Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

2009 Pest Management Research Report (PMRR) 2009 Growing Season

2009 Rapport de recherches sur la lutte dirigée (RRLD) pour la saison 2009

Canada

English

2009 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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This is the tenth 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 39 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 Allison Plunkett for editorial and computer compilation services.

Suggestions for improving this publication are always welcome.

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Procedures for the 2010 Annual PMR Report will be sent in fall, 2010. They will also be available from Allison Plunkett.

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 2009 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 48.

An individual report will be cited as follows:
Author(s). 2009. Title. 2009 Pest Management Research Report - 2009 Growing Season. Agriculture and AgriFood Canada. May 2010. Report No. x. Vol. 48: pp-pp.

Français

Rapport de recherches sur la lutte dirigée - 2009

Préparé par: Centre de la lutte antiparasitaire, Agriculture et Agroalimentaire Canada
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Titre officiel du document
2009 Rapport de recherches sur la lutte dirigée - pour la saison 2009. Compilé par Agriculture et Agroalimentaire Canada, 960 avenue Carling, Ed. 57, Ottawa, ON K1A 0C6, Canada
mai 2010 volume 48[1]. 119 pp. 39 reports.
Publié sur Internet à http://www.cps-scp.ca/publications.htm.

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 39 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 Allison Plunkett 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 2010 PMR seront introduites à l'automne 2009. Elles seront aussi disponibles par Allison Plunkett.

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 2009 correspond au volume 48.

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

En 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. 2009. Titre. 2009 Rapport de recherche sur la lutte dirigée. Agriculture et Agroalimentaire Canada. mai, 2010. Rapport n^{o} x. vol. 48: pp-pp.

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2009 PMR REPORT # 01 **SECTION A: FRUIT - Insect of Tree Fruits**

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%), CALYPSO 480 SC (thiacloprid 48%)

METHODS: During the June 2009 codling moth (CM) flight, 3 conventionally managed apple orchards in Essex County and 6 in Norfolk County, Ontario, were selected for the collection of male CM adults. Orchards were selected based on adult CM trap catch data and damage reports from the previous 2 seasons within each region. One abandoned and minimal-spray orchard was also surveyed in Essex and Norfolk, respectively, to provide assumed baseline insecticide susceptibility. In each orchard, 30 pheromone-baited sticky traps were installed when monitoring traps indicated peak flight. Sticky liners were removed daily over a 2-3 week period and taken to the Insecticide Toxicology laboratory, AAFC London, for direct contact bioassays. Adult male CM caught on collected sticky liners were exposed to a diagnostic dose (DD) treatment with either 1µl dose of acetone (control), the active ingredient of organophosphorus insecticide, GUTHION 50 WSB (azinphos-methyl) at 250 ppm in acetone or the active ingredient of neonicotinoid insecticide, CALYPSO 480 SC (thiacloprid) at 625 ppm in acetone. Using a micropipette, the dose was applied directly on the thorax of each CM selected at random. The DD was determined with dose-response data from 48 h direct contact bioassays with an insecticide-susceptible CM strain from AAFC London exposed to a range of up to 3 concentrations per compound. The concentration for each compound that caused >95% but <100% mortality was designated as the DD. Direct contact bioassays were conducted daily until each treatment tested 30-50 moths/orchard minimum. The treated moths were kept under control conditions (25ºC, 50% RH, 16:8 L:D) for 48 h. Mortality was

assessed after 24 and 48 h. Moths were considered dead if they did not respond to probing with a fine paintbrush. During the August 2009 CM flight period, direct contact bioassays with male CM were repeated as previously described in 2 Essex County orchards and 6 Norfolk County orchards. All mortality was corrected using Abbotts formula and analyzed in SAS using ANOVA General Linear Model with Tukey's test at p= 0.05 level of significance.

RESULTS: As outlined in Tables 1 and 2.

CONCLUSIONS: Abandoned and minimal-spray orchard populations of CM were highly susceptible to azinphos-methyl with mortality greater than 88%, while mortality to thiacloprid was between 75 and 95% (Tables 1 & 2).The tolerance of CM to the azinphos-methyl DD was highest in Essex County during the June flight for orchards 2 and 3 but during the August flight for orchard 4 (Table 1). In June 2 orchards and in August one orchard had significantly lower CM mortality than did the abandoned orchard ($p< 0.05$). The CM collected from Norfolk County orchards were generally more susceptible to the azinphos-methyl DD (60 – 100%) than were CM from Essex County (Table 2). Only CM from one of the six managed Norfolk orchards had significantly lower percent mortality ($p<0.05$) with the azinpohos-methyl DD compared to CM from the minimal spray orchard.

The tolerance of CM to the thiacloprid DD was also higher in Essex County (Table 1). In 3 of 3 orchards in June, the average percent mortality 48 h after treatment with the thiacloprid DD was less than 50%, though only at two of the orchards was CM mortality significantly lower relative to the abandoned orchard ($p< 0.05$). Similar results were observed during the August flight with CM at 2 of 2 managed orchards surveyed ($p < 0.05$). The CM collected from managed orchards in Norfolk County were more susceptible to thiacloprid, in both June and August, than CM collected from Essex County (Table 2). There were no significant differences between the minimal-spray and managed orchards ($p>0.05$) in Norfolk County.

In general, CM collected during August flight periods were often, but not always, more susceptible to both azinphos-methyl and thiacloprid DDs than the CM collected during June (Tables 1 & 2). This may have resulted from CM more susceptible to insecticides than the resident, overwintering populations, entering the managed orchards throughout the growing season from outside sources. However, a more susceptible August population was not always the case. Susceptibility to azinphos-methyl decreased in one Essex County orchard (from 66% to 51% percent mortality) and in two Norfolk County orchards (from 80% to 60% and 93% to 81% mortality). As well, these three orchards had the greatest number of CM catches and visible fruit damage compared to other tested orchards in their respective regions.

The number of CM collected during June and August in both regions was below catch average and both flight periods were generally more dispersed than in past years. Several factors are thought to be responsible for this, including: 1) the use of new insecticide classes, such as DELEGATE (spinetoram 25%) and ALTACOR (chlorantraniliprole 35%) dampening down populations, and 2) cool, wet weather conditions.

Based on these surveys, there is potential for tolerance to organophorphorus and neonicotinoid insecticides to become 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.

ACKNOWLEDGEMENTS: We greatly appreciate the data collection support from OMAFRA, C. Franklin, M. Klitzke, D. MacArthur, A. Alhemzawia, E. D'Aprile, J. Tanner and J. Konopka. 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 and August 2009 codling moth flight from Essex County. CM adult male were treated with azinphos-methyl (250 ppm) and thiacloprid (625 ppm).

	Azinphos-methyl				Thiacloprid			
Orchard	June		August		June		August	
	N	% mort.	N	% mort.	N	% mort.	N	% mort.
1[1]	111	88 a[2]	33	100 a	80	75 a	10	87 a
2	33	58 b	31	65 ab	34	41 ab	17	43 b
3	29	54 ab	0	NA[3]	31	28 b	0	NA
4	72	66 b	71	51 b	70	34 b	73	

[1] Orchard #1 is an abandoned orchard.
[2] Numbers in a column followed by the same letter are not significantly different at p= 0.05.
[3] No moths were collected at this orchard for this treatment.

Table 2. 48 h corrected percent mortality for the June and August 2009 codling moth flight from Norfolk County. CM adult male were treated with azinphos-methyl (250 ppm) and thiacloprid (625 ppm).

	Azinphos-methyl				Thiacloprid			
Orchard	June		August		June		August	
	N	% mort.	N	% mort.	N	% mort.	N	% mort.
1[1]	23	97 a[2]	37	89 abc	9	83 a	32	95 a
2	0	NA[3]	46	97 b	0	NA	45	71 a
3	23	62 ab	29	100 a	23	47 a	14	63 a
4	8	67 ab	0	NA	8	63 a	0	NA
5	48	80 ab	35	60 c	49	57 a	35	71 a
6	30	70 b	35	87 abc	30	71 a	35	76 a
7	30	93 ab	54	81 c	34	83 a	54	

[1] Orchard #1 is a minimal-spray orchard.
[2] Numbers in a column followed by the same letter are not significantly different at p= 0.05.
[3] No moths were collected at this orchard for this treatment.

2009 PMR REPORT # 02 **SECTION A: LES INSECTES DES ARBRES FRUITIERS**

CULTURE: *Malus domestica* (cv. McIntosh)
RAVAGEUR: Mouche de la pomme, *Rhagoletis pomonella* (apple maggot)

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TITRE: **Protection des fruits contre la mouche de la pomme dans un verger de pommiers grâce à un insecticide à risque réduit, verger de l'IRDA au Parc du Mont-Saint-Bruno, Québec 2008 et 2009**

PRODUITS: GF-120 NF Naturalyte (spinosad 0,02%) est un appât mélangé à du spinosad.

