (Table 4).

CONCLUSIONS: Symptom development on bean was clear and quite easy to recognize. Also, there were no other foliar pathogens of bean present at the trial site to confound disease assessment. None of the treatments affected seedling establishment or yield, except for a small increase in yield for halo blight. There were differences in disease incidence for all four pathogens in late August, which were associated with small differences in disease severity at that date. Disease epidemics developed too late and too slowly to have a substantial impact on yield. Also, conditions during seed maturation in September were quite dry, so it is unlikely that the seed carried substantial amounts of inoculum. However, the consistent differences that were observed for disease incidence late in the season are promising.

One unexpected observation was that Apron Maxx had the same impact on the bacterial pathogens as Agress. Seedling blight was not a major problem at this site. If it had been, the fungicide seed treatment would have had a larger impact on seedling establishment.

REFERENCE:

Horsfall, J. G. and Barrett, R. W. 1945. An improved grading system for measuring plant diseases. Phytopathology 35: 655.

Table 1. Impact of seed treatments on emergence, disease incidence (%) and severity (0–11 scale[1]), and seed yield in a dry bean trial inoculated with *Curtobacterium flaccumfaciens* (bacterial wilt) at Saskatoon, 2008.

Treatment	Seedlings (m^{-1} row)	Wilt incidence (%)		Wilt severity[1]		Yield (mg/ha)
		Jul. 31	Aug. 22	Jul. 31	Aug. 26	
Apron Maxx (AM)	15.1 a	4.4 a	8.2 c	1.1 b	4.9 b	1.87 b
Agress (0.05%) + AM	14.5 a	5.0 a	10.7 b	1.4 ab	5.3 a	2.20 a
Agress (0.1%) + AM	14.6 a	4.6 a	10.7 b	1.0 b	5.2 a	2.12 ab
Agress (1%) + AM	13.9 a	4.5 a	7.6 c	1.2 ab	4.7 c	2.09 ab
Agress (0.1 %) + Secure	14.1 a	5.7 a	9.1 bc	1.4 ab	4.9 b	2.00 ab
Agress (0.1%)	15.2 a	5.2 a	8.9 c	1.3 ab	4.9 b	2.11 ab
Nontreated control	12.6 a	6.2 a	15.9 a	1.6 a	5.3 a	1.98 ab

(a-d) Means in a column followed by the same letter do not differ based on the Waller-Duncan K-ratio t test at $P = 0.05$.

[1] Horsfall-Barratt scale.

Table 2. Impact of seed treatments on seedling emergence, disease incidence and severity (0–11 scale[1]), and seed yield in a dry bean trial inoculated with *Pseudomonas syringae* pv. *syringae* (brown spot) at Saskatoon SK, 2008.

Treatment	Seedlings (m^{-1} row)	Incidence (%)		Severity		Yield (mg/ha)
		Jul. 31	Aug. 22	Jul. 31	Aug. 26	
Apron Maxx (AM)	13.5 a	4.9 a	9.4 c	0.5 a	4.8 c	1.58 a
Agress (0.05%) + AM	14.5 a	4.7 a	11.4 b	1.0 a	5.1 b	1.43 a
Agress (0.1%) + AM	15.6 a	4.5 a	11.6 b	0.7 a	5.1 b	1.57 a
Agress (1%) + AM	13.6 a	5.2 a	7.7 d	0.9 a	4.7 cd	1.63 a
Agress (0.1 %) + Secure	14.4 a	5.6 a	9.9 c	0.9 a	4.7 cd	1.53 a
Agress (0.1%)	14.1 a	4.6 a	8.4 d	0.6 a	4.6 d	1.61 a
Nontreated control	15.2 a	5.1 a	14.6 a	0.6 a	5.2 a	1.46 a

(a-d) Means in a column followed by the same letter do not differ based on the Waller-Duncan K-ratio t test at $P = 0.05$.

[1] Horsfall-Barratt scale.

Table 3. Impact of seed treatments on seedling emergence, disease incidence and severity (0–11 scale[1]), and seed yield in a dry bean trial inoculated with *Xanthomonas axonopodis* (common blight) at Saskatoon, SK in 2008.

Treatment	Seedlings (m^{-1} row)	Blight incidence (%)		Blight severity		Yield
		Jul. 31	Aug. 22	Jul. 31	Aug. 26	(mg/ha)
Apron Maxx (AM)	14.7 a	4.2 bc	8.6 c	0.9 b	4.9 bc	1.84 a
Agress (0.05%) + AM	13.6 a	5.1 b	12.0 b	1.0 b	5.1 a	1.88 a
Agress (0.1%) + AM	15.0 a	3.9 c	11.4 b	1.1 b	5.0 b	1.84 a
Agress (1%) + AM	16.6 a	3.6 c	7.9 c	1.1 b	4.8 cd	1.87 a
Agress (0.1 %) + Secure	13.4 a	3.2 c	9.2 c	1.1 b	4.7 d	1.94 a
Agress (0.1%)	15.7 a	5.1 b	8.1 c	0.9 b	4.8 bc	1.86 a
Nontreated control	13.2 a	6.2 a	15.2 a	1.7 a	5.3 a	1.77 a

(a-d) Means in a column followed by the same letter do not differ based on the Waller-Duncan K-ratio t test at $P = 0.05$.
[1] Horsfall-Barratt scale.

Table 4. Impact of seed treatments on seedling emergence, disease incidence and severity (0–11 scale[1]), and seed yield in a dry bean trial inoculated with *Pseudomonas syringae* pv. *phaseolicola* (halo blight) at Saskatoon, SK in 2008.

Treatment	Seedlings	Blight incidence (%)		Blight severity[1]		Yield
	(m^{-1} row)	Jul. 31	Aug. 22	Jul. 31	Aug. 26	(mg/ha)
Apron Maxx (AM)	12.9 b	2.5 b	8.7 c	0.8 a	5.1 b	1.66 abc
Agress (0.05%) + AM	13.1 b	4.7 a	11.5 b	1.2 a	5.2 a	1.61 abc
Agress (0.1%) + AM	13.6 ab	4.4 a	11.0 b	1.1 a	5.2 a	1.69 ab
Agress (1%) + AM	13.5 ab	5.2 a	8.0 c	0.8 a	4.8 d	1.72 a
Agress (0.1 %) + Secure	16.0 a	5.7 a	8.7 c	1.1 a	5.1 b	1.50 c
Agress (0.1%)	12.6 b	4.1 ab	8.0 c	1.0 a	5.0 c	1.66 abc
Nontreated control	13.4 ab	5.5 a	15.0 a	1.5 a	5.2 a	1.53b c

(a-d) Means in a column followed by the same letter do not differ based on the Waller-Duncan K-ratio t test at $P = 0.05$.
[1] Horsfall-Barratt scale.

2008 PMR REPORT # 51 **SECTION M: FIELD LEGUME - Diseases**

CROP: Chickpea (*Cicer arietinum* L.) cv. CDC Xena (kabuli type).
PEST: Ascochyta blight (*Didymella rabiei* (Kovachevski) Arx, anamorph *Ascochyta rabiei* (Pass.) Labrousse)

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TITLE: **EVALUATION OF PENTHIOPYRAD FUNGICIDE FOR CONTROL OF ASCOCHYTA BLIGHT ON CHICKPEA IN 2007 AND 2008**

MATERIALS: LEM17 EC and SC (penthiopyrad, E.I. DuPont Canada Co., Mississauga, ON); Bravo 500 (chlorothalonil, Syngenta Crop Protection Canada, Inc., Guelph, ON); Quadris (azoxystrobin, 250g/L; Syngenta Crop Protection Canada Inc.); Manzate 200 DF (mancozeb, E.I. DuPont Canada Co.) ; Lance 70% DF (boscalid, BASF Canada Inc., Toronto, ON).

METHODS: A trial to assess the impact of foliar fungicide application on ascochyta blight severity and seed yield of chickpea cv. CDC Xena was conducted on a Sutherland clay-loam soil at the AAFC Research Farm at Saskatoon in 2007 and 2008. The chickpea cv. CDC Xena, which was assessed in both years, has a unifoliate leaf type, late maturity, and is highly susceptible to ascochyta blight (Saskatchewan Seed Guide, 2007). The seed was treated with Allegiance FL (metalaxyl, Bayer CropScience Inc. Calgary, AB) at 0.016 L/100 kg of seed before seeding to control seedling blight caused by *Pythium* spp. The plots were direct seeded at about 45 plants per m^2 using a double-disc drill seeder. The trial was seeded on 11 May in 2007. In 2008, a portion of the trial was seeded on 16 May and the remainder on 23 May.

The studies were laid out as a RCBD with four replications. Each plot consisted of eight rows, each 6-m long, with 0.3 m between rows (15 m^2) and 1.2 m between plots, separated by wheat or barley guard rows. The plot areas had been seeded to barley the previous year. Edge herbicide (ethalfluralin, Dow AgroSciences Canada Inc., Calgary, AB) plus 11-51-0 fertilizer was applied and incorporated with tillage the fall before the trial to provide early-season weed control. Another tillage pass was made in early spring to produce a smooth seedbed for seeding, and subsequent weed control was achieved with hand tillage at the seedling stage and hand roguing as needed.

There were 14 treatments in the trial in 2007, with each applied at the pre-bloom and mid-bloom stage: LEM17 EC at 100, 150, 200, 250 and 300 g a.i./ha, LEM17 SC at 100, 150, 200, 250 and 300 g a.i./ha, Manzate 200 DF at 1.7 kg a.i./ha, Lance at 290 g a.i./ha; and Bravo 500 at 1.5 kg a.i./ha at pre-bloom stage and Quadris at 120 g a.i./ha at mid-bloom stage, plus an untreated control. In 2008, treatments LEM 17 EC and LEM 17 SC at 150 g a.i./ha and Manzate 200 DF at 1.7 kg a.i./ha were dropped from the trial. The treatments were applied with a CO_2 backpack sprayer (Model GS, R&D Sprayers, Inc.) equipped with an aluminum spray boom with four XR TeeJet 8002 VS nozzles spaced 48 cm apart, calibrated to deliver 250 L/ha at 240 kPa. The fungicide treatments were applied at early flowering (13 July, 2007 and 29 July, 2008) and early pod stage (27 July, 2007 and 14 August, 2008).

Ten plants per plot were selected at random and assessed for ascochyta blight severity on whole plants (foliage and stems) using the Horsfall-Barratt scale (0-11) on 12 and 26 July, and 13 August in 2007 and

28 July and 12 and 29 August in 2008. Crop tolerance (% foliar damage/injury) was assessed on July 26 and August 13 in 2007, and 12 and 29 August in 2008; no injury was observed on any plot. The trial was harvested on 10 11 September in 2007 and 22 23 October in 2008. The seed was air-dried and cleaned, then weighed. Analysis of variance (General Linear Model Procedure of SAS) was conducted to assess the impact of treatments, with means separation using the Waller-Duncan K-ratio t test. Differences are significant at $P = 0.05$ unless specifically noted.

RESULTS: Seedlings emerged quickly and uniformly in 2007 and plant growth stage was uniform across the trial. In 2008, soil conditions were so dry that most of the seedlings did not emerge until early June, after rains in late May. This resulted in uneven stands throughout the season and increased variability in assessments of both foliar disease and yield.