MÉTHODES: L'essai a été réalisé au verger du Parc national du Mont-Saint-Bruno (45˚ 32' 36'' N, 73˚ 20' 33'' O) dans des blocs d'arbres standard plantés à 9,1 m sur le rang et 10,7 m entre les rangs. Trois traitements ont été comparés dans trois parcelles distinctes : a) une parcelle de 2,1 ha, traitée avec le produit attracticide (parcelle GF-120) ; b) une parcelle témoin sans insecticide de 0,5 ha, séparée de la parcelle traitée au produit attracticide par une parcelle tampon de 0,5 ha traitée avec des organophosphorés ; c) une parcelle « producteur », traitée avec des organophosphorés (OP) qui s'étendait sur 0,8 ha. Les traitements avec les organophosphorés étaient appliqués en fonction des résultats de dépistage des mouches de la pomme dans les sphères rouges engluées installées au pourtour des blocs de verger, en utilisant un seuil d'intervention de 1 mouche par sphère pour le premier traitement et 5 mouches par sphère par la suite.
PARCELLE GF-120. Les traitements avec le GF-120 étaient effectués grâce à un véhicule tout terrain (VTT) se déplaçant de 7,2 km/h (2008) à 8,9km/h (2009), sur lequel était installé un pulvérisateur électrique (5,8 A, 14V) équipé de deux buses produisant des gouttelettes de 5 mm de diamètre ou plus et un débit total de 0,88 (2009) à 0,96 l/min (2008). La pulvérisation était orientée vers la moitié supérieure des arbres de chaque rangée. Une partie de GF-120 était diluée dans 4 (2008) à 4,57 (2009) parties d'eau pour obtenir une dose d'application de 1,5 l/ha et 1 l/ha de produit en 2008 et 2009. Les traitements avec le produit attracticide ont débuté de 1 (2008) à 3 (2009) jours après la première capture de mouche de la pomme sur les sphères rouges, soit le 3 juillet 2008 et le 9 juillet 2009. Les traitements subséquents ont été effectués tous les 7 (2008) à 10 (2009) jours (ou avant en cas de délavage par une pluie d'au moins 6 mm) pour un total de 8 (2009) à 10 (2008) traitements pour la saison. Le produit attracticide n'était pas appliqué sur un feuillage mouillé ou dans les 48 heures précédant une prévision d'au moins 5 mm de pluie.
PARCELLE producteur. Trois traitements organophosphorés ont été effectués en 2008 pendant la période d'activité des mouches de la pomme adultes dans la parcelle producteur, un premier le 12 juillet 2008, contre la carpocapse, avec Zolone Flo (phosalone) à 2,0 l/ha, un deuxième le 23 juillet 2008, contre la mouche de la pomme, avec Zolone Flo à 2,0 l/ha et un dernier le 5 août 2008, contre la mouche de la pomme, avec Imidan 50W (phosmet) à 1,5 kg/ha. Deux traitements ont été effectués pendant la même période en 2009, un premier le 20 juillet 2009 avec Zolone Flo (phosalone) à 3 l/ha contre la mouche de la pomme, un second traitement visant le même ravageur a été effectué le 11 août 2009 avec Imidan 50W (phosmet) à 2,25 kg/ha. Tous les traitements ont été effectués avec à un pulvérisateur à jets portés.

Un total de pommes de la variété MacIntosh par parcelle de 498, 299 et 498 en 2008 et de 500, 320 et 500 en 2009 a été observé pour détecter la présence de dommages de mouches de la pomme respectivement pour la parcelle traitée au GF-120, la parcelle témoin sans insecticide et la parcelle traitée aux organophosphorés , à raison de 20 pommes par arbre choisies au hasard. Les pommes ont été cueillies le 25 août 2008 et le 4 septembre 2009 et conservées à 4˚C pour 14 et 7 semaines en 2008 et 2009 afin d'amplifier les symptômes éventuels d'infestation. L'extérieur et l'intérieur des fruits ont ensuite été examinés et le nombre de fruits endommagés par la mouche de la pomme a été dénombré pour chaque arbre.

RÉSULTATS ET CONCLUSIONS: Sur les 1295 pommes observées en 2008, 8 (2,3%) étaient endommagées par la mouche de la pomme et toutes provenaient de la parcelle témoin (sans insecticide). Ce pourcentage de dégâts est significativement plus élevé ($H= 13,97$, $p<0,01$) que celui observé dans la parcelle traitée avec le produit attracticide et la parcelle traitée avec des organophosphorés (0%) (Tableau 1). En 2009, aucune différence significative ($H= 4,49$, $p>0,05$) n'a été détectée entre les trois parcelles. Au total 6 pommes endommagée par la mouche sur un total de 1320 ont été retrouvée réparties également entre les parcelles témoins et traitées avec les organophosphorés pour un pourcentage de dégâts respectivement de 0,9 % et 0,6 %.
Des captures moyennes de 3,9 et 8,2 mouches par sphère ont été enregistrées respectivement en 2008 et 2009. Les captures ont par contre atteint jusqu'à 25 mouches par sphère dans certaines zones en 2009. Ces résultats indiquent que la population de mouches de la pomme peut être contrôlée dans les parcelles de verger traitées soit avec le GF-120 ou avec les organophosphorés, et ce malgré une pression élevée.

Tableau 1. Pourcentages moyens de pommes endommagées par les mouches de la pomme dans le verger du Parc du Mont-Saint-Bruno, 2008 et 2009.

	2008	2009
Treatment	% moyen de pommes avec des dommages écart-type	
OP	0 b	0.6 ± 1.7 a
GF-120	0 b	0 a
Témoin	2.3 ± 4.6 a	0.9 ± 2.0 a

[1] Les traitements suivis de lettres différentes dans chaque colonne sont significativement différents selon un test de Krusk al-Wallis.

2009 PMR REPORT # 03 **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 80 W(spinosad 80%), CRUISER 5 FS (thiamethoxam 47.6%), SEPRESTO 75 WS (clothianidin 56.25% + imidacloprid 18.75%), THIRAM 42 S (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%). In early April insecticides were applied to the seed by A. Taylor using a batch seed treater located in Geneva, NY. 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 measured 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 most effective treatment was 15%, a reduction in damage of nearly 65% as compared to damage recorded in untreated check plots. Carrots grown from seeds treated with either rate of CRUISER, ENTRUST at the high rate (7.5 g ai) or SEPRESTO at the high rate (11.25 g ai) had significantly less rust fly damage than carrots from the check plots. There were no significant differences in rust fly damage to carrots grown from seeds treated with either the low (2.5 g ai) or medium (3.75 g ai) rate of ENTRUST, or the low rate of SEPRESTO (5.63 g ai) and the untreated check plots. Carrot weevil damage was very low in this trial and no significant differences in the percentage of carrots damaged by carrot weevil were found among the treatments (Table 1). Although the lowest yields were harvested from check plots no statistically significant differences in yield were found among the treatments (Table 1).

ACKNOWLEDGMENT: Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program. The New York State Agricultural Experiment Station, Cornell University also 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	2.50	15.0 a[1]	1.2 ns[2]	62.4 ns
CRUISER	3.75	21.7 ab	0.6	63.9
ENTRUST	7.50	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	2.50	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

2009 PMR REPORT # 04 **SECTION B : VEGETABLE and SPECIAL CROPS - Insect Pests**

CROP: Spanish onion, *Allium cepa* L., cv. Ovation (transplanted)
PEST: Onion thrips (OT), *Thrips tabaci* Lindeman

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TITLE: SMALL PLOT, FIELD EVALUATION OF BIOPESTICIDES FOR CONTROL OF ONION THRIPS ATTACKING TRANSPLANTED SPANISH ONIONS IN MINERAL SOIL, 2009

MATERIALS: BOTANIGARD ES (*Beauveria bassiana* conidia 11.3% [w/w]), DELEGATE WG (spinetoram 25% [w/w]), ENTRUST NATURALYTE INSECTICIDE (spinosad A/D 80% [w/w]), SURROUND WP (kaolin 95% [w/w]), TRILOGY (neem oil extract 70% [w/w]), REQUIEM 25 EC (*Chenopodium ambrosioides* extract 25% [w/w]), MOVENTO 240 SC (spirotetramat 22.4% [w/w]), CARZOL SP (formetanate hydrochloride 92% [w/w]), MATADOR 120 EC (lambda-cyhalothrin 13.1% [w/w])