When the fungicide treatments were initiated, levels of ascochyta blight were low, but the disease was present in all plots in both years. This indicates that natural inoculum for ascochyta was present at the site. At the first rating date (prior to treatment initiation), severity was low and there were no differences among treatments in either year (Tables 1 and 2). This low level of ascochyta blight indicates that conditions early in the growing season were not conducive for disease development in either year. At the 2nd rating date, severity had increased substantially. There were differences in severity between the treatments and the control in 2007 (Table 1), but no difference in 2008 (Table 2). At the 3rd rating date, there were differences among treatments in both 2007 and 2008, with the control having the highest severity. These differences were reflected in seed yield, with the fungicide treatments having higher yields than the control. Yield was quite variable in 2008, likely because of uneven seedling establishment during dry conditions in May. Also, yields were about twice as high in 2007 as 2008.

CONCLUSIONS: Application of LEM 17 consistently reduced the severity of ascochyta blight and there was no evidence of phytotoxicity at any rate. Both formulations of LEM17 were effective. In 2007, the severity of ascochyta blight was low but all of the fungicides except Manzate increased seed yield compared to the control. In 2008, disease pressure was low to moderate until late in the season. Efficacy of LEM17 increased with increasing rate up to 250 gm, with the best treatment yielding more than 200% of the control in 2008. This indicates that two spray applications provided good control of blight on this highly susceptible cultivar.

REFERENCE:

Horsfall, J. G. and Barrett, R. W. 1945. An improved grading system for measuring plant diseases. Phytopathology 35: 655.

Table 1. Impact of two applications of foliar fungicide on severity of ascochyta blight (0 - 11 scale[1]) and seed yield of chickpea cv. Xena at Saskatoon in 2007.

Treatment	Rate	Blight severity			Yield
	(g a.i./ha)	Jul. 12	Jul. 26	Aug. 13	(mg/ha)
Nontreated control	---	2.0 a	3.3 a	4.7 a	1.97 b
LEM17 EC	100	1.9 a	2.7 b	3.9 b	2.40 ab
	150	1.7 a	2.6 bc	3.7 bc	2.61 a
	200	1.7 a	2.4 cde	3.1 f	2.52 a
	250	1.6 a	2.6 bc	3.3 c-f	2.59 a
	300	1.7 a	2.5 bcd	3.2 ef	2.58 a
LEM17 SC	100	1.7 a	2.3 de	3.4 c-f	2.11 ab
	150	1.8 a	2.5 bcd	3.2 def	2.50 a
	200	1.8 a	2.4 cde	3.6 cd	2.61 a
	250	1.8 a	2.4 cde	3.1 f	2.39 ab
	300	1.7 a	2.3 de	3.2 def	2.51 a
Bravo + Quadris	1500/124	1.6 a	2.2 de	3.1 f	2.59 a
Manzate	1700	1.8 a	2.4 b-d	3.4 cde	2.15 ab
Lance	300	1.7 a	2.1 e	3.1 f	2.60 a

(a-f) Means in a column followed by the same letter do not differ at $P = 0.05$ based on the Waller-Duncan K-ratio t test.
[1] Horsfall-Barratt scale.

Table 2. Impact of two applications of foliar fungicide on severity of ascochyta blight (0 - 11 scale[1]) and seed yield of chickpea cv. Xena at Saskatoon in 2008.

Treatment	Rate	Blight severity			Yield
	(g a.i./ha)	Jul. 28	Aug. 12	Aug. 29	(mg/ha)
Nontreated control	---	2.6 a	5.8 a	6.7 a	0.82 c
LEM17 EC	100	2.5 a	5.4 a	5.4 b	1.02 bc
	200	2.2 a	5.3 a	5.2 bc	1.30 abc
	250	2.3 a	5.1 a	4.9 d	1.37 abc
	300	2.7 a	5.4 a	5.0 cd	1.59 ab
LEM17 SC	100	2.6 a	5.6 a	5.3 b	1.02 bc
	200	2.6 a	5.2 a	5.2 bc	1.78 a
	250	2.4 a	5.4 a	5.0 cd	1.32 abc
	300	2.5 a	5.3 a	5.0 cd	1.27 abc
Bravo + Quadris	1500/120	2.5 a	5.6 a	5.3 b	1.66 a
Lance	290	2.4 a	5.4 a	4.9 cd	1.36 abc

(a-f) Means in a column followed by the same letter do not differ at $P = 0.05$ based on the Waller-Duncan K-ratio t test.
[1] Horsfall-Barratt scale.

2008 PMR REPORT # 52 **SECTION M: FIELD LEGUMES - Diseases**

CROP: Lentil (*Lens culinaris* Medik.) cv. CDC Milestone
PEST: Ascochyta blight (*Ascochyta lentis* Vassilievsky) and Anthracnose (*Colletotrichum truncatum* (Schwein) Andrus & W.D. Moore)

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TITLE: EVALUATION OF PENTHIOPYRAD FUNGICIDE FOR CONTROL OF ASCOCHYTA BLIGHT AND ANTHRACNOSE IN LENTIL, 2007 AND 2008

MATERIALS: LEM17 EC and SC (penthiopyrad, E.I. DuPont Canada Co., Mississauga, ON); Bravo 500 (chlorothalonil, Syngenta Crop Protection Canada, Inc., Guelph, ON); Quadris (azoxystrobin, 250g/L; Syngenta Crop Protection Canada Inc.); Manzate 200 DF (mancozeb, E.I. DuPont Canada Co.); Lance 70% DF (boscalid, BASF Canada Inc., Toronto, ON).

METHODS: A trial to assess the impact of foliar fungicide application on foliar disease severity and seed yield of lentil cv. CDC Milestone was conducted on a Sutherland clay-loam soil at the AAFC Research Farm at Saskatoon in 2007 and in 2008. CDC Milestone is in the small green market class, with early maturity and good resistance to ascochyta blight but is susceptible to anthracnose (Saskatchewan Seed Guide, 2007). The trial was seeded on 14 May in 2007 and on 13 May in 2008. The trial was direct seeded at about 130 plants per m^2 using a double-disc drill seeder. In 2008, seedling emergence was slow and uneven until rains in late May provided sufficient moisture for consistent seed germination. As a result, plant growth stage was quite uneven throughout the season.

The study was arranged in a RCBD with four replications. In 2007, one replicate was lost due to spring flooding. Each plot consisted of eight rows, each 6-m long, with 0.3 m between rows and 1.2 m between plots, separated by wheat or barley guard rows. Edge herbicide (ethalfluralin, Dow AgroSciences Canada Inc., Calgary, AB) plus 11-51-0 fertilizer was applied and incorporated with tillage the previous fall or in early spring before seeding to provide early-season weed control. Another tillage pass was made in early spring to produce a smooth seedbed for seeding, and subsequent weed control was achieved with hand weeding (tillage) at the seedling stage and hand roguing as needed.

In 2007, the study was inoculated twice to initiate an epidemic. First, lentil crop residue infected with anthracnose was spread uniformly throughout the study area on July 11. On July 24, inoculum of *C. truncatum* grown on autoclaved rye grain for 7 10 days was spread throughout the plot area at 2 g/m^2 to increase disease severity. Overhead irrigation was also applied using a riser and impact nozzle system on four dates (about 1 cm per application) in late July and early August in response to hot dry conditions. In 2008, the study was not inoculated and no irrigation was applied.

There were 14 treatments in 2007: LEM17 EC at 100, 150, 200, 250 and 300 g a.i./ha, LEM17 SC at 100, 150, 200, 250 and 300 g a.i./ha, Manzate 200 DF at 1.7 kg a.i./ha, Lance at 290 g a.i./ha; Bravo 500 at 1.5 kg a.i./ha at pre-bloom with Quadris at 120 g a.i./ha at mid-bloom , and a nontreated control. In 2008, treatments LEM 17 EC and LEM 17 SC at 150 g a.i./ha and Manzate 200 DF were dropped from the trial. For each treatment, two fungicide applications were planned, to be applied at the pre-bloom and mid-

bloom stage. In both years, the first fungicide application was delayed because disease levels were low and conditions were not conducive for epidemic development. Instead, the initial fungicide treatments were applied at the early pod stage (02 August, 2007 and 07 August, 2008) and the second application at the late pod stage (12 August, 2007 and 19 August, 2008). The treatments were applied with a CO_2 backpack sprayer (Model GS, R&D Sprayers, Inc.) equipped with an aluminum spray boom with four XR TeeJet 8002 VS nozzles spaced 48 cm apart and calibrated to deliver 250 L/ha at 240 kPa.

Ten plants per plot were selected at random and assessed for severity of ascochyta blight and anthracnose on whole plants (foliage and stems) using the 0-11 Horsfall-Barratt scale (Horsfall and Barratt, 1945) on 01, 10, and 21 August in 2007 and on 06, 20, and 29 August in 2008. Crop tolerance was assessed on 10 and 21 August in 2007 and 20 and 29 August in 2008; no injury was observed in any treatment.

The trial was harvested on 26 30 August in 2007 and on 09 11 September in 2008 using a small plot combine. The seed was air-dried and cleaned, then weighed. Analysis of variance (General Linear Model Procedure of SAS) was used to assess the impact of treatments, and means separation was conducted using the Waller-Duncan K-ratio t test. Differences are significant at $P = 0.05$ unless specifically noted.

RESULTS: Seedling emergence was rapid and uniform in 2007, but soil conditions at seeding in 2008 were so dry that most of the seed did not emerge until early June, after rains in late May. This resulted in uneven stands and increased variability in yield assessments.

The pattern of response was the same in both years. When the fungicide treatments were initiated, levels of ascochyta and anthracnose were very low (Tables 1 and 2) but both diseases were present in all plots (based on visual assessment of symptoms). There were no differences among treatments. At the 2nd rating date, severity was lower in most of the fungicide treatments compared to the control. At the final rating date, differences in severity between the fungicide treatments and the control had increased but the epidemics never developed to severe levels. However, there were no difference among treatments for seed yield (Tables 1 and 2).

CONCLUSIONS: Application of LEM17 fungicide consistently reduced the severity of ascochyta and anthracnose, and there was no evidence of phytotoxicity on lentil at any rate. Both formulations of LEM17 were effective. There was a consistent trend of increasing efficacy (reduction in foliar disease severity) with increasing rate up to about 250 g a.i. There was a similar trend in seed yield, where the best treatment yielded almost 45% more than the control, but differences were not significant. It is likely that disease pressure developed too late in both years to have a substantial impact on seed yield.

REFERENCE:

Horsfall, J. G. and Barrett, R. W. 1945. An improved grading system for measuring plant diseases. Phytopathology 35: 655.

Table 1. Effect of two applications of foliar fungicide on severity of ascochyta blight and anthracnose (0 - 11 scale[1]) and seed yield of lentil cv. CDC Milestone at Saskatoon in 2007.

Treatment	Rate	Ascochyta			Yield
	(g a.i./ha)	Aug. 01	Aug. 10	Aug. 21	(mg/ha)
Nontreated control	---	0.83 a	2.9 a	4.6 a	1.99 a
LEM17 EC	100	0.85 a	1.4 bc	2.9 bc	1.91 a
	150	0.95 a	1.7 b	2.7 cd	2.00 a
	200	0.73 a	1.1 c	2.4 ef	2.11 a
	250	0.80 a	1.4 bc	2.3 fg	2.03 a
	300	0.70 a	1.1 c	2.1 g	1.93 a
LEM17 SC	100	0.90 a	1.4 bc	3.1 b	2.15 a
	150	0.73 a	1.3 c	2.6 cde	2.30 a
	200	0.77 a	1.4 bc	2.4 def	2.00 a
	250	0.70 a	1.1 c	2.0 gh	2.08 a
	300	0.93 a	1.2 c	2.3 fg	2.07 a
Bravo + Quadris	1500/120	0.80 a	1.3 c	1.6 i	2.11 a
Manzate	1700	0.77 a	1.3 c	2.6 c-f	2.17 a
Lance	300	0.87 a	1.2 c	1.7 hi	2.15 a

(a - i) Means in a column followed by the same letter do not differ at $P = 0.05$ based on the Waller-Duncan K-ratio t test.
[1] Horsfall-Barratt scale

Table 2. Effect of two applications of foliar fungicide on severity of ascochyta blight and anthracnose (0 - 11 scale[1]) and seed yield of lentil cv. CDC Milestone at Saskatoon in 2008.

Treatment	Rate	Disease severity			Yield
	(g a.i./ha)	Aug. 06	Aug. 20	Aug. 29	(mg/ha)
Nontreated control	---	0.90 a	2.4 ab	7.0 a	0.82 a
LEM17 EC	100	0.72 a	2.7 a	6.5 b	1.00 a
	200	1.07 a	1.5 d	6.0 c	0.94 a
	250	0.87 a	1.5 d	4.9 de	0.90 a
	300	0.75 a	1.5 d	4.6 f	1.19 a
LEM17 SC	100	0.80 a	2.2 b	6.6 b	1.03 a
	200	0.87 a	2.0 bc	5.8 c	0.90 a
	250	0.72 a	1.5 d	4.9 de	1.15 a
	300	0.70 a	1.6 cd	4.7 ef	0.77 a
Bravo + Quadris	1500/120	0.60 a	1.5 d	5.0 d	0.86 a
Lance	300	0.80 a	1.3 d	5.8 c	0.86 a

(a - f) Means in a column followed by the same letter do not differ at $P = 0.05$.
[1] Horsfall-Barratt scale.

2008 PMR REPORT # 53 **SECTION M: FIELD LEGUMES - Diseases**

CROP: Field pea (*Pisum sativum* L.) cv. Nitouche
PEST: Powdery mildew (*Erisyphe pisi* Syd.) and mycosphaerella blight (*Mycosphaerella pinodes* (Berk. & Blox.) Vestergr.)

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TITLE: EFFICACY OF V-10116 FUNGICIDE FOR CONTROL OF FOLIAR DISEASES IN FIELD PEA, 2007 AND 2008

MATERIALS: V-10116 50WDG (metconazole, Engage Agro, Guelph, ON); Headline EC (pyraclostrobin, BASF Canada Inc., Toronto, ON)

METHODS: Trials to assess the efficacy of V-10116 fungicide to control foliar diseases in field pea were conducted at the AAFC Research Farm at Saskatoon on a heavy clay-loam soil in 2007 and 2008. Two trials were conducted each year, one at a location where irrigation was available if required (Site 1), and a second (Site 2) at a rain-fed location about 1 km from Site 1. Cultivar Nitouche was selected for the study because it has some resistance to mycosphaerella blight but is susceptible to powdery mildew (Saskatchewan Seed Guide, 2007); powdery mildew was the focus of the study. In 2007, Site 1 was seeded on 14 May and Site 2 on 15 May. In 2008, Site 1 was seeded on 13 May and Site 2 on 14 May. The plots were direct seeded at about 88 plants per m^2 using a double-disc drill seeder. The layout was a RCBD with four replications. Each plot consisted of eight rows, each 6-m long, with 0.3 m between rows and 1.2 m between plots, separated by wheat or barley guard rows. Weed control consisted of an application of Edge (ethalfluralin, Dow AgroSciences Canada Inc., Calgary, AB) plus 11-51-0 fertilizer in early spring or the previous fall, tillage to prepare the seed bed in early spring, hand tillage at the seedling stage, and hand roguing as needed. Pea residue infected with mycosphaerella blight and powdery mildew (collected the previous fall) was chopped and spread uniformly across the plot area on 17 July in 2007 (Site 2) and 23 July in 2008 (Sites 1 and 2). A rain event after the inoculum was applied in 2008 provided excellent conditions for spore dispersal and infection.

In late July of 2007, foliar disease severity was low and the crop was severely drought-stressed following a prolonged period of hot dry weather in July. Site 1 was irrigated four times in late July and early August using an overhead riser and impact sprinkler system, with about 1 cm of water applied each time. At site 2, emergency irrigation was also applied (about 1 cm) on five days at Site 2. No irrigation was applied in 2008.

The treatments were: V-10116 50WDG at 70, 140, and 280 g a.i./ha, V-10116 at 140 g a.i./ha in a low water volume (50 L) to simulate aerial application, Headline EC at 100 g a.i./ha and a nontreated check. The foliar fungicide applications were planned for the early bloom (25 % flowering) and full bloom growth stage. However, application was delayed at all four sites because disease levels were low and weather conditions were not conducive to disease increase. In both years, the initial fungicide treatments were applied at early pod stage (01 August 2007, 06 August 2008). A second application was made at the late pod stage (14 August 2007, 20 August 2008). Fungicides were applied with a CO_2 backpack sprayer

equipped with four XR TeeJet 8002 VS nozzles spaced 45 cm apart and calibrated to deliver 250 L/ha at 240 kPa.

Ten plants per plot were selected at random and assessed for mycosphaerella blight severity on foliage using the Xue scale (Xue et al. 1996) on 31 July, 10 and 22 August in 2007, and 08 and 19 August and September 03 in 2008. Ten plants per plot were also assessed for powdery mildew using the Horsfall-Barratt scale (Horsfall and Barratt 1945) on the same dates. Crop tolerance was assessed on 10 and 22 August in 2007, and 19 August and 03 September in 2008; no injury was observed on any plot. In 2007, Site 1was harvested on August 25 using a small plot combine, and Site 2 was harvested on 29 August. In 2008, Site 1 was harvested on 09 September and Site 2 on 15 September. Seed was air-dried, cleaned, and weighed. Analysis of variance was used for statistical analysis (General Linear Model Procedure of SAS), and means separation was conducted using the Waller-Duncan K-ratio t test. Differences are significant at $P = 0.05$ unless specifically noted.

RESULTS: The pattern of response to treatment was similar across sites and years. At the first rating date (prior to treatment initiation) in three of the four site-years, foliar disease severity was low (Tables 1 and 2). In fact, no symptoms of powdery mildew were observed at this date in 2008. The exception was Site 2 in 2007, where the mean severity of mycosphaerella blight was 5.7 (moderate) and powdery mildew mean was 3.0 (about 10% of leaf area affected). There were no differences among treatments in any trial on the first rating date. By the 2nd rating date, disease severity had increased and there were differences in severity between the fungicide treatments and the control for both diseases in each trial. At the 3rd rating date, severity had continued to increase, as had the differences between fungicide treatments and the control. There were no differences in seed yield among the treatments in 2007, but differences did develop in 2008.

CONCLUSIONS: The low levels of disease severity when the fungicide treatments were initiated reflect the conditions during the growing seasons of 2007 and 2008, which were not conducive for development of either powdery mildew or mycosphaerella blight at Saskatoon. Foliar disease severity increased until harvest, but the epidemics never developed to severe levels.

Application of V-10116 consistently reduced the severity of both powdery mildew and mycosphaerella blight (similar to Headline). The impact of V-10116 on disease severity generally increased with increased application rate, but the impact of increasing rate on yield was not consistent. There was no evidence of phytotoxicity at any rate. The low carrier volume treatment was almost as effective as the standard rate in these trials. Development of both diseases was delayed until late in the season due to hot dry conditions in July and much of August in both 2007 and 2008. As a result, disease pressure developed late, and was not severe enough to have a measurable impact on seed yield in 2 of 4 trials.

REFERENCES:

Horsfall, J. G. and Barrett, R. W. 1945. An improved grading system for measuring plant diseases. Phytopathology **35**: 655.

Xue, A.G., Warkentin, T.D., Greeniaus, M.T., and Zimmer, R.C. 1996. Genotypic variability in seedborne infection of field pea by *Mycosphaerella pinodes* and its relation to foliar disease severity. Can. J. Plant Pathol. 18: 370 374.

Table 1. Severity of mycosphaerella blight (0 - 9 scale[1]), powdery mildew (0 - 11 scale[2]), and seed yield on field pea cv. Nitouche at two sites in Saskatoon, 2007.

Product	Rate	Mycosphaerella			Powdery mildew			Yield
	(g a.i./ha)	Jul. 31	Aug. 10	Aug. 22	Jul. 31	Aug. 10	Aug. 22	(mg/ha)
Site 1								
Nontreated control	---	0.85 a	5.8 a	8.0 a	2.7a	6.5 a	7.3 a	3.03 a
V-10116	70	0.85 a	4.5 b	6.9 b	2.7 a	5.3 c	6.7 b	3.10 a
	140	0.85 a	4.3 b	6.9 b	2.7 a	5.9 ab	6.6 b	3.05 a
	280	1.05 a	4.5 b	6.7 b	2.6 a	5.4 bc	6.5 b	3.01 a
V-10116 (low H2O)	140	0.95 a	4.4 b	6.7 b	2.8 a	5.6 bc	6.6 b	2.99 a
Headline	100	1.15 a	4.1 c	5.1 c	2.9 a	5.8 bc	5.8 c	3.20 a
Standard error		0.06	0.12	0.19	0.05	0.11	0.09	0.034
Site 2								
Nontreated control	---	5.9 AB	7.1 A	8.2 A	3.0 A	7.0 A	7.1 A	3.21 A
V-10116	70	5.8 ABC	6.4 B	7.0 B	2.9 A	6.4 AB	6.6 B	3.60 A
	140	6.1 A	6.4 B	6.9 BC	3.0 A	5.9 B	6.6 B	3.51 A
	280	5.4 BC	6.1 BC	6.9 BC	3.1 A	6.6 AB	6.3 C	3.15 A
V-10116 (low H2O)	140	5.3 C	5.9 CD	6.6 C	3.0 A	6.4 AB	6.7 B	3.40 A
Headline	100	5.8 ABC	5.7 D	5.7 D	3.0 A	6.0 AB	6.1 C	3.48 A
Standard error		0.09	0.1	0.16	0.04	0.13	0.08	0.058

(a-d) Means in a column followed by the same letter at each site do not differ at $P = 0.05$ based on the Waller-Duncan K-ratio t test.

[1] Xue scale (1996).

[2] Horsfall-Barratt scale.

Table 2. Severity of mycosphaerella blight (0 - 9 scale[1]), powdery mildew (0 - 11 scale[2]), and seed yield of field pea cv. Nitouche at two sites in Saskatoon, 2008.

Product	Rate	Mycosphaerella blight			Powdery mildew			Yield
	(g a.i./ha)	Aug.08	Aug.19	Sept.03	Aug.08	Aug.19	Sept.03	(mg/ha)
Site 1								
Nontreated control	---	1.8	5.1 a	6.3 a	0	5.9 a	6.9 a	2.87 b
V-10116	70	1.5	4.9 ab	5.3 b	0	3.5 b	5.0 b	3.29 a
	140	1.8	4.2 c	5.3 b	0	3.1 bc	4.3 c	3.35 a
	20	1.9	3.5 d	4.2 c	0	3.0 c	3.1 d	3.28 a
V-10116 (low H2O)	140	1.8	4.7 b	5.4 b	0	3.0 c	4.6 bc	3.42 a
Headline	100	1.6	3.7 d	4.2 c	0	2.9 c	4.2 c	3.12 ab
Standard error		NS	0.13	0.17	NS	0.23	0.25	0.07
Site 2								
Nontreated control	---	2.1	4.9 A	5.9 A	0	6.0 A	7.1 A	2.10 B
V-10116	70	2.2	4.5 A	4.5	0	3.8 B	4.3 BC	2.65 A
	140	2.1	3.9 B	4.7 BC	0	3.3 C	3.8 CD	2.64 A
	280	2	3.4 C	4.3 CD	0	3.2 C	3.6 D	2.61 A
V-10116 (low H2O)	140	2.3	4.0 B	4.9 B	0	3.6 B	4.9 B	2.57 A
Headline	100	1.9	3.7 BC	4.1 D	0	3.2 C	4.3 BC	2.44 AB
Standard error		NS	0.15	0.14	NS	0.21	0.26	0.07

(a-d) Means in a column followed by the same letter at each site do not differ based on the Waller-Duncan K-ratio t test at $P = 0.05$. NS = not significant.