METHODS: Commercially grown Spanish onion transplants were machine planted on 5 May at 15 cm spacing, in 6-row plots with 0.6 m row spacing on the Delhi Research Farm (42° 51' N; 80° 33' W) in coarse, sandy loam (pH 6.7, 77% sand, 12% silt, 11% clay, 1.5% OM). All treatments were replicated 4x in a randomized complete block design. Replicate ranges were separated by 3 m cultivated buffers while plots within ranges were separated by 2.4 m cultivated buffers. Maintenance insecticides were applied to the entire block on 12 and 25 May to control European chafer, *Rhizotrogus majalis* (Razoumowsky), grubs and darksided cutworm, *Euxoa messoria* (Harris), respectively. Maintenance fungicides were applied on 13, 25 May, 16 Jun, 20, 28 Jul and 06 Aug while foliar fertilizer was applied on 15, 25 May, 1, 16 Jun, 6, 16, 20, 28 Jul and 6 Aug. Weeds were controlled by post transplant application of herbicide on 6 May followed by manual removal on 16, 26 Jun, 17 and 22 Jul. Natural rainfall was supplemented by traveling irrigation gun on 12 May (10 mm) and by solid set sprinkler irrigation on 22 May (14 mm) and 13 Jul (25 mm).
All experimental treatments except Tmt. 4 were applied on 23 Jun (Application A), 2 (B), 8 (C), 16 (D), 24 Jul (E) and 6 Aug (F)at 210 kPa in 600 L ha using a tractor mounted, CO_2-pressurized, side delivery

sprayer fitted with a 3.6 m boom equipped with 6 spray tips. Each spray tip was centred over a plot row. TTJ 11004 spray tips were utilized for Applications A and B; TJ AI-11002 spray tips were employed for Applications C-F. The altered parameters of Tmt. 4 (SURROUND WP) were as outlined in Table 1, Footnote 2. If OT numbers for a specific treatment did not exceed the threshold of 1.0 OT/leaf in the most recent count, that treatment was not applied for any given scheduled application.
Beginning on 16 Jun and continuing at regular intervals thereafter (Table 2), 5 plants were randomly selected from the centre 4 rows of each plot, pulled and the number of OT counted on the youngest 4 leaves of each plant. To stabilize non-homogenous variation, insect counts were subjected to square root (x+0.5) transformation prior to Analysis of Variance (ANOVA) to determine significance of observed differences among treatments. Significance of differences among individual treatments was then determined using Tukey's HSD procedure. De-transformed results were expressed as the mean number OT/leaf for each treatment (Table 2).

RESULTS: Results are presented in Table 2 (OT-numbers), Table 3 (OT-damage) and Table 4 (onion yield).
OT-populations increased only slowly across the block and did not reach the OMAFRA-recommended threshold of 1 OT/leaf until 16 Jun when onions had developed 3-7 leaves (Table 2). Numbers thereafter continued to increase. On 22 Jun, numbers ranged from 3.3-5.1 OT/leaf across all plots with no significant differences in populations among plots designated for various treatments (Table 2) which were first applied on 23 Jun. By 30 Jun, 7 days after treatment (DAT), OT populations were significantly reduced relative to untreated plots only in plots treated with MATADOR (Tmt. 11). Although populations were reduced 46.4% in plots treated with DELEGATE (Tmt. 2) and by 35.7% in plots treated with MOVENTO (Tmt. 10) the reduction was not statistically significant. OT-populations in untreated plots (Tmt. 12) reached highest levels on 7 Jul, 5 DAT-02. On that date, OT-populations were significantly reduced by 92.6% in plots treated with MATADOR (Tmt. 11) and by 64.8% in plots treated with DELEGATE (Tmt. 2). At that time, numerical reductions of 40.7% and 38.9% were recorded in plots treated with MOVENTO (Tmt. 10) and ENTRUST (Tmt. 3), respectively (Table 2). On 15 Jul, 7 DAT-03, due to high field variability, no significant differences among treatments in OT-numbers were recorded. OT-numbers were, however, numerically reduced by at least 60% in plots treated with CARZOL (Tmt. 10, 11) or DELEGATE during the 3rd application. By 27 July, 11 DAT-04 and 3 DAT-05, OT-populations had fallen in all plots, including untreated plots. Although once again no significant differences were measured in OT-numbers among treatments, lowest populations were recorded in plots treated with either CARZOL during the 4th application or DELEGATE during the 5th application (Table 2). No insecticide was applied in plots scheduled for Tmt. 10 or 11 during the 5th application as OT-numbers were below the threshold of 1.0 OT/leaf. Similarly, no insecticides were applied on 8 Aug during the 6th application, to plots designated to receive either DELEGATE (Tmt. 2) or Tmt. 10 or Tmt. 11 when below threshold OT-numbers were recorded. On 12 Aug, 6 DAT-06, most onions across the entire block had lodged, tops were drying and OT populations were very low. No significant differences among OT-populations for any treatment were recorded on that date.
Each leaf inspected for OT-presence was also rated for OT feeding damage on a 0-5 scale where 0 = no feeding damage and 5 = total leaf surface showing signs of OT feeding. To stabilize non-homogenous variation, damage assessment values were subjected to square root (x+0.5) transformation prior to undertaking ANOVA to determine significance of observed differences among treatments. Significance of differences among individual treatments was again determined using Tukey's HSD procedure. Results were expressed as the Mean Leaf Damage for each plot (Table 3).
On 24 Aug, all onions with 15 cm spacing from adjacent onions were pulled from the centre 2 rows of each plot and allowed to dry on the soil surface for 24 h. On 25 Aug all onions harvested from each plot were placed in separate, labelled bins, transported to a drying kiln and dried at 26°C for 7 days. All onions from each plot were then topped, measured and weighed. To account for varying numbers of onions harvested from each plot, yields were corrected by calculating the harvested area for each plot and expressing yield in tonnes/ha. Significance of observed differences in bulb diameter and yields was

determined by ANOVA while significance of differences among individual treatments was again determined using Tukey's HSD procedure.
Immediately prior to the 1st application on 23 Jun, damage to the inner leaves by feeding OT was spread reasonably uniformly across the experimental block; mean leaf damage ranged from 1.6-2.6 with no significant differences among treatments (Table 3). By 7 Jul, 5 DAT-02 feeding damage was significantly lower in plots treated with either DELEGATE (Tmt. 2) or MATADOR (Tmt. 11)(Table 3), reflecting the lower OT-populations recorded in these treatments (Table 2). For both treatments, significant reductions in OT-damage relative to damage in untreated plots persisted until 4 Aug. A significant reduction in OT-damage in plots treated with MOVENTO/CARZOL (Tmt. 10) was first recorded on 15 Jul and also continued until 4 Aug (Table 3). By 12 Aug, significant leaf senescence and lodging was observed in all plots; no significant differences in OT-damage to rated leaves was recorded at that time (Table 3).
Due to high field variability, no significant differences among treatments were recorded for either mean bulb diameter at harvest or mean yield (Table 4).

CONCLUSIONS: Under the conditions of this trial the largest reductions in onion leaf damage by feeding OT followed application of a scheduled program of 2 applications of either MATADOR (Tmt. 11) or MOVENTO (Tmt. 10) followed by 2 applications of CARZOL. Regular scheduled application of 5 foliar sprays of the biopesticide DELEGATE also significantly reduced OT-damage to the leaves of Spanish onion transplants. Although results were not statistically significant, OT-damage in plots treated throughout (Tmt 3) or early (Tmt. 8) in the season with ENTRUST tended to be less than in untreated plots (Tmt. 12) but higher than in the 3 best treatments. Regular scheduled application of neither BOTANIGARD (Tmt. 1), nor SURROUND (Tmt. 4), nor TRILOGY (Tmt. 5), nor REQUIEM (Tmt. 6) nor 3 applications of BOTANIGARD followed by either SURROUND (Tmt. 7) or DELEGATE (Tmt. 9) had any impact on either OT-numbers or OT-feeding damage. While ENTRUST was the only organically approved biopesticide causing any numerical impact on OT in this trial, program application of "classical" insecticides with different modes of action proved more effective and consistent. By regularly rotating among insecticides with several modes of action, development of resistance may be delayed if not prevented. DELEGATE, a purified isomer of spinosad, would be a useful member of such an OT-management program.

OBSERVATIONS: No significant phytotoxicity was observed following any application of any treatment. Due to its formulation, application of kaolin (SURROUND WP) resulted in a thin whitish deposit on the surface of treated leaves which was easily removed by moderate rainfall or irrigation, necessitating re-application. Uneven growth following transplanting revealed variation in soil pH across the experimental block. Even though foliar fertilizers were applied a number of times in an attempt to improve plant health and growth, resulting variation in bulb size among plots hindered determination of any significant differences in onion yield among the impact of foliar pesticides compared for OT-control.

Table 1. Foliar biopesticides applied to Spanish onions for management of onion thrips, *Thrips tabaci* Lindeman, Delhi, ON, 2009.