[1] Xue scale (1996).

[2] Horsfall-Barratt scale.

2008 PMR REPORT # 54 **SECTION O: CEREALS, FORAGE CROPS and OILSEEDS- Diseases**

CROP: Spring barley (*Hordeum vulgare* L). several
PEST: Fusarium head blight**,** *Fusarium graminearum* Schwabe

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TITLE: **DEOXYNIVALENOL (DON) LEVEL IN SPRING BARLEY WITH PROLINE APPLICATION AND CONTROLS IN INOCULATED, MISTED PLOTS**

MATERIALS: PROLINE 480 SC (480 g ai/L prothiconazole)

METHODS: Barley varieties were planted on May 4, 2008 in Ridgetown, Ontario. The plots were planted in a randomized block design with four replications in 4-m long single rows, spaced 17.8 cm apart; fertilized and maintained using provincial recommendations. Half of each plot was sprayed with PROLINE 480 SC when the barley heads were fully emerged (Feeks Growth Stage 10.5) for each variety using a back pack precision sprayer with a boom fitted with 2 twin
jet nozzles spaced at 50 cm delivering 240 l/ha of water. The plots were spray-inoculated with a 100-mL suspension of macroconidia of four *Fusarium graminearum* isolates at 50,000 spores/ml two days following the fungicide application. The suspension was produced in liquid shake culture using modified Bilay's medium. Plots were misted daily beginning after the first plots were inoculated. The mist system was engaged until three days after the last line was inoculated. The overhead mister delivered about 7.5 mm of water daily. For DON analysis, the samples were ground using a Romer mill (Model 2A, Romer Labs, Inc. Union, MO). DON was extracted from a 10g subsample of ground grain in 50mL deionized water. Quantification of the DON was done using ELISA with a DON detection limit of 0.5ppm (Sinha and Savard 1996) using EZ-Quant® Vomitoxin ELISA kit from Diagnostix (www.diagnostix.ca).

RESULTS: The results are given below.

CONCLUSIONS: DON content across all spring barley cultivars tended to be lower when PROLINE 480 SC application was made. The best results were obtained in OAC STAFFA cultivar, with or without PROLINE application, suggesting that barley resistance to *Fusarium graminearum* is very important and that cultivars need to be evaluated for FHB susceptibility and DON accumulation. The highest level of DON was recorded in OAC RIPLEY; with PROLINE application DON level was significantly lower than in control (Figure 1).

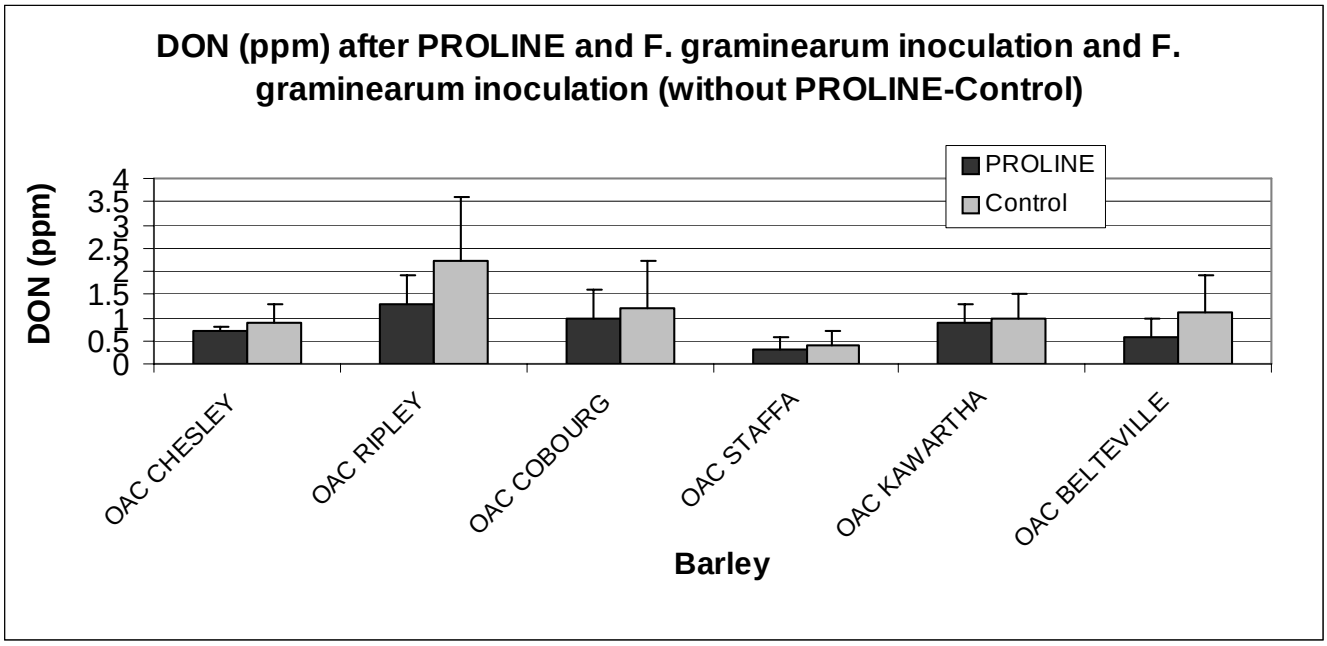

Figure 1. Deoxynivalenol (DON) content (ppm) + SE in spring barley with/without PROLINE 480 SC application. Ridgetown, 2008.

2008 PMR REPORT # 55 **SECTION O: Cereals, Forage Crops and Oilseeds - Diseases**

CROP: Oats (*Avena sativa L.*), cv. Morgan and CDC Orrin
PEST: Leaf blotch, *Pyrenophora avenae (Ito and Kuribayashi)* Crown rust, *Puccinia coronata (Corda f.sp) avenae Eriks*

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TITLE: EFFECT OF FUNGICIDE AND CULTIVAR ON OAT LEAF SPOT DISEASES AND YIELD

MATERIALS: Headline (pyraclostobin 125 g.ai/ha), Tilt (propiconazole 125 g.ai/ha) and Stratego (propiconazole/trifloxystobin 125 g.ai each active/ha)

METHODS: Oat cultivars Morgan and CDC Orrin were direct seeded into standing canola stubble at Melfort, SK on 12 May using an Edwards hoe drill with a 20 cm row spacing. Urea fertilizer was side banded at 60 kg/ha of actual N and 100 kg/ha 14-20-10-10 seed placed at time of seeding. Target seeding rate was 250 plants per meter square for each cultivar. Plots of 4 X 10 meters were arranged in a split plot design with cultivars as the main plots and fungicide treatments as the sub plots. Frontline herbicide (4g/L florasulam and 280 g/L MCPA ester) was applied in crop at the 2-3 leaf stage to control broadleaf weeds, very few grassy weeds were observed. All fungicides were applied by bicycle sprayer in 200 L of water/ha July 3 at which time the flag leaf was fully emerged. On 21 August 25 plants per plot were assessed for leaf spot disease symptoms at the soft dough stage based on the percentage of flag and penultimate leaf area diseased and using a whole plant assessment (0-no disease to 11- severe symptoms over the whole plant). Yield measurements were made on harvested samples taken from a 1.3 x 10 meter strip from the centre of each plot on 9 September with a Wintersteiger plot combine. Quality measurements were taken from harvested samples and data were analyzed using analysis of variance procedures.

RESULTS: See Table 1. Experimental conditions were good due to mild summer temperatures and sufficient moisture during the growing season

CONCLUSIONS: Disease symptoms in this experiment were very light relative to the previous year and no crown rust was observed. Differences between varieties or among fungicide treatments were not detected for any of the factors measured except disease symptoms over the whole plant. Whole plant disease symptoms were slightly lower on Morgan than CDC Orrin, and fungicide treatments reduced symptoms marginally from the unsprayed check, although there were no differences among the fungicides.

ACKNOWLEDGMENT: Financial support from the Agri-ARM program of the Saskatchewan Ministry of Agriculture was appreciated.

Table 1. Effect of variety and fungicide treatment on foliar disease symptoms, yield, test weight (TW) and thousand kernel weight (TKW) of oat at Melfort, SK, 2008.

Cultivar / Fungicide Treatment	Symptoms on flag & penultimate leaves (%)	Symptoms over the whole plant (0-11)	Yield (kg/ha)	TW (kg/hl)	TKW (grams)
Morgan	3.8	1.9 a	7137	51.2	37.8
CDC Orrin	1.8	1.4 b	7127	51.0	38.4
$Lsd_{(0.05)}$	2.4	0.3	198	0.6	1.4
Check	4.4 a	1.9 a	7087	51.0	37.7
Headline	1.9 b	1.4 b	7198	51.2	38.3
Stratego	2.4 b	1.6 ab	7090	51.1	38.0
Tilt	2.5 b	1.6 ab	7153	51.0	38.5
$Lsd_{(0.05)}$ [1]	1.9	0.4	180	0.5	0.9

[1] Values in the same column followed by the same letter are not significantly different according to the least significant difference test at the 0.05 probability level

2008 PMR REPORT # 56 **SECTION O: Cereals, Forage Crops and Oilseeds - Diseases**

CROP: Wheat (*Triticum aestivum L.*), cv. Infinity
PEST: Tan spot (*Pyrenophora tritici repentis (Died.) Drechs.*), Septoria complex (*Septoria spp.*), Fusarium Head Blight (*Fusarium spp)*

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TITLE: EFFECT OF FUNGICIDE ON LEAF SPOT DISEASES AND YIELD OF INFINITY WHEAT

MATERIALS: Bravo (chlorothalonil 1250 g. ai./ha in 200 L water/ha), Folicur (tebuconazole 125 g. ai./ha in 200 L water/ha), Proline (prothioconazole 200 g. ai./ha in 100 L water/ha) and Tilt (propiconazole 125 g. ai/ha in 200 L water/ha)

METHODS: Spring wheat (cv. Infinity) was direct seeded into standing canola stubble at Melfort, SK on 12 May using an Edwards hoe drill with a 20 cm row spacing. Following soil test recommendations, urea fertilizer was side banded at 120 kg/ha of actual N and 100 kg/ha 14-20-10-10 seed placed. Target seeding rate was 300 plants per meter square. Plots of 4 X 10 meters were arranged in a randomized complete block design with four replicates. Frontline herbicide (4g/L florasulam and 280 g/L MCPA ester) was applied in crop at the 2-3 leaf stage to control broadleaf weeds, very few grassy weeds were observed. Fungicides were applied at flowering on July 16 using a bicycle sprayer. On 21 August at the soft dough stage, 15 plants per plot were assessed for disease symptoms based on percentage of flag and penultimate leaf surface area infected and over the whole plant (0-no disease, 11-all foliage severely infected). Yield measurements were made on harvested samples taken from a 1.3 x 10 meter strip from the centre of each plot on 9 September with a Wintersteiger plot combine. Quality measurements were taken from harvested samples and data were analyzed using analysis of variance procedures.