Tmt. No.	Treatment Applied		Rate Applied		Applic'n Code[1]
	Active Ingredient	Formulation	g a.i./ha	Product/ha	
1	*Beaveria bassiana* conidia	BOTANIGARD ES	226.0	2.0 L	ABCDEF
2	spinetoram	DELEGATE WG	70.0	280.0 g	ABCDEF
3	spinosad	ENTRUST	87.2	109.0 g	ABCDE
4[2]	kaolin	SURROUND WP	23, 750.0	25.0 kg	ABCDEF
5	neem oil extract	TRILOGY	4,200.0	6.0 L	ABCDEF
6	*Chenopodium ambrosioides* extract	REQUIEM 25 EC	1,250.0	5.0 L	ABCDEF
7	*Beaveria bassiana* conidia + kaolin	BOTANIGARD ES + SURROUND WP	45.2 + 23,750.0	2.0 L + 25.0 kg	ABC + DEF
8	spinosad + *Chenopodium ambrosiodes* extract	ENTRUST + REQUIEM 25 EC	87.2 + 1,250.0	109.0 g + 5.0 L	ACE + BDF
9	*Beaveria bassiana* conidia + spinetoram	BOTANIGARD ES + DELEGATE WG	226.0 + 70.0	2.0 L + 280.0 g	ABC + DEF
10	spirotetramat + formeta-anate hydrochloride	MOVENTO 240 SC + CARZOL SP	89.8 + 772.8	374.0 ml + 840.0 g	AB + CD
11	lambda-cyhalothrin + for-metanate hydrochloride	MATADOR 120 EC + CARZOL SP	22.6 +772.8	188.0 ml + 840.0 g	AB + CD
12	no treatment	---	---	---	---

[1] **Date of Application:** A - 23 Jun; B - 2 Jul; C - 8 Jul; D - 16 Jul; E - 24 Jul; F - 6 Aug

[2] Application A - 50 kg at 210 kPa in 600 L/ha; Applications B, D, F - 25 kg at 210 kPa in 600 L/ha; Applications C, E - 50 kg at 275 kPa in 1,000 L/ha. using TJ XR11002 spray tips.

Table 2. Impact of foliar biopesticides on populations of onion thrips, *Thrips tabaci* Lindeman, on the inner 4 leaves of Spanish onion transplants, Delhi, ON, 2009.

Tmt. No.	Mean No. Onion Thrips/Leaf on Indicated Date							
	16 Jun	22 Jun	30 Jun	7 Jul	15 Jul	27 Jul	4 Aug	12 Aug
1	1.5 a[1]	4.3 a	3.8 ab	4.4 abc	3.9 a	1.5 ab	1.3 ab	0.3 b
2	1.4 a	3.3 a	1.5 bc	1.9 c	0.9 de	0.2 c	0.6 ab	0.3 b
3	1.9 a	5.1 a	3.3 ab	3.3 bc	1.5 b-e	0.6 abc	0.5 b	0.3 b
4	1.5 a	3.9 a	2.8 ab	6.3 ab	3.5 ab	1.1 abc	2.0 a	0.5 b
5	1.4 a	3.4 a	3.7 ab	5.1 ab	3.2 a-d	1.6 a	1.9 a	1.6 a
6	1.5 a	4.4 a	4.5 a	5.6 ab	3.3 abc	0.9 abc	0.6 ab	0.4 b
7	1.6 a	3.7 a	4.4 a	7.2 a	3.1 a-d	0.8 abc	0.8 ab	0.5 b
8	1.2 a	3.4 a	2.1 abc	5.0 ab	2.5 a-e	0.6 abc	0.9 ab	0.4 b
9	1.6 a	3.3 a	3.3 ab	5.2 ab	3.5 ab	0.4 bc	0.4 b	0.5 b
10	1.7 a	4.0 a	1.8 bc	3.2 bc	0.6 e	0.2 c	0.2 b	0.3 b
11	1.7 a	3.8 a	0.2 c	0.4 d	1.0 cde	0.2 c	0.2 b	0.5 b
12	2.2 a	4.0 a	2.8 ab	5.4 ab	2.7 a-e	0.7 abc	0.6 ab	0.5 b
BBCH[2]	103-107	103-108	104-111	105-113	403-407	405-407	407-408	408-409

[1] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and Tukey's HSD Range separation test.

[2] Minimum-Maximum BBCH Growth Stage on indicated date - 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 3. Impact of foliar biopesticides on damage by onion thrips, *Thrips tabaci* Lindeman, to the inner 4 leaves of Spanish onion transplants, Delhi, ON, 2009.

Tmt. No.	Mean Leaf Damage[1] by Onion Thrips on Indicated Date						
	22 Jun	30 Jun[2]	7 Jul	15 Jul	27 Jul	4 Aug	12 Aug
1	2.0 a[3]	2.3	1.8 ab	2.0 ab	2.7 ab	2.1 abc	2.4 a
2	2.4 a	1.7	1.1 b	1.0 bc	1.5 bc	1.3 c	2.0 a
3	2.6 a	1.7	1.7 ab	1.4 abc	1.8 abc	1.9 abc	2.4 a
4	2.6 a	2.3	1.8 ab	2.0 ab	2.5 abc	2.7 a	2.9 a
5	2.4 a	2.3	1.9 ab	1.9 abc	1.6 abc	2.6 a	2.8 a
6	2.2 a	2.2	2.1 ab	1.8 abc	2.5 abc	2.1 abc	2.8 a
7	1.8 a	2.2	2.0 ab	2.2 a	2.3 abc	2.4 abc	2.6 a
8	2.2 a	1.8	1.6 ab	1.6 abc	2.3 abc	1.5 ab	2.6 a
9	2.4 a	2.4	2.0 ab	2.3 a	2.4 abc	2.2 abc	2.2 a
10	2.3 a	1.6	1.6 ab	1.1 bc	1.5 bc	1.4 bc	2.0 a
11	2.0 a	1.3	1.2 b	0.8 c	1.4 c	1.4 bc	2.2 a
12	2.1 a	2.2	2.4 a	2.4 a	3.0 a	2.9 a	2.8 a
BBCH[4]	103-108	104-111	105-113	403-407	405-407	407-408	408-409

[1] Rated on a 0-5 Scale where 0 = healthy, undamaged leaf and 5 = dead leaf with all leaf surface showing evidence of damage by feeding thrips.
[2] Data for 30 June could not be homogenized by any tested transformation. Significance of differences among treatment means was not determined.
[3] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and Tukey's HSD Range separation test.
[4] Minimum-Maximum BBCH Growth Stage on indicated date - 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 4. Impact of foliar biopesticides applied for management of onion thrips, *Thrips tabaci* Lindeman, on harvest bulb diameter and yield of Spanish onion transplants, Delhi, ON, 2009.

Tmt. No.	Treatment Applied	Rate Applied (Product/ha)	Applic'n Code[1]	Mean Bulb Dia. (cm)	Mean Yield (m ton/ha)
1	BOTANIGARD ES	2.0 L	ABCDEF	6.5 a	30.9 a
2	DELEGATE WG	280.0 g	ABCDEF	6.7 a	32.2 a
3	ENTRUST	109.0 g	ABCDE	6.8 a	38.5 a
4	SURROUND WP	25.0 kg	ABCDEF	6.9 a	37.2 a
5	TRILOGY	6.0 L	ABCDEF	5.3 a	22.6 a
6	REQUIEM 25 EC	5.0 L	ABCDEF	7.0 a	36.6 a
7	BOTANIGARD ES + SURROUND WP	2.0 L + 25.0 kg	ABC + DEF	6.7 a	38.3 a
8	ENTRUST + REQUIEM 25 EC	109.0 g + 5.0 L	ACE + BDF	6.6 a	32.3 a
9	BOTANIGARD ES + DELEGATE WG	2.0 L + 280.0 g	ABC + DEF	6.6 a	31.0 a
10	MOVENTO 240 SC + CARZOL SP	374.0 ml + 840.0 g	AB + CD	6.7 a	31.1 a
11	MATADOR 120 EC + CARZOL SP	188.0 ml + 840.0 g	AB + CD	7.4 a	36.2 a
12	---	---	---	6.6 a	34.4 a

[1] **Date of Application:** A - 23 Jun; B - 2 Jul; C - 8 Jul; D - 16 Jul; E - 24 Jul; F - 6 Aug

2009 PMR REPORT # 05 **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 DRENCH-TREATMENTS FOR CONTROL OF CABBAGE MAGGOT ATTACKING EARLY SEASON RUTABAGA IN MINERAL SOIL, 2009