RESULTS: See Table 1. Experimental conditions were good due to mild summer temperatures and sufficient moisture during the growing season

CONCLUSIONS: Symptoms of fusarium head blight were present, but only at trace levels and could not accurately be assessed. Differences between the check and fungicide treatments were detected for all factors measured except TW. All fungicides reduced leaf spot disease symptoms from the check, although Bravo did not appear to provide as effective control as the other fungicides. Folicur and Proline appeared to reduce leaf spot symptoms slightly over that of Tilt when assessed over the whole plant but differences were not detected from the flag and penultimate leaf assessment. Tilt, Folicur and Proline all increased yield over the unsprayed check. There was little effect of fungicide treatment on seed quality (TW and TKW).

ACKNOWLEDGMENT: Financial support from the Agri-ARM program of the Saskatchewan Ministry of Agriculture was appreciated.

Table 1. Effect of fungicide treatment on Infinity wheat foliar disease symptoms, yield, test weight (TW) and thousand kernel weight (TKW) at Melfort, 2008.

Cultivar / Fungicide Treatment	Symptoms on flag & penultimate leaves (%)	Whole plant disease assessment (0-11)	Yield (kg/ha)	TW (kg/hl)	TKW (grams)
Check	29.9 a	4.0 a	4883 b	81.5	34.5 b
Tilt	3.2 c	1.9 c	5334 a	81.9	35.9 a
Bravo	11.7 b	3.0 b	4925 b	81.6	35.7 ab
Folicur	1.1 c	1.3 d	5215 a	81.9	35.3 ab
Proline	1.6 c	1.4 d	5455 a	81.4	35.8 ab
$Lsd_{(0.05)}$	5.9	0.3	265	1.0	1.3

Values in the same column followed by the same letter are not significantly different according to the least significant difference test at the 0.05 probability level

2008 PMR REPORT # 57 **SECTION O: CEREALS, FORAGE CROPS and OILSEEDS-Diseases**

CROP: Winter wheat (*Triticum aestivum* L.), cv. Several
PEST: Fusarium head blight, *Fusarium graminearum* Schwabe

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TITLE: **EVALUATION OF WINTER WHEAT CULTIVARS AND BREEDING LINES FOR RESISTANCE TO FUSARIUM HEAD BLIGHT (FHB) IN INOCULATED AND MISTED PLOTS- NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY (NUWWSN)**

METHODS: The crop was planted on October 21, 2007 at Ridgetown, Ontario. The plots were planted in a randomized block design with three replications at 270 seeds/plot, in 4-m long single rows, spaced 17.8 cm apart. The breeding lines represent Northern Uniform Winter Wheat Scab Nursery (NUWWSN) established across North America. Four lines (52-55) from Canada (Ridgetown Campus, University of Guelph FHB breeding program) were entered to the test. The plots were fertilized and maintained using provincial recommendations. Heading date was recorded for each line. Each plot was inoculated with a combined suspension of macroconidia of four *Fusarium graminearum* isolates at a total of 50.000 spores/ml (with relatively the same number of each isolate) when primary wheat heads were at 50% anthesis for each variety (Zadoks growth stage, ZGS 65). The suspension was produced in liquid shake culture using modified Bilay's medium. Plots were misted daily beginning after the first plots were inoculated. The overhead mister was set to run from 11:00 - 16:00 and misted for approximately 60-90 seconds every 8-10 minutes. The mist system was engaged until three days after the last variety was inoculated. Each variety was assessed for visual symptoms when the early dough stage was reached (ZGS 83). Twenty wheat heads were selected at random out of each plot, and rated for disease incidence and severity using the scoring system developed by Stack and McMullen (1994). A fusarium head blight index (FHBI) was applied to the data, which was the product of the percent heads infected and the percent spikelets infected divided by 100.

RESULTS: The results are given in the Table 1.

CONCLUSIONS: Average FHB index across the test was 33.2%. Two lines had FHB index lower than 10 % (MSU Line E6003 and DH 22/24-from Ridgetown Campus, University of Guelph) (Table 1).

Table 1: Fusarium head blight reaction of winter wheat breeding lines (NUWWSN test) in inoculated and misted plots at Ridgetown, Ontario. 2007-2008.

No.	Winter wheat lines	Heading date (Julian)	Severity (%)	Incidence	FHB Index (%)
1	ERNIE	154	26.7	56.7	16.8
2	TRUMAN	159	22.7	60.0	14.0
3	FREEDOM	157	38.7	53.3	21.6
4	PIONEER 2545	156	60.7	80.0	48.0
5	MSU Line E6002	157	29.0	63.3	18.9
6	MSU Line E6001	156	50.0	76.7	38.3
7	MSU Line E6003	160	21.0	36.7	7.7
8	MSU Line E5011	157	68.7	80.0	54.9
9	P.99600A2-4-93	156	44.3	73.3	32.7
10	P.0179A1-17	157	49.7	73.3	36.4
11	P.011010A1-15	155	74.7	83.3	62.4
12	P.03112A1-7-3	158	38.7	70.0	26.5
13	KS980512-2-2	158	44.3	70.0	31.0
14	KS05HW14-3	155	50.0	80.0	40.0
15	MO050143	157	55.0	83.3	46.2
16	MO050699	158	55.3	76.7	42.6
17	MO050921	161	33.0	83.3	27.5
18	MO050101	158	50.0	80.0	40.0
19	VA05W-425	157	38.7	83.3	32.0
20	VA05W-775	157	38.7	80.0	30.9
21	VA05W-777	157	33.0	83.3	27.5
22	VA05W-534	155	22.7	60.0	14.0
23	MD01W233-06-1	155	29.0	66.7	19.6
24	MD01W233-06-16	159	38.7	80.0	30.4
25	MD99W483-06-11	155	34.7	76.7	26.6
26	NYCalresel-L	156	49.7	73.3	35.9
27	NY94052-9340	160	38.7	70.0	26.5
28	NYW103-1-9100	160	55.3	70.0	38.7
29	NYW103-70-9232	158	74.7	80.0	59.7
30	NY93246SP-9070	160	38.7	80.0	31.5
31	SE911492-4	157	59.7	76.7	46.1
32	SE89-1873-2	157	68.7	80.0	54.9
33	SE98-1089-34	157	86.3	86.7	75.1
34	SE93-1094-8	154	50.0	76.7	38.3
35	NE05418	155	29.0	70.0	19.9
36	NE05549	157	66.0	80.0	52.8
37	NE05537	156	38.7	53.3	21.6
38	NE03488	157	29.0	73.3	21.0
39	NE01643	158	44.3	86.7	38.2
40	KY00C-2059-16	157	50.0	80.0	40.0
41	KY00C-2143-08	155	29.0	80.0	23.2
42	KY00C-2755-03	158	33.0	76.7	25.3
43	KY97C-0321-05-2	158	60.7	81.7	50.2
44	M04*5109	158	38.7	86.7	33.7
45	M04-4802	157	55.0	80.0	42.9
46	M03-3616-B11	156	34.7	80.0	27.7
47	M03-3616-C10	156	44.3	80.0	35.5
48	OH02-13567	158	44.3	70.0	31.0
49	OH03-235-2	158	44.0	80.0	34.1
50	OH02-12678	157	38.7	73.3	28.2
51	OH02-7217	159	33.0	86.7	28.6
52	DH 22/8	156	44.3	83.3	36.6
53	DH 22/24	156	22.7	40.0	9.3
54	DH 19/176B	159	58.7	83.3	48.8

55	DH F/SF, 23	158	65.0	80.0	52.4
56	IL02-18228	155	25.0	63.3	15.3
57	IL02-19463	152	25.0	66.7	16.4
58	IL04-10118	155	29.0	70.0	20.3
59	IL04-10721	156	33.0	76.7	25.3
60	IL04-10741	155	29.0	73.3	21.4
	AVERAGE	157	43.6	74.3	33.2
	LSD	1.5	16.1	14.4	13.8
	CV	0.6	22.7	11.9	25.1

2008 PMR REPORT # 58 **SECTION O: CEREALS, FORAGE CROPS and OILSEEDS-Diseases**

CROP: Winter wheat (*Triticum aestivum* L.), cv. Several
PEST: Fusarium head blight, *Fusarium graminearum* Schwabe

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TITLE: **EVALUATION OF WINTER WHEAT CULTIVARS AND BREEDING LINES FOR RESISTANCE TO FUSARIUM HEAD BLIGHT (FHB) IN INOCULATED AND MISTED PLOTS- PRELIMINARY NORTHERN UNIFORM WINTER WHEAT SCAB NURSERY (PNUWWSN)**

METHODS: The crop was planted on October 21, 2007 at Ridgetown, Ontario using a 8-row cone seeder at 270 seeds/plot, 4 m in length, placed in a randomized block design with three replications. The breeding lines represent Preliminary Northern Uniform Winter Wheat Scab Nursery (PNUWWSN) established across North America. Six lines (50-55) from Canada (Ridgetown Campus, University of Guelph breeding program) were entered to the test. The plots were fertilized and maintained using provincial recommendations. Heading date was recorded for each line. Each plot was inoculated with a combined suspension of macroconidia of four *Fusarium graminearum* isolates at a total of 50.000 spores/ml (with relatively the same number of each isolate) when primary wheat heads were at 50% anthesis for each variety (Zadoks growth stage, ZGS 65). The suspension was produced in liquid shake culture using modified Bilay's medium. Plots were misted daily beginning after the first plots were inoculated. The overhead mister was set to run from 11:00 - 16:00 and misted for approximately 60-90 seconds every 8-10 minutes. The mist system was engaged until three days after the last variety was inoculated. Each variety was assessed for visual symptoms when the early dough stage was reached (ZGS 83). Twenty wheat heads were selected at random out of each plot, and rated for disease incidence and severity using the scoring system developed by Stack and McMullen (1994). A fusarium head blight index (FHBI) was applied to the data, which was the product of the percent heads infected and the percent spikelets infected.

RESULTS: The results are given in the Table 1.

CONCLUSIONS: Heading date ranged from153 to 160. The range for FHB index was between 7.9% (VA06W-558) to 55% (KY01C-1542-07).

Table 1. Fusarium head blight reaction of winter wheat breeding lines (PNUWWSN test) in inoculated and misted plots at Ridgetown, Ontario. 2007-2008.