MATERIALS: CLUTCH 50 WDG (clothianidin 50% [w/w]), BRIGADE 2 EC (bifenthrin 25.1% [w/w]), DPX-HGW86 200 SC (cyantraniliprole 20.0% [w/w]), ACTARA 240 SC (thiamethoxam 21.6% [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 55 m) was seeded on 6 May on the SCPFRC-London Research Farm (43° 01' 51.0" N; 81° 12' 30.7" W) in 1.0 m row spacing, in Embro loam (57.2% sand, 23.5% silt, 19.4% clay, 3.6% organic matter). Single row, 10 m plots were established on 21 May. All treatments (Table 1) 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 3x throughout the season on: 25 May at the first true leaf stage (BBCH 11)(Enz and Dachler, 1997); 9 June when plants had developed 3 pairs of true leaves (BBCH 13); and, 23 June when plants had developed 4-5 pairs of true leaves and roots attained a diameter of ca. 2 cm (BBCH 15, 41-42). For Tmt. 6, CLUTCH 50 WDG was applied in Drench I, DPX-HGW86 200 SC was applied in Drench II and BRIGADE 2 EC was applied in Drench III. All treatments were at 210 kPa in 10.0 L/100 m row and were applied in a 10-15 cm wide band centred on the row, using a hand-held, CO_2-pressurized, R&D plot sprayer with a single 6508E flat spray tip. MATADOR 120 EC (50 ml/ha) was applied to the entire block on 22 May to control a very high population of crucifer flea beetle, *Phyllotreta cruciferae* (Goeze). In an attempt to increase CM-pressure in the block, on 12 and 23 June, 300 and 800 adult CM were respectively released as uniformly as possible across all 4 replicates.
On 6 July, 14 days after Drench III, 1 root was selected at random in each plot and the next 10 consecutive roots > 1.0 cm diameter harvested, topped, placed in labelled containers and returned to the laboratory for grading. An additional set of roots was similarly collected on 20 July, 28 days following Drench III; no root < 3.0 cm diameter was included in this sample. Guard plants at either row end were

not considered. All roots were rated for CM-feeding damage according to the scale developed by King and Forbes (1954) (See footnote 1, Table 2). For each harvest, 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. A Damage Index (D.I.) was similarly calculated except that the factor of 0 was applied roots assigned both the Clean and Light rating, thus considering the fact that Light damage is actually negligible and roots could be readily marketed. 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. For each treatment the mean % Reduction in the D.I. due to CM-damage was calculated (See footnote 3, 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.

RESULTS: Results are presented in Table 2. At the time of Rating III, CM-damage was relatively moderate in untreated CONTROL plots (Tmt. 8). The mean D.I. was 38.8 at that time and nearly 60% of rutabagas harvested from CONTROL plots were assigned a Clean or Light rating (Table 2). CM-damage continued to increase, however. After 14 days, when Rating IV was completed, only 10% of rutabagas from CONTROL plots were given a Clean or Light rating (Table 2). The mean D.I. for rutabagas from those plots had increased by over 60% to 63.8.

The lowest D.I. for Rating III was recorded in plots receiving 3 drench applications of PYRINEX (Tmt. 7). However, although the D.I. was reduced by 90% in PYRINEX-treated plots relative to CONTROL plots, due to field variability, the reduction was not statistically significant. 95% of rutabagas harvested from plots drenched with PYRINEX received a Clean or Light grade for Rating III, significantly more than from any other treatment. The highest D.I. recorded for Rating III was for rutabagas treated with ACTARA (Tmt. 5). The D.I. for these rutabagas was significantly higher than the D.I. recorded for rutabagas treated with PYRINEX and numerically higher than for rutabagas harvested from all other treatments.

CM-damage increased in all treatments during the 14 days between Rating III and Rating IV. By Rating IV only 10% of rutabagas harvested from CONTROL plots (Tmt. 8) received a grade of Clean or Light, significantly lower than the 65% of harvested roots receiving the same grade for PYRINEX-treated plots (Tmt. 7). While at least 40% of examined roots rated a grade of Clean or Light in plots receiving either 1 drench of CLUTCH (Tmt. 1) or 3 drenches of BRIGADE (Tmt. 3) or DPX-HGW86 (Tmt. 4), the observed improvement in control of CM-damage was not statistically significant. Although the highest D.I. in Rating IV was recorded in CONTROL plots and the lowest in plots treated with PYRINEX (Tmt. 7), no statistically significant differences were determined.

CONCLUSIONS: Under the conditions of this trial, only scheduled multiple drench application of PYRINEX, one formulation of the current commercial standard, significantly increased the % of rutabagas receiving a grade of Clean or Light 14 days after the 3rd application. Although CM-damage increased, by 28 days after Drench III the % of roots with a Clean or Light rating was still significantly higher in plots receiving a banded drench of PYRINEX than in CONTROL plots. Due to field variability, however, no treatment significantly reduced the D.I. in harvested roots. Considering the results of this trial, the search for an effective replacement for the standard organophosphorus insecticide must continue. Tested replacements may have promise but rates and timing of application must be refined to achieve commercially acceptable levels of CM-control.

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King, K.M. and A.R. Forbes. 1954. Control of root maggots in rutabagas. J. Econ. Entomol. 47: 607-615.

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

Table 1. Field, drench-treatments for control of damage by cabbage maggot, *Delia radicum*, attacking spring-planted rutabaga in mineral soil in small plots, London, ON, 2009.

Tmt. No.	Treatment Applied		Rate Applied/ 100 m Row		No.
	Insecticide	Formulation	g a.i.	Product	Applic'n
1	clothianidin	CLUTCH 50 WDG	1.35	2.70 g	1
2	clothianidin	CLUTCH 50 WDG	1.35	2.70 g	3
3	bifenthrin	BRIGADE 2 EC	0.67	2.81 ml	3
4	cyantraniliprole	DPX-HGW86 200 SC	3.00	15.0 ml	3
5	thiamethoxam	ACTARA 240SC	1.10	4.58 ml	3
6	clothianidin + cyantraniliprole + bifenthrin	CLUTCH 50 WDG + DPX-HGW 200 SC + BRIGADE 2 EC	1.35 + 2.70 + 0.67	2.70 g + 13.5 ml + 2.81 ml	1 (Drench I) 1 (Drench II) 1 (Drench III)
7	chlorpyrifos	PYRINEX 480 EC	10.10	21.0 ml	3
8	no insecticide	CONTROL	----	----	---

Table 2. Impact of field, drench-treatments for control of damage by cabbage maggot, *Delia radicum*, attacking spring-planted rutabaga in mineral soil in small plots, London, ON, 2009.

Tmt. No.	Mean Treatment-Impact							
	Rating 3 (06-July)				Rating 4 (20-July)			
	Infest'n Index[1]	Damage Index[2]	% D.I. Reduction[3]	% Clean + Light[4]	Infest'n Index[1]	Damage Index[2]	% D.I. Reduction[3]	% Clean + Light[4]
1	38.4 ab[5]	35.3 ab	9.0	45.6 b	46.9 a	45.0 a	29.5	42.5 ab
2	16.9 ab	13.8 ab	64.4	80.0 b	52.5 a	50.0 a	21.6	27.5 ab
3	24.5 ab	23.1 ab	40.5	62.5 b	36.3 a	36.3 a	43.2	40.0 ab
4	23.8 ab	20.7 ab	46.6	70.7 b	40.6 a	37.5 a	41.2	47.5 ab
5	44.2 a	41.5 a	-7.0	48.3 b	56.3 a	53.8 a	15.8	27.5 ab
6	21.7 ab	17.9 ab	53.9	71.7 b	46.3 a	43.8 a	31.4	37.5 ab
7	4.4 b	3.8 b	90.2	95.0 a	30.6 a	26.3 a	58.9	65.0 a
8	38.8 ab	38.8 ab		58.6 b	64.4 a	63.8 a		10.0 b

[1] Infestation Index (I.I.) developed by King and Forbes (1954) 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] Damage Index (D.I.) calculated as I.I. except that a factor of 0 was applied to roots assigned either a Clean or Light classification.

[3] Mean % Reduction relative to Damage Index (D.I.) for Untreated CONTROL plots.
% Reduction = D.I..(CONTROl) - D.I.(Tmt. x)/D.I.(CONTROL) x 100%

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

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

2009 PMR REPORT # 06 **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 LATE SEASON RUTABAGA IN MINERAL SOIL, 2009

MATERIALS: BRIGADE 2 EC (bifenthrin 25.1% [w/w]), DPX-HGW86 200 SC (cyantraniliprole 20.0% [w/w]), PYRINEX 480 EC (chlorpyrifos 44.7% [w/w])

METHODS: A block of rutabagas (6 rows x 55 m) was seeded on 4 Aug on the SCPFRC-London Research Farm (43° 01' 51.9" N; 81° 12' 31.1" W) in 1.0 m row spacing, in Embro loam (57.2% sand, 23.5% silt, 19.4% clay, 3.6% organic matter). Single row, 10 m plots were established on 11 Aug. All treatments (Table 1) 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 3x throughout the growing season on: 14 Aug at the first true leaf stage (BBCH 11)(Enz and Dachler, 1997); 31 Aug when plants had developed 4-5 pairs of true leaves (BBCH 14-15); and, 14 Sep when plants had developed 8 pairs of true leaves and roots attained a diameter of ca. 2.5-3.0 cm (BBCH 18, 43-44). For all 3 drenches, all treatments were at 210 kPa in 10.0 L/100 m row and were applied in a 10-15 cm wide band centred on the row, using a hand-held, CO_2-pressurized, R&D plot sprayer with a single 6508E flat spray tip. In an attempt to increase CM-pressure in the block, on each of 1 and 15 Sep, 2,000 adult CM were released as uniformly as possible across all 4 replicates.
On 28-29 Sep, 14 days after Drench III, leaving the guard plant at the west end, the next 10 consecutive roots > 3.0 cm diameter were harvested from each plot, topped, placed in labelled containers and returned to the laboratory for grading. All roots were rated for CM-feeding damage according to the scale developed by King and Forbes (1954) (See footnote 1, Table 1). 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. A Damage Index (D.I.) was similarly calculated except that the factor of 0 was applied roots assigned both the Clean and Light rating, thus considering the fact that Light damage is actually negligible and roots could be readily marketed. 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. For each treatment, the mean % Reduction in the D.I. due to CM-damage was calculated (See footnote 3, Table 1). 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 1.

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

RESULTS: Results are presented in Table 1. The effort to increase CM-pressure in the block proved reasonably successful. By the time of harvest and rating, 14 days after Drench III, the mean D.I. in untreated plots was 78.3; only 5% of harvested roots from those plots received a damage rating of Clean or Light. Scheduled drench application of the commercial standard, chlorpyrifos (PYRINEX 480 EC)(Tmt. 5) provided excellent protection of harvested roots at that time. The D.I. was significantly reduced by over 95% in plots drenched 3x with chlorpyrifos; 95% of roots harvested from those plots were graded as Clean or Light. Drench application of remaining treatments (Table 1) also resulted in significant reductions in the D.I. of harvested roots, ranging from 56.9% in roots from plots treated with cyantraniliprole (Tmt. 2) to 72.9% for roots from plots treated with the full rate tank-mix combination of cyantraniliprole with bifenthrin (Tmt. 3). The D.I. of roots from plots drenched with the commercial standard, however, was significantly lower than for all treatments except Tmt. 3 and numerically lower than all tested treatments. Similarly, while drench application of all experimental treatments (Tmt. 1-4) significantly increased the % roots rated as Clean or Light relative to untreated plots, the % roots with those ratings was significantly lower than in plots drenched with the commercial standard (Tmt. 5).

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. No experimental insecticide, however, proved as effective as the currently registered organophosphorus commercial standard, chlorpyrifos. Tank-mix combination of candidate insecticides may warrant further investigation as combination of the full rates of cyantraniliprole and bifenthrin was numerically but not significantly more effective than application of either insecticide alone. A range of rates of application, however, should be investigated as the apparent level of control was reduced when the combined rate of application was halved. Effective CM-management on a marketable root remains a very challenging problem requiring further research.

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Table 1. Impact of field, drench-treatments for control of damage by cabbage maggot, *Delia radicum*, attacking late season rutabaga in mineral soil in small plots, London, ON, 2009.

Tmt. No.	Treatment Applied		Rate Applied/ 100 m Row		Mean Treatment-Impact			
	Insecticide	Formulation	g a.i.	Product	Infest'n Index[1]	Damage Index[2]	% D.I. Reduction[3]	% Clean + Light[4]
1	bifenthrin	BRIGADE 2 EC	1.12	4.71 ml	31.9 b[5]	31.2 b	60.1	55.0 b
2	cyantranilipro le	DPX-HGW86 200 SC	0.90	4.50 ml	38.1 b	33.8 b	56.9	47.5 b
3	cyantranilipro le + bifenthrin	DPX-HGW86 200 SC + BRIGADE 2 EC	0.90 + 1.12	4.50 ml + 4.71 ml	22.5 bc	21.3 bc	72.9	70.0 b
4	cyantranilipro le + bifenthrin	DPX-HGW86 200 SC + BRIGADE 2 EC	0.45 + 0.56	2.25 ml + 2.36 ml	33.8 b	32.5 b	58.5	52.5 b
5	chlorpyrifos	PYRINEX 480 EC	10.10	21.0 ml	3.1 c	2.5 c	96.5	95.0 a
6	no insecticide	CONTROL	----[6]	----	79.0 a	78.3 a		5.0 c

[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] Damage Index (D.I.) calculated as I.I. except that a factor of 0 was applied to roots assigned either a Clean or Light classification.

[3] Mean % Reduction relative to Damage Index (D.I.) for Untreated CONTROL plots.
% Reduction = D.I..(Control) - D.I.(Tmt. x)/D.I.(Control) x 100%

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

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

[6] No insecticide applied.

2009 PMR REPORT # 07 **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, 2009

MATERIALS: ADMIRE 240 F (imidacloprid 21.4 %), ACTARA 240 SC (thiamethoxam 21.6 %), TITAN 600 FS (clothianidin 48 %), CORAGEN (chlorantraniliprole 18.4 %), DPX-HGW86 200SC (cyantraniliprole 20%).

METHODS: Colorado potato beetle (CPB) adults or mature larvae were collected from 51 field sites in 6 Canadian provinces. Either neonicotinoid insecticide or chlorantranilaprole control failure had been reported from some of those sites. CPB were shipped in chilled containers overnight to AAFC London and placed on fresh potato foliage (cv. Kennebec). The F1 generation 2nd instar larvae were used in subsequent 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) for each insecticide. Discs were allowed to dry and then 5, 2nd instar larvae were placed on each disc and held in a covered, disposable, plastic 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, thiamethoxam and cyantraniliprole) 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 causing from 0%-100% mortality in the susceptible population. Each field population was tested with a minimum of 60 larvae/DC. 48 h bioassays with a control mortality $\geq$ 10% and 72 h bioassays with a control mortality $\geq$ 15% were not used for the final results. Due to the loss of several populations before the completion of the bioassays, partial test result data (< 60 larvae/DC) have been included to indicate trends in those populations.

RESULTS: As outlined in Table 1 and 2.
Less than one quarter (7 out of 39 or 18%) of the Canadian CPB populations surveyed can be considered tolerant (< 30% mortality) at the imidacloprid DC (LC_{95}). Control (> 70% mortality) was still achieved in approximately 60% of the CPB populations. Of the remaining populations where partial test results with imidacloprid were obtained (Data not shown), 2 out of 12 (17%) showed trends toward tolerance (< 30% mortality), while 50% of the populations could be considered susceptible. No resistance was observed with thiamethoxam, clothianidin, chlorantraniliprole or cyantraniliprole; control was respectively achieved in 80%, 86%, 86% and 93% of the CPB populations using the DCs for each insecticide. The partial test result data for thiamethoxam, clothianidin , chlorantraniliprole and cyantraniliprole similarly indicated that 80% (12 out of 15), 89% (17 out of 19), 86% (12 out of 14) and 94% (15 out of 16) respectively, could still be considered controlled (Data not shown). Regression analyses of percent

mortality for imidacloprid with the other 4 compounds indicated a moderate correlation with clothianidin (R^2=0.73) and thiamethoxam (R^2=0.59), but low correlation with chlorantraniliprole (R^2=0.01) and cyantraniliprole (R^2=0.14).

CONCLUSIONS: Insecticide-resistance is a growing concern for Canadian potato growers. For the past 15 years growers have relied heavily on foliar or soil application of imidacloprid or, more recently another neonicotinoid insecticide. As was observed in the 2008 survey, it appears that this reliance has led to resistance to imidacloprid in an increasing number of populations. The number of populations surveyed was greater in 2009 but overall the proportion regarded as tolerant to imidacloprid was < 50% the proportion recorded in 2008 when 42 populations were surveyed. This observation may partly be explained by the broader criteria for selection of CPB field sites in 2009. The criteria did not exclusively include fields experiencing control failures after imidacloprid use as was the case for many of the 2008 collection sites. As baseline studies for the next generation anthranilic diamide compound, cyantraniliprole, was the focus of the 2009 survey a broad selection of potato fields where CPB could be collected across the country was desired.
The 2009 survey was also the second year where our findings show a moderate positive correlation between CPB mortality to imidacloprid, the 1st generation neonicotinoid, with clothianidin and thiamethoxam, 2nd generation neonicotinoid insecticides. This observation heightens the concern over potential development of cross-resistance among the 3 neonicotinoids tested. Continued surveillance is required along with increased implementation of resistance management strategies to prevent additional CPB control failures. Mortality of CPB exposed to chlorantraniliprole and cyantraniliprole, both members of the anthranilic diamide class of insecticide, had a low correlation with imidacloprid CPB mortality. While the potential for cross-resistance may currently be less with these compounds, an effective resistance management strategy to extend their use is still warranted.

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Table 1. Number of tested CPB populations in each province with < 30% mortality at the DC (LC_{95}) for 5 insecticides, 2009.