No.	Winter wheat lines	Heading date	Severity (%)	Incidence (%)	FHB Index (%)
1	ERNIE	154	26.7	40.0	11.9
2	TRUMAN	158	16.3	60.0	9.8
3	FREEDOM	157	29.0	70.0	21.1
4	PIONEER 2545	156	60.7	80.0	48.5
5	MSU Line E2043	160	55.3	83.3	45.9
6	MSU Line E6059	158	44.3	80.0	34.9
7	MSU Line E6042	156	22.7	43.3	11.4
8	MSU Line E6038	155	26.7	50.0	14.6
9	MSU Line E5024	157	44.3	86.7	38.2
10	P.992192A1-5-4-5-81	156	59.7	83.3	50.4
11	P.0172A1-12-1	154	29.0	70.0	21.1
12	P.0175A1-37-4	156	38.7	80.0	30.9
13	P.04281A1-4-5	153	44.3	80.0	35.5
14	P.04287A1-16	156	54.0	80.0	43.2
15	P.03630A1-18	154	38.7	73.3	28.7
16	MO050600	158	60.7	80.0	48.5
17	MO050261	157	55.3	90.0	49.8
18	MO051150	156	33	73.3	24.2
19	MO050617	155	29.0	76.7	22.1
20	MO041020	159	34.7	83.3	28.8
21	MO050917	158	38.7	83.3	32.6
22	VA06W-553	156	34.7	80.0	28.1
23	VA06W-558	153	16.3	40.0	7.9
24	VA06W-561	155	16.3	60.0	9.8
25	VA06W-615	155	44.3	70.0	31
26	VA06W-622	156	29.0	73.3	22.2
27	TRIBUTE	155	34.7	66.7	23.6
28	BDLS. HONEY-6	156	38.7	76.7	29.3
29	SE98 1083-14	157	33	76.7	25.3
30	SEKY93 C-1699-14	155	44.3	73.3	32.1
31	SE94 C-0480-2-2	155	44.3	76.7	33.8
32	SE98 1106-6	157	44.3	83.3	37.1
33	SE94-1012-25	156	59.7	80.0	47.7
34	KY02C-3005-25	159	33.0	70.0	23.1
35	KY02C-3005-44	156	49.7	80.0	38.6
36	KY02C-3008-05	156	40.0	83.3	33.8
37	KY02C-3004-04	156	29.0	73.3	21.0
38	KY01C-1542-07	157	66.0	83.3	55.0
39	KY99C-1205-06-1	157	44.3	80.0	36.0
40	M04-4566	154	44.3	66.7	28.8
41	M04-4715	153	38.7	73.3	28.7
42	M05-1172	156	33.0	66.7	22.0
43	M05*1589	156	34.7	80.0	28.3
44	M05-1531	154	33.0	76.7	25.3
45	OH04-213-39	158	34.7	80.0	28.7
46	OH04-264-58	157	40.3	80.0	32.3
47	OH04-268-39	159	50.0	90.0	45.0
48	OH04-176-29	156	44.3	76.7	34.4
49	OH03-41-45	154	38.7	70.0	27.1
50	DH ACF112103 -8T	158	50.0	86.7	43.3
51	RCUOGF110202D/4	156	44.3	76.7	33.8
52	RCUOGDHACF1109O2D	160	26.7	40.0	11.9
53	RCATTF174/1C	158	50.0	76.7	38.3

54	RCATTF203/2	159	44.3	73.3	31.6
55	RCATL31	159	55.3	70.0	38.2
56	IL01-34159	153	34.7	73.3	25.9
57	IL79-002T-B-B	153	29.0	66.7	19.6
58	IL04-7874	154	34.7	70.0	24.7
59	IL04-8445	155	44.3	73.3	32.7
60	IL04-17204	154	29.0	60.0	18.2
	AVERAGE	156	39.6	73.3	30.1
	LSD	1.4	16.2	17.3	14.7
	CV	0.5	24.5	14.4	28.9

2008 PMR REPORT # 59

SECTION P: ORNAMENTALS, GREENHOUSE CROPS and TURF – Diseases

CROP: Greenhouse cucumber 'Long English' cv. 'Frida'
PEST: Powdery mildew (*Podosphaera xanthii* (Castagne) U. Braun & Shishkoff (a.k.a. *Sphaerotheca fuliginea*)

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TITLE: BIOLOGICAL AND CHEMICAL FUNGICIDES FOR CONTROL OF POWDERY MILDEW OF GREENHOUSE CUCUMBER IN BRITISH COLUMBIA. 2008

MATERIALS: PLANTSHIELD (*Trichoderma harzianum* strain T-22, Rifai strain KRL-RG2, 1 x 10^7 cfu/g dry weight), PRESTOP (*Gliocladium catenulatum* strain J1446, 2.8 x 10^8 cfu/mL), RHAPSODY ASO (*Bacillus subtilis* strain QST 713, 1.34 %, 1 x 10^9 cfu/g), LEM17 20% SC (penthiopyrad 20%), BAS 560F (metrafenone 30%), NOVA 40W (myclobutanil 40%), KUMULUS DF (sulphur 80%), SWITCH 62.5 WG (cyprodinil 37.5%, fludioxonil 25.0%)

METHODS: Four-week-old cucumber transplants cv. 'Frida' in plugs and rockwool blocks were transplanted on January 08, 2008 into sawdust bags on benches in a research greenhouse with individual drip lines to each plant. Plants were fertigated twice a day for the first four weeks and then three times a day with 7-11-27 (N, P, K) at 1.15 g/L water plus 0.775 g/L $CaNO_3$, pH 4.2. Each plot consisted of two plants (plot area = 70 x 30 cm^2 = 0.2 m^2), arranged on two benches in a randomized complete block (RCB) design with four replicates per treatment. Treatments were first applied on Feb. 5 when powdery mildew was observed on ≤ 10% of leaf area and weekly or bi-weekly, thereafter. Treatments were applied in a solution volume of 100 mL/plot directed to the upper leaf surface using a CO_2 backpack sprayer at 40 psi (276 kPa) equipped with a single Teejet 8001VS low-volume delivery nozzle (450 mL/minute). To ensure high disease pressure, two groups of four 'Frida' plants with sporulating powdery mildew were kept under each bench for the duration of the trial. After the first treatment application, the trial plants were inoculated by shaking some of these mildew-infested cucumber leaves over each plant. Flowers and young

developing fruit were picked off weekly and completely necrotic lower leaves were removed prior to each application. *Encarsia formosa* were released on Feb. 15 and spinosad (SUCCESS 480 SC) was applied at 0.05 mL/L on Feb. 22 to control thrips. Pre-treatment and weekly thereafter, the number of leaves with powdery mildew was counted prior to each application and the percent leaf area per total leaf area was estimated visually. Evaluations were continued for two weeks after the final 14-day application (three weeks after the final 7-day application). The area under the disease progress curve (AUDPC) was calculated for the total number of diseased leaves and percent leaf area diseased. Statistical analysis (ANOVA) was performed using CoStat, Version 6.303, 2004, CoHort Software, Monterey, California, USA, © 1998-2004 and means were compared in Tukey's HSD at P=0.05.

RESULTS: Results are presented in Tables 1 and 2.

CONCLUSIONS: Weekly application of the fungicides LEM17 or BAS 560F significantly reduced the number of leaves and percent leaf area with powdery mildew on the highly susceptible cultivar 'Frida' compared to the check. There was no statistically significant difference in disease control between the lower rate (1.25 L product/ha) and the higher rate (1.75 L/ha) of LEM17, when applied weekly, or between LEM17 and BAS 560F at 1.12 L/ha when applied weekly or on a 14-day interval. The 7-day application of BAS 560F significantly reduced the disease until 21 days after the final application, when powdery mildew began to appear on the underside of the leaves (sprays were directed to the upper side of the leaves). SWITCH 62.5 WG provided significant disease control also, but there was a possibility of phytotoxicity (curled and puckered leaves and small, stunted leaves in one or two replicates). However, the symptoms may have been due to interaction of the product with too high light intensity. PLANTSHIELD, RHAPSODY and PRESTOP did not reduce cucumber powdery mildew significantly compared to the untreated check. Initially, RHAPSODY reduced the leaf area covered with mildew by 26-56% compared to the check (Table 2), but the disease increased rapidly after Week 4.

Table 1: Greenhouse Cucumber 'Long English' cv. 'Frida': Mean number of leaves with powdery mildew per treatment per week, 2008.

Treatment	Rate of Product Applied	Appl. Interval (days)	Disease Incidence (No. Leaves with Powdery Mildew)[1]						
			Wk 1 Feb 05[2]	Wk 2 Feb 12	Wk 3 Feb 19	Wk 4 Feb 26	Wk 5 Mar 04	Wk 6 Mar 11	AUDPC
CHECK (water)	0	7	1.9 a	4.0 ab	5.6 a	7.4 a	10.6 a	12.0 ab	241.9 a
PLANTSHIELD	0.9 g/L	7	2.0 a	4.2 a	5.5 a	8.0 a	11.4 a	12.5 a	254.6 a
PRESTOP	5.0 g/L	7	2.4 a	3.9 abc	5.4 a	6.5 a	10.8 a	11.9 ab	235.3 a
RHAPSODY	10.0 mL/L	7	1.8 a	3.5 bc	5.6 a	7.8 a	11.1 a	13.9 a	250.7 a
LEM17 20 % SC	1.25 L/ha	7	2.0 a	1.9 cd	1.2 b	0.9 bc	1.0 b	1.5 de	47.2 b
LEM17 20 % SC	1.75 L/ha	7	2.9 a	1.4 d	1.6 b	1.1 bc	1.4 b	2.5 cde	57.3 b
BAS 560F	1.12 L/ha	7	2.1 a	2.8 abcd	1.5 b	1.9 bc	0.9 b	0.8 e	59.1 b
BAS 560F	1.12 L/ha	14	2.8 a	3.1 abcd	2.8 b	3.1 b	2.4 b	7.4 bc	115.1 b
NOVA 40W	340 g/ha	14	1.9 a	2.1 bcd	1.6 b	1.1 bc	1.6 b	6.8 c	75.7 b
KUMULUS DF	1.20 g/L	7	2.2 a	3.5 abc	2.1 b	2.5 bc	3.2 b	5.9 cd	108.1 b
SWITCH 62.5 WG	975 g/ha	7	1.5 a	1.9 cd	1.8 b	0.2 c	0.8 b	1.5 de	42.9 b

[1] Values are means of four replicates; two plants per plot, RCB design.

[2] Numbers in a column followed by the same letter are not significantly different in Tukey's HSD at P = 0.05.

Table 2: Greenhouse Cucumber 'Long English' cv. 'Frida': Mean percent leaf area with powdery mildew per treatment per week and area under the disease progress curve (AUDPC), 2008.

Treatment	Rate of Product Applied	Appl. Interval (days)	Disease Severity (% Leaf Area Diseased)[1]						
			Wk 1 Feb 05[2]	Wk 2 Feb 12	Wk 3 Feb 19	Wk 4 Feb 26	Wk 5 Mar 04	Wk 6 Mar 11	AUDPC
CHECK (water)	0	7	2.5 a	20.6 a	68.8 a	66.9 ab	66.2 a	82.5 a	1855.0 ab
PLANTSHIELD	0.9 g/L	7	4.6 a	20.0 a	63.8 a	74.4 a	77.5 a	89.1 a	1977.5 a
PRESTOP	5.0 g/L	7	7.9 a	21.2 a	55.6 a	58.1 bc	60.6 a	74.1 a	1656.4 ab
RHAPSODY	10.0 mL/L	7	5.9 a	16.2 ab	30.0 b	49.4 c	66.9 a	72.5 a	1411.8 b
LEM17 20 % SC	1.25 L/ha	7	3.6 a	3.5 c	1.8 c	0.8 d	0.5 b	2.0 d	65.2 c
LEM17 20 % SC	1.75 L/ha	7	8.4 a	3.9 c	2.0 c	2.9 d	1.4 b	5.0 cd	117.7 c
BAS 560F	1.12 L/ha	7	6.6 a	9.0 bc	3.1 c	1.6 d	0.8 b	0.4 d	126.0 c
BAS 560F	1.12 L/ha	14	7.9 a	11.6 abc	9.2 c	7.5 d	1.8 b	27.6 bc	335.1 c
NOVA 40W	340 g/ha	14	5.9 a	6.8 bc	3.1 c	1.8 d	1.9 b	30.0 b	220.1 c
KUMULUS DF	1.20 g/L	7	4.8 a	11.6 abc	5.8 c	3.1 d	2.9 b	17.2 bcd	240.6 c
SWITCH 62.5 WG	975 g/ha	7	2.5 a	5.1 c	3.6 c	0.2 d	0.5 b	2.0 d	82.2 c

[1] Values are means of four replicates; two plants per plot, RCB design.

[2] Numbers in a column followed by the same letter are not significantly different in Tukey's HSD at $P = 0.05$.