Province	Imidacloprid	Thiamethoxam	Clothianidin	Chlorantraniliprole	Cyantraniliprole
AB	0 / 2[1]	0 / 2	0 / 1	0 / 2	0 / 2
MB	0 / 5	0 / 5	0 / 2	0 / 2	0 / 3
ON	1 / 13	0 / 9	0 / 7	0 / 10	0 / 9
QC	3 / 4	0 / 4	0 / 2	0 / 1	0 / 2
NB	3 / 11	0 / 8	0 / 6	0 / 5	0 / 9
PEI	0 / 4	0 / 2	0 / 3	0 / 2	0 / 4
Total	7 / 39	0 / 30	0 / 21	0 / 22	0 / 29

[1] No. resistant populations / Total populations tested

Table 2. Number of tested CPB populations in each province with ≥ 70% mortality at the DC (LC_{95}) for 5 insecticides, 2009.

Province	Imidacloprid	Thiamethoxam	Clothianidin	Chlorantraniliprole	Cyantraniliprole
AB	2 / 2[1]	2 / 2	1 / 1	2 / 2	2 / 2
MB	5 / 5	5 / 5	2 / 2	1 / 2	3 / 3
ON	8 / 13	8 / 9	6 / 7	9 / 10	8 / 9
QC	1 / 4	2 / 4	2 / 2	1 / 1	2 / 2
NB	3 / 11	5 / 8	5 / 6	4 / 5	8 / 9
PEI	4 / 4	2 / 2	3 / 3	2 / 2	4 / 4
Total	23 / 39	24 / 30	18 / 21	19 / 22	27 / 29

[1] No. susceptible populations / Total populations tested

2009 PMR REPORT # 08 **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, 2009

MATERIALS: PYRINEX 480 EC (chlorpyrifos 44.7% [w/w]), BRIGADE 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]), ALLEGRO 500 F (fluazinam 40.0% [w/w]), IGNITE 15 SN (glufosinate ammonium 13.5% [w/w])

METHODS: Hard red, spring wheat, cv. Superb, for the attract and kill (A&K) treatment (Tmt. 11 - 170 seeds/m row) was commercially treated and received in April 2008; laboratory tests verified good germination in April 2009. Seed potatoes were hand cut on 11 May. On 12 May, using a hand-operated mist-applicator, seed dressings (SD) (Table 1, Tmts. 4, 6, 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 pieces. Seed pieces for all other treatments were similarly treated with MAXIM PSP only. After treatment, bags were opened and seed allowed to dry until planting.
On 13 May, single row plots were established in sandy loam soil near Rodney, Ontario (42° 33' 18.9" N; 81° 38' 49.6" W). Rows were planted on 1 m spacing. Individual plots measured 5 m long. With the exception of Tmt. 12, 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. 12) were established so that every treated row was adjacent to an untreated row. Tmt. 8 was received after plot randomization and randomly replaced 1 untreated row in each range. Each replicate range thus contained 4 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. 1) and A&K (Tmt. 11) 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, 3, 5-8,10) 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. Plots were subsequently hilled on 03 July and weeds removed manually as required until harvest. To control foliar diseases, a tank mixture of BRAVO 500 + ALLEGRO 500 F (2.0 + 0.4 L/ha) was applied on 4 July. IGNITE 15 SN (3.0 L/ha) was applied to the entire block on 27 August to speed desiccation of potato vines and weeds.

On 16 September, 126 days after planting, all potatoes from Hills 2-7 of each plot were carefully dug, placed in labelled burlap bags and returned to the laboratory. All tubers in each bag were washed and allowed to dry prior to grading. During grading, the 50 largest tubers for each plot were individually weighed and checked for WW feeding damage; where tuber numbers were limited, all tubers $\geq$ 15 mm diameter were so evaluated. 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 plots in each replicate range were 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 a Least Significant Difference (LSD) means separation test. Results are presented as the mean 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 LSD 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 5-7 cm height by the time LOROX was applied; subsequent growth of wheat plants was stunted and wheat did not compete with growing potato plants. A total of 175.5 mm rainfall was recorded during the 126 days between planting and harvest.

RESULTS: Impact of planting treatments on WW-damage to harvested potato tubers is shown in Table 1. Although WW-damage to tubers was relatively low in this trial, damage was recorded in plots with no planting treatments across all ranges of the experimental block. An average of 10.8 WW-blemishes/10 tubers was recorded in plots with no planting treatment (Tmt. 12) while an average of 48.0% of harvested tubers was damaged by WW in those plots.

IFG-application of the commercial standard THIMET 15 G (phorate)(Tmt. 1) provided the most effective control of WW-damage. WW-tuber damage was significantly reduced by 84.3% to 1.7 WW-blemishes/10 tubers in plots treated with phorate. Although all remaining treatments with the exception of IFS-application of thiamethoxam + bifenthrin (Tmt. 7) numerically decreased the incidence of WW-damage to tubers, the reduction was statistically significant only in plots receiving: SD-application of clothianidin followed by IFS-application of bifenthrin (Tmt. 6); IFS-application of a tank-mixture of thiamethoxam + chlorpyrifos (Tmt. 8); the experimental A & K treatment (Tmt. 11); IFS-application of bifenthrin (Tmt. 3); or, SD-application of clothianidin (Tmt. 4). The observed decrease in WW-damage to tubers following IFS-application of either cyantraniliprole (Tmt. 10), or chlorpyrifos (Tmt. 2), or thiamethoxam (Tmt. 5) or SD-application of cyantraniliprole (Tmt. 9) relative to damage in untreated plots was not statistically significant. IFS-application of a tank mixture of thiamethoxam with chlorpyrifos (Tmt. 8) numerically improved WW control relative to control by IFS-application of either partner alone (Tmt. 2 or Tmt. 5); the increase was not, however, statistically significant. Similarly, while a combination of SD-application of clothianidin with IFS-application of bifenthrin (Tmt. 6) improved

WW-control relative to that observed with either partner applied alone (Tmt. 4 or Tmt. 3), the improvement was not statistically significant. On the other hand, WW-damage to tubers was higher in plots treated with IFS-application of a tank mixture of thiamethoxam and bifenthrin (Tmt. 7) than in plots treated with IFS-application of either partner alone (Tmt. 3 or Tmt. 5); the damage was significantly higher than in plots treated with IFS-application of bifenthrin (Tmt. 3).
Only 8.8% of harvested tubers showed signs of WW-feeding in plots receiving IFG-application of phorate (Tmt. 1). Fewer than 15% of tubers were damaged in plots receiving IFS-application of thiamethoxam + chlorpyrifos (Tmt. 8), SD-application of clothianidin + IFS-application of bifenthrin (Tmt. 6) or the experimental A&K treatment (Tmt. 11), a statistically significant reduction of at least 70%.

CONCLUSION: Under the conditions of this experiment, while IFG-application of the commercial standard, THIMET 15 G (phorate) continued to provide most effective control of WW-damage to potato tubers, 2 combination planting treatments (clothianidin SD + bifenthrin IFS [Tmt. 6] and thiamethoxam + chlorpyrifos IFS [Tmt. 8])also provided >80% reduction. Further study of combination treatments is warranted, especially since damage in a 3rd combination treatment (thiamethoxam + bifenthrin IFS [Tmt. 7]) actually exceeded the damage recorded for either partner alone (Tmt. 3 or Tmt. 5). The experimental A&K treatment (Tmt. 11) also effectively controlled WW-damage to potato.

Table 1. Impact of planting treatments on damage to potato tubers by wireworm, primarily *Melanotus* spp., on mineral soil, Rodney, ON, 2009.

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	phorate	IFG	32.25	1.7 c[3]	84.3	8.8 e	81.7
2	chlorpyrifos	IFS	10.4	6.3 abc	41.7	22.4 bcd	53.3
3	bifenthrin	IFS	3.0	4.3 bc	60.2	21.5 bcde	55.2
4	clothianidin	SD	12.5[4]	4.3 bc	60.2	20.3 bcde	57.7
5	thiamethoxam	IFS	1.06	5.3 abc	50.9	31.6 ab	34.2
6	clothianidin + bifenthrin	SD + IFS	12.5[4] + 3.0	1.8 c	83.3	14.1 cde	70.6
7	thiamethoxam + bifenthrin	IFS	1.06 + 3.0	10.8 a	0.0	36.8 ab	23.3
8	thiamethoxam + chlorpyrifos	IFS	1.06 + 10.4	1.9 c	82.4	13.6 cde	71.7
9	cyantraniliprole	SD	20.25[4]	5.1 abc	52.8	28.2 b	41.3
10	cyantraniliprole	IFS	4.5	8.4 ab	22.2	37.3 ab	22.3
11	experimental	A & K	confidential	2.1 c	80.6	13.7 de	71.5
12	no insecticide	---	---	10.8 a	---	48.0 a	---

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

[2] Relative to values recorded in absence of insecticide (Tmt. 12).

[3] Means within a column followed by the same letter are not significantly different ($P \leq 0.05$) as determined using ANOVA and Least Significant Difference range test.