2008 PMR REPORT # 60

SECTION P: ORNAMENTALS, GREENHOUSE CROPS and TURF – Diseases

CROP: Deer fern (*Blechnum spicant* (L.) Sm.)
PEST: Rhizoctonia aerial blight (*Rhizoctonia solani* Kuhn)

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TITLE: EVALUATION OF BIOLOGICAL FUNGICIDES FOR CONTROL OF RHIZOCTONIA AERIAL BLIGHT OF FERN, 2006

MATERIALS: PRESTOP (*Gliocladium catenulatum* strain J1446, 2.8 x 10^8 cfu/mL), PLANTSHIELD (*Trichoderma harzianum* strain T-22, Rifai strain KRL-RG2, 1 x 10^7 cfu/g dry weight), SERENADE MAX (*Bacillus subtilis* strain QST 713, 14.6 %, 7.3 x 10^9 cfu/g).

METHODS: The trial was conducted in 2006 in a commercial shaded greenhouse with overhead irrigation on deer fern (*Blechnum spicant)* grown from spores by the nursery and transplanted into 72-cell plug flats (0.15 m^2 surface area per flat) in Sunshine Mix #4 growth medium on Feb. 28. There was one flat per plot with 72 plants per flat and five replicates per treatment in a randomized complete block (RCB) design. Relative humidity was 80% and temperature was 17-18° C in March and April, rising to a maximum of 28° C in May and June. Starting on March 28, prior to disease symptoms, treatments were applied every 14 days to June 6 (total of six applications) as a foliar spray to run-off with a CO_2 backpack sprayer at 40 psi (276 kPa) in a solution volume of 250 mL per flat (1.25 L per treatment). Between products, the sprayer was rinsed with CHEMPROCIDE (7.5% DDAC) disinfectant at 4 mL/L followed by a water rinse to ensure there was no cross-contamination between the microbials. On May 2, *Rhizoctonia solani* was isolated on PDA media from older, symptomatic *B. spicant* plants in the same greenhouse and on May 9, 20 additional *B. spicant* ferns of the same age as the trial plants were inoculated with a hand-sprayer containing a mycelial suspension of this isolate and placed randomly within the trial area to supplement the natural inoculum. Symptom development was monitored on these plants and surface-sterilized, necrotic lesions cultured on PDA. The number of ferns in each trial flat with symptoms of Rhizoctonia aerial blight was counted weekly from May 23, eight weeks after the first application when symptoms first appeared to June 20, two weeks after the final application. The percent area of diseased fronds per flat was estimated visually and the area under the disease progress curve (AUDPC) was calculated for each plot. A visual quality rating of the plants in each flat was made on a scale of 1 to 10, where 1 = completely necrotic and 10 = completely

healthy plants. Statistical analysis (ANOVA) was performed using CoStat 6.303, 2004, CoHort Software, Monterey, California, USA, © 1998-2004 and means compared in Duncan's Multiple Range Test at $P = 0.05$.

RESULTS: Results are presented in Tables 1-3. Rhizoctonia aerial blight was first observed on May 2 in an older crop of *B. spicant* in the same greenhouse (transplanted two weeks previous to the trial crop on Feb. 14), when day temperatures in the greenhouse reached 26° C or higher and relative humidity was ≥ 80%. On the 20 additional plants inoculated on May 9 with a mycelial suspension of *R. solani* isolated from these older plants, symptoms of aerial blight (soft, necrotic rot of fronds) appeared within three days: 85% of plants developed symptoms within one week of inoculation and *R. solani* was re-isolated in culture from the necrotic fronds.

CONCLUSIONS: PLANTSHIELD (*T. harzianum*) provided some disease suppression but none of the microbial fungicides provided statistically significant control of Rhizoctonia aerial blight of deer fern when applied as foliar sprays on a 14-day schedule starting prior to disease development. No phytotoxicty was observed in any treatment but SERENADE MAX left a white residue on foliage.

ACKNOWLEDGMENTS: Funding for this trial was provided by a grant from the Reduced-Risk Pesticide Program of Agriculture and Agri-Food Canada's Pest Management Centre to Peter Isaacson, IPM/Minor Use Co-ordinator for the Canadian Nursery and Landscape Association.

Table 1. Mean number of deer ferns per week with symptoms of Rhizoctonia aerial blight, 2006.

Treatment	Rate of Product Applied	Disease Incidence (No. of Plants)[1]				
		May 23/06	May 30/06	June 06/06	June 13/06	June 20/06
CHECK	-	2.4 b[2]	2.4 a	5.8 a	17.4 a	27.8 a
PRESTOP	5.0 g/L	4.4 a	3.4 a	10.4 a	37.4 a	40.6 a
PLANTSHIELD	0.9 g/L	1.4 b	1.8 a	5.6 a	16.0 a	17.8 a
SERENADE MAX	1.13 g/m^2	0.8 b	3.6 a	11.8 a	16.8 a	18.8 a

[1] Values are the means of five replicates; one 72-cell plug flat per plot, 72 plants per flat, RCB design.
[2] Numbers in a column followed by the same letter are not significantly different in Duncan's MRT at $P = 0.05$.

Table 2. Rhizoctonia aerial blight of deer fern: mean percent leaf area diseased and area under the disease progress curve (AUDPC).

Treatment	Rate of Product Applied	Disease Severity (% Leaf Area)[1]					
		May 23/06	May 30/06	June 06/06	June 13/06	June 20/06	AUDPC
CHECK	-	1.2 b[2]	3.0 a	7.0 a	20.2 a	38.8 a	357.0 a
PRESTOP	5.0 g/L	2.6 a	4.4 a	14.0 a	46.0 a	54.0 a	648.9 a
PLANTSHIELD	0.9 g/L	0.7 b	2.2 a	8.0 a	16.8 a	22.2 a	262.8 a
SERENADE MAX	1.13 g/m^2	0.4 b	4.8 a	16.0 a	21.5 a	22.2 a	409.5 a

[1] Values are the means of five replicates; one 72-cell plug flat per plot, 72 plants per flat, RCB design.
[2] Numbers in a column followed by the same letter are not significantly different in Duncan's MRT at $P = 0.05$.

Table 3. Mean plant quality rating of deer ferns on a visual scale of 1-10 where 10 = best.

Treatment	Rate of Product Applied	Plant Quality Rating[1]				
		May 23/06	May 30/06	June 06/06	June 13/06	June 20/06
CHECK	-	9.5 a[2]	8.5 a	8.3 a	7.0 a	6.0 a
PRESTOP	5.0 g/L	8.5 b	8.8 a	7.0 a	5.4 a	5.0 a
PLANTSHIELD	0.9 g/L	9.3 a	9.0 a	8.2 a	7.6 a	7.0 a
SERENADE MAX	1.13 g/m^2	8.4 b	7.5 a	6.6 a	6.1 a	5.8 a

[1] Values are the means of five replicates; one 72-cell plug flat per plot, 72 plants per flat, RCB design.
[2] Numbers in a column followed by the same letter are not significantly different in Duncan's MRT at $P = 0.05$.

2008 PMR REPORT # 61

SECTION P: ORNAMENTALS, GREENHOUSE CROPS and TURF – Diseases

CROP: Western maidenhair fern (*Adiantum aleuticum* (Ruprect) C.A. Paris)
PEST: Rhizoctonia aerial blight (*Rhizoctonia solani* Kuhn)

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TITLE: EVALUATION OF BIOLOGICAL AND CHEMICAL FUNGICIDES FOR CONTROL OF RHIZOCTONIA AERIAL BLIGHT OF FERN, 2007

MATERIALS: PLANTSHIELD (*Trichoderma harzianum* strain T-22, Rifai strain KRL-RG2, 1 x 10^7 cfu/g dry weight), PRESTOP (*Gliocladium catenulatum* strain J1446, 2.8 x 10^8 cfu/mL), RHAPSODY ASO (*Bacillus subtilis* strain QST 713, 1.34%, 1 x 10^9 cfu/g), SENATOR 70 WP (thiophanate-methyl 70%), SERENADE MAX (*Bacillus subtilis* strain QST 713, 14.6 %, 7.3 x 10^9 cfu/g).

METHODS: The trial was conducted using natural inoculum in a commercial, shaded greenhouse with overhead irrigation on 72-cell plug flats (0.15 m^2 surface area per flat) of western maidenhair (*Adiantum aleuticum)* ferns produced from spores by the grower and transplanted into Sunshine Mix #4 growth medium on March 2, 2007. At the start of the trial, asymptomatic fern plug plants were selected and transplanted into experimental flats. There was one flat (72 plants) per plot with four replicates per treatment in a randomized complete block (RCB) design. Relative humidity was 80% and mean temperature ranged from 17-18° C in June to 30-32° C in July and August. Beginning on June 20, prior to disease symptoms, treatments were applied every 14 days as a foliar spray to run-off with a CO_2 backpack sprayer at 40 psi (276 kPa) in a solution volume of 250 mL per flat (1 L per treatment), for a total of six applications to August 29. Between product applications, the sprayer was rinsed with CHEMPROCIDE (7.5% DDAC) disinfectant at 4 mL/L followed by a water rinse to ensure that there was no cross-contamination between microbial fungicides. The percent area of diseased fronds per flat was estimated visually at 7 and 14 days after the first application and every 14 days thereafter, up to Sept. 5, 7 days after the final application. The area under the disease progress curve (AUDPC) was calculated for each plot. Plant quality was rated visually on a scale of 1 to 9, where 9 = best. Phytotoxicity (chlorosis, necrosis, stunting, or leaf distortion) was rated on a scale of 0 to 10, where 10 equaled completely necrotic plants. Statistical analysis (ANOVA) was performed using CoStat 6.303, 2004, CoHort Software, Monterey, California, USA, © 1998-2004 and means compared in Duncan's Multiple Range Test and Tukey's HSD at $P = 0.05$.

RESULTS: Results are presented in Tables 1 and 2. Disease was first observed on July 11 when day temperatures were ≥ 26° C. Disease severity was variable among plots in the biological treatments.

CONCLUSIONS: PLANTSHIELD (*Trichoderma harzianum*) significantly reduced Rhizoctonia aerial blight of western maidenhair fern (*A. aleuticum*) compared to the untreated check under moderately high disease pressure. Disease control with PLANTSHIELD was statistically different from the check in Duncan's MRT at $P = 0.05$ (though not in Tukey's HSD, data not shown) and was not statistically different from that obtained with the standard fungicide SENATOR 70 WP. Though not statistically significant from the check in the later weeks, SERENADE MAX and RHAPSODY ASO suppressed the disease somewhat and may have performed better if applied on a weekly schedule. PRESTOP was ineffective. No phytotoxicity was observed but SERENADE MAX left a white residue on the fronds.

ACKNOWLEDGMENT: Funding for this trial was provided by a grant from the Reduced-Risk Pesticide Program of Agriculture and Agri-Food Canada's Pest Management Centre to Peter Isaacson, IPM/Minor Use Co-ordinator for the Canadian Nursery and Landscape Association.

Table 1. Rhizoctonia aerial blight of western maidenhair fern: mean percent diseased leaf area and area under the disease progress curve (AUDPC).

Treatment	Rate of Product Applied	Disease Severity (% Leaf Area)[1]					
		July 11/07	July 25/07	Aug 08/07	Aug 22/07	Sept 05/07	AUDPC
CHECK	-	10.0 a[2]	11.2 ab	26.2 ab	45.0 a	67.5 a	1767.5 a
RHAPSODY ASO	20 mL/L	8.8 a	5.0 c	35.0 a	33.8 ab	40.0 ab	1452.5 ab
SERENADE MAX	1.13 g/m²	8.8 a	8.8 bc	25.0 ab	23.8 bc	42.5 ab	1242.5 ab
PRESTOP	5.0 g/L	9.6 a	15.0 a	26.2 ab	31.2 ab	61.2 a	1578.5 ab
PLANTSHIELD	0.9 g/L	7.8 a	8.2 bc	21.2 ab	20.0 bc	30.0 b	1011.5 bc
SENATOR 70 WP	0.85 g/L	6.1 a	7.8 bc	10.0 b	5.0 c	17.5 b	551.2 c

[1] Values are the means of four replicates; one 72-cell flat per plot, 72 plants per flat, RCB design.
[2] Numbers in a column followed by the same letter are not significantly different in Duncan's MRT at $P = 0.05$.