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

2009 PMR REPORT # 09 **SECTION E : CEREAL, FORAGE CROPS, and OILSEEDS - Insect Pests**

CROP: Soybean, *Glycine max* (L.) Merr., Hyland Seed cv. RR Respond (3000 CHU)
PEST: Soybean aphid (*Aphis glycines* Matsumura)

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TITLE: EVALUATION OF FOLIAR INSECTICIDES FOR CONTROL OF SOYBEAN APHIDS

MATERIALS: MATADOR 120 EC (Lambda-cyhalothrin, 120.0 g ai/L); ENDIGO A13623B (Thiamethoxam, 141.0 g ai/L, Lambda-cyhalothrin, 106.0 g ai/L); CYGON 480 EC (Dimethoate, 480.0 g ai/L).

METHODS: The seed weight of RR Respond was 148.1 g/1000 seeds. The trial was planted on 25 May 2009 on clay loam soil at Ridgetown, ON, at a seeding rate of 20 seeds per metre using a 2-row cone seeder. 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. Insecticides were applied on 22 August using a handheld CO_2 precision sprayer (R&D Sprayers Inc., Opelousas, LA). The nozzle type used was Teejet TT11002 placed in pairs on "Y" nozzle bodies spaced 50 cm apart. Insecticides were prepared in two-litre plastic pop bottles according to assigned rates with 0.600 L of distilled water or 200 L/ha. The sprayer was held at a height of 0.5 m from the ground and applied with a walking speed of 0.5 m/s at 50 psi. Air temperature was 18.3 ˚C, 79% RH and wind speed was 0.5 kph during insecticide application.
Three plants were randomly selected from the centre two rows of each plot and destructively sampled on each assessment date; 0 (pre-spray), 10, 13, and 28 days after application (DAA). All morphs and stages of soybean aphids were counted on each entire plant. The two centre rows of each plot were harvested using a Hege plot combine and yields were corrected to 14.5% moisture. Sampling 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. 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: Following a foliar application of insecticides, all treated plots had a significant reduction in the number of aphids compared to the untreated plots on all assessment dates (Table 1). Ten days after

application, the greatest reduction in aphid populations was found in plots treated with the high rate of ENDIGO (45.5 g ai/ha) followed by the low rate of ENDIGO (37.0 g ai/ha), the high rate of MATADOR (28.0 g ai/ha) and CYGON, respectively. The low rate of MATADOR (10.0 g ai/ha) provided the smallest reduction in aphid numbers among the applied treatments. Thirteen days after application, plots treated with both rates of ENDIGO had significantly fewer aphids than those treated with the either rate of MATADOR. The high rate of MATADOR (28.0 g ai/ha) provided similar aphid reduction as CYGON, while the low rate of MATADOR (10.0 g ai/ha) had the highest number of aphids of any of the insecticide treatments. Twenty-eight days after application, aphid populations were lowest in plots treated with the high rate of ENDIGO (45.5 g ai/ha), but both rates of ENDIGO, CYGON and the high rate of MATADOR were statistically similar. No differences were measured in yield or 1000 seed weight among any treatment.

CONCLUSIONS: The greatest reduction in soybean aphid populations was achieved with either rate of ENDIGO (37.0, 45.5 g ai/ha) followed by CYGON 480 EC (480.0 g ai/ha) and the high rate of MATADOR 120 EC (28.0 g ai/ha). No differences were measured in yield among treatments; this may have been due to suppression of the soybean aphid infestation shortly after the economic threshold was reached and the infestation occurring late in the crop's development (R5).

Table 1: Mean number of soybean aphids per plant and yield of soybeans treated with foliar insecticides at Ridgetown, ON in 2009.

Treatment	Rate (g ai/ha)	Mean number of aphids per plant[1]				Yield (T/ha)	1000 seed weight (g)
		Pre-spray 21 Aug (R5)	31 Aug (R5)	3 Sept (R5)	18 Sept (R6)	27 Oct (R8)	
		0 DAA	10 DAA	13 DAA	28 DAA		
Untreated	---	378.0 a[2]	823.2 d	835.0 d	90.2 c	2.6 a	134.0 a
Matador 120 EC	10.0	513.2 a[3]	161.6 c	168.5 c	4.3 b	2.6 a	137.1 a
Matador 120 EC	28.0	375.9 a	38.8 b	46.2 b	3.1 ab	2.9 a	139.7 a
Endigo A13623B	37.0	469.8 a	23.4 ab	8.5 a	2.6 ab	2.8 a	143.4 a
Endigo A13623B	45.5	405.9 a	10.3 a	8.1 a	0.9 a	2.8 a	142.5 a
Cygon 480 EC	480.0	224.3 a	54.2 b	15.3 ab	1.7 ab	2.7 a	133.8 a
se		0.1494	0.1385	0.1914	0.1453	0.1426	2.2863
Pr >F		0.6074	<0.0001	<0.0001	<0.0001	0.7331	0.0332

[1] Data were analyzed following transformation with $\log_{10}(x+0.5)$; reported means are back transformed.
[2] Means followed by the same letter do not significantly differ ($P < 0.05$, LSD) as determined by ANOVA and Fisher's Protected LSD.
[3] A datum point determined to be an outlier was removed from the analysis.

2009 PMR REPORT # 10 **SECTION E: CEREAL, FORAGE CROPS, and OILSEEDS - Insect Pests**

CROP: Soybean, Glycine max (L.) Merr., Hyland Seed cv. RR Respond (3000 CHU)
PEST: Soybean aphid (Aphis glycines Matsumura), Bean leaf beetle (Cerotoma trifurcata Förster)

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TITLE: **EVALUATION OF SEED TREATMENT COMBINATIONS FOR CONTROL OF FOLIAR SOYBEAN PESTS**

MATERIALS: APRON MAXX RFC (Fludioxonil, 2.31%, Metalaxyl-M, 3.46%); CRUISER MAXX® Beans (Thiamethoxam, 22.6 %, Metalaxyl-M, 1.7 %, Fludioxonil, 1.12%); TRILEX AL (Trifloxystrobin, 13.5 g ai/L, Metalaxyl, 10.8 g ai/L); GAUCHO 480 FS (Imidacloprid, 480 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 149.4 g per 1000 seeds. The trial was planted on 22 May 2009 on clay loam soil at Ridgetown, ON, at a seeding rate of 20 seeds per metre using a 2-row cone seeder. Plots were 12 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 evaluated three times on the 3rd, 6th, and 9th row of each plot during early vegetative stages by counting all emerged plants in these rows. Vigour was assessed on each entire plot using a scale of 0-100% (0 = plants dead in plot and 100 = furthest developed plants in the trial). Pest counts and defoliation ratings were done on five plants in each of the 3rd, 6th, and 9th rows at each evaluation date; pest counts were done in situ on the whole plant and percent defoliation was assessed on the last fully expanded trifoliate. Five plants were destructively sampled from each of the 2nd, 5th, and 8th rows to determine the mean vegetative growth stage, plant height, and plant fresh weight per treatment on 9 July. Eight rows were harvested from the centre of each plot using an Allis-Chalmers K2 combine equipped with a HarvestMaster plot harvest data system (Juniper Systems, Inc., Logan, UT); yields were corrected to 14.5% moisture. Sampling 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. 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 each evaluation date, plant population was higher with CRUISER MAXX Beans than all other treatments and these plots appeared more vigourous than the other treatments (Table 1). By the V1 stage, plots treated with both rates of GAUCHO had higher plant stands and more vigour than the plots without insecticide (Table 1). When bean leaf beetle feeding occurred at the V1 stage, plots treated with CRUISER MAXX (56.23 g ai/100 kg seed) and the high rate of GAUCHO (125.0 g ai/100 kg seed) had less defoliation than plots treated with the low rate GAUCHO (62.5 g ai/100 kg seed) or untreated plots (Table 2). Bean leaf beetle presence decreased after the V4 stage and no further differences were measured among treatments (Table 2). No differences were detected in soybean aphid infestation levels among treatments; very low numbers were found in this trial (Table 3). No differences were measured in plant stage or fresh weight following destructive sampling on 8 July, but plants treated with CRUISER MAXX and the high rate of GAUCHO (125.0 g ai/100 kg seed) were taller than the low GAUCHO rate (62.5 g ai/100 kg seed) or the plants with no insecticide treatment (Table 4). Yield was significantly higher from plots treated with CRUISER MAXX and the high rate of GAUCHO (125.0 g ai/100 kg seed) compared to the low GAUCHO rate (62.4 g ai/100 kg seed), but these were not statistically higher than yield in the untreated plots (Table 4). No differences were measured in 1000 seed weight among the treatments (Table 4).

CONCLUSIONS: Soybeans treated with CRUISER MAXX and the high rate of GAUCHO (125.0 g ai/100 kg seed) were better protected from defoliation by bean leaf beetle feeding. Higher yields were achieved in plots with these treatments compared to plots treated with the low rate of GAUCHO