Table 2. Mean plant quality rating of western maidenhair ferns on a scale of 1-9 where 9 = best.

Treatment	Rate of Product Applied	Plant Quality Rating[1]					
		June 27/07	July 11/07	July 25/07	Aug 08/07	Aug 22/07	Sept 05
CHECK	-	9.0 a[2]	10.0 a	7.8 a	6.0 ab	4.8 b	3.0 b
RHAPSODY ASO	20 mL/L	9.0 a	8.8 a	8.0 a	5.1 b	5.8 ab	5.9 ab
SERENADE MAX	1.13 g/m²	9.0 a	8.8 a	7.8 a	6.2 ab	6.5 ab	5.6 ab
PRESTOP	5.0 g/L	9.0 a	9.6 a	7.0 a	6.2 ab	5.8 ab	4.4 ab
PLANTSHIELD	0.9 g/L	9.0 a	7.8 a	7.8 a	6.2 ab	7.2 ab	6.8 a
SENATOR 70 WP	0.85 g/L	9.0 a	6.1 a	8.0 a	7.5 a	7.5 a	7.2 a

[1] Values are the means of four replicates; one 72-cell flat per plot, 72 plants per flat, RCB design.
[2]Numbers in a column followed by the same letter are not significantly different in Tukey's HSD at P = 0.05.

2008 PMR REPORT # 62

SECTION P: ORNAMENTALS, GREENHOUSE CROPS and TURF – Diseases

CROP: Hybrid rose (*Rosa* L. *x hybrida)* cv. 'Orange Blossom Special'
PEST: Black spot (*Marsonnina rosae* (Lib.) Lind. = *Diplocarpon rosae* Wolf)

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TITLE: EVALUATION OF BIOLOGICAL AND CHEMICAL FUNGICIDES FOR CONTROL OF BLACK SPOT OF HYBRID ROSE, 2007

MATERIALS: MESSENGER (harpin protein), MILSTOP Foliar Fungicide (potassium bicarbonate 85%), NOVA 40W (myclobutanil 40%), PLANTSHIELD (*Trichoderma harzianum* strain T-22 Rifai strain KRL-RG2, 1 x 10^7 cfu/g dry weight), PRESTOP (*Gliocladium catenulatum* strain J1446, 2.8 x 10^8 cfu/mL), PRISTINE WG Fungicide (boscalid 25.2 %, pyraclostrobin 12.8%), RHAPSODY ASO (*Bacillus subtilis* strain QST 713, 1.34 %, 1 x 10^9 cfu/g), RAINGROW SUPERFLOW surfactant (*Yucca schidigera* extract + non-ionic surfactant).

METHODS: Two trials (A and B) were conducted in 2007 on outdoor, two-gallon (22 cm diameter) container-grown hybrid rose cv. 'Orange Blossom Special' in Langley, British Columbia using natural inoculum. Each trial was a randomized complete block (RCB) design with four replicates per treatment and two plants per plot. Plants were spaced for a surface area per treatment (eight plants) of 0.5 m^2. Products were applied as preventative foliar sprays before disease appeared using a CO_2 backpack sprayer at 40 psi (276 kPa) equipped with a single adjustable nozzle in 2400 L water per ha = 15 mL of solution per plant to cover foliage to run-off (MESSENGER at 1800 L/ha = 11.25 mL/plant) or as a fine mist "to glisten" for MILSTOP. Plants were fertilized with Quality Rose Food 15-9-12 slow release (1 tablespoon (15 g) per pot) on May 22. In Trial A, the first treatment application was made on May 22 and the final on June 26. On July 5, the plants were pruned back (removing all diseased leaves), fertilized again and allowed to flush out new, healthy leaves. The first application in Trial B was made on July 17 and the last on Aug. 21. FLORAMITE SC (bifenazate) was applied at 0.3 mL/L on August 8 to control two-spotted spider mites. Plants were evaluated weekly prior to each product application and for two weeks after the final application. The percent leaf area affected by black spot per plot was estimated visually and area under the disease progress curve (AUDPC) was calculated for each treatment. Statistical analysis (ANOVA) was performed using CoStat, Version 6.303 CoHort Software, Monterey, California, USA, © 1998-2004 and means were compared in Tukey's HSD at $P = 0.05$.

RESULTS: Results are presented in Table 1 (Trial A) and Table 2 (Trial B), below. No phytotoxicity was observed in any treatment.

CONCLUSIONS: In Trial A under moderate disease pressure in spring/early summer (Table 1) all products reduced the overall percentage of leaf area (AUDPC) with black spot significantly compared to the untreated check. However, in Week 6 and 7 (June 26 and July 3) when disease pressure became more

severe, only plants treated with NOVA 40W or PRISTINE WG were significantly different from the check. When applied every 14 days, NOVA, and PRISTINE at the high rate (1.6 kg/ha = 0.64 g/L) reduced the percent leaf area diseased (AUDPC) by 80-88%. Treatments that reduced disease levels by 60-75% were PRISTINE at the low rate (1.3 kg/ha= 0.52 g/L) every 14 days; MILSTOP at 2.8 or 5.6 g/L on a 7-day interval; PRESTOP every 14 days; RHAPSODY every 7 days; and MESSENGER when applied every 21 days. Poorest treatments were PLANTSHIELD every 14 days, SUPERFLOW every 7 days, and MILSTOP at the low rate (2.8 g/L) when the interval was extended to 14 days.

In Trial B under high disease pressure in late summer (Table 2), PRISTINE WG (both high and low rates) or NOVA 40W applied every 14 days, and the low rate of MILSTOP (2.8 g/L) applied at either 7 or 14 days reduced the percent leaf area affected by 70 to 88% for the first month and suppressed disease (AUDPC) by 55-64% overall. In this experiment, the high rate of MILSTOP (5.6 g/L) every 7 days did not perform as well as the lower rate every 14 days. The biologicals, PLANTSHIELD, RHAPSODY and PRESTOP, as well as SUPERFLOW and MESSENGER reduced the percent leaf area affected by approximately 40-50% for the first month but disease suppression was overcome after Week 4.

Table 1. Trial A: Rose cv. 'Orange Blossom Special': Mean percent leaf area with black spot per treatment per week under moderate disease pressure in early summer, 2007.

Treatment	Rate of Product Applied	Appl. Int. (D)	Disease Severity (% Leaf Area Diseased per Week)[1]						
			Week 2 May 29[2]	Week 3 June 04	Week 4 June 12	Week 5 June 19	Week 6 June 26	Week 7 July 03	AUDPC (% Reduc. w.r.t Check)
CHECK	-	-	12.5 ab	23.0 a	43.8 a	57.5 a	62.5 a	78.8 a	1670.4 a
PLANTSHIELD	0.9 g/L	14	7.5 ab	3.0 a	17.5 ab	21.2 b	12.8 b	71.2 a	683.4 b (59.1)
RHAPSODY	20.0 mL/L	7	6.2 ab	2.5 a	10.5 b	20.0 b	18.8 ab	65.0 ab	633.5 b (62.1)
PRESTOP	5.0 g/L	14	10.0 ab	5.8 a	13.8 b	18.8 b	12.5 b	65.0 ab	652.8 b (60.9)
NOVA 40W	0.34 g/L	14	2.2 ab	3.5 a	2.2 b	6.5 b	2.2 b	21.2 cd	191.6 b (88.5)
MILSTOP	2.8 g/L	7	7.8 ab	6.5 a	8.8 b	18.8 b	13.8 b	56.2 abcd	585.4 b (65.0)
MILSTOP	2.8 g/L	14	7.5 ab	10.5 a	6.2 b	18.8 b	25.2 ab	75.0 a	740.2 b (55.7)
MILSTOP	5.6 g/L	7	2.0 b	5.2 a	4.0 b	10.2 b	10.2 b	51.2 abcd	401.6 b (76.0)
PRISTINE WG	1.3 kg/ha	14	7.5 ab	9.8 a	10.0 b	15.0 b	11.2 b	26.2 bcd	466.4 b (72.1)
PRISTINE WG	1.6 kg/ha	14	5.8 ab	10.0 a	6.8 b	12.5 b	4.0 b	16.2 d	329.9 b (80.2)
SUPERFLOW	2.5 mL/L	7	16.0 a	2.8 a	18.8 ab	22.5 b	26.2 ab	82.5 a	892.5 b (46.6)
MESSENGER	56.0 mg/m^2	21	1.8 b	5.8a	7.2 b	10.5 b	12.8 b	61.2 ab	480.4 b (71.2)

[1] Values are the means of four replicates; two plants per plot, RCB design.

[2] Numbers in a column followed by the same letter are not significantly different in Tukey's HSD at P = 0.05.

Table 2. Trial B: Rose cv. 'Orange Blossom Special': Mean percent leaf area with black spot per treatment per week under high disease pressure in late summer, 2007.

Treatment	Rate of Product Applied	Appl. Int. (D)	Disease Severity (% Leaf Area Diseased per Week)[1]					
			Week 2 July 24[2]	Week 3 July 31	Week 4 Aug 07	Week 5 Aug 14	Week 6 Aug 21	AUDPC (% Reduc. w.r.t Check)
CHECK	-	-	5.0 a	67.5 a	90.0 a	95.0 a	100.0 a	2152.5 a
PLANTSHIELD	0.9 g/L	14	0.0 a	6.8 b	28.8 bc	76.2 ab	91.2 a	1101.6 b (48.8)
RHAPSODY	20.0 mL/L	7	0.2 a	11.2 b	36.2 bc	68.8 ab	88.8 ab	1126.1 b (47.7)
PRESTOP	5.0 g/L	14	0.0 a	31.2 ab	48.8 abc	82.5 ab	100.0 a	1487.5 ab (30.9)
NOVA 40W	0.34 g/L	14	0.2 a	6.8 b	23.8 c	61.2 ab	90.0 a	959.0 b (55.4)
MILSTOP	2.8 g/L	7	1.2 a	10.0 b	30.0 bc	48.8 b	86.2 ab	931.9 b (56.7)
MILSTOP	2.8 g/L	14	1.2 a	11.2 b	27.8 bc	50.0 b	78.8 abc	907.4 b (57.8)
MILSTOP	5.6 g/L	7	2.5 a	28.8 ab	73.8 ab	75.0 ab	87.5 ab	1566.2 ab (27.2)
PRISTINE WG	1.3 kg/ha	14	0.0 a	5.0 b	26.2 bc	50.0 b	58.8 c	774.4 b (64.0)
PRISTINE WG	1.6 kg/ha	14	0.2 a	9.0 b	22.5 c	45.0 b	67.5 bc	773.5 b (64.1)
SUPERFLOW	2.5 mL/L	7	0.5 a	16.5 b	57.5 abc	83.8 ab	96.2 a	1444.6 ab (32.9)
MESSENGER	56.0 mg/m^2	21	0.2 a	6.2 b	57.5 abc	81.2 ab	96.2 a	1353.6 ab (37.1)

[1] Values are the means of four replicates; two plants per plot, RCB design.

[2]Numbers in a column followed by the same letter are not significantly different in Tukey's HSD at P = 0.05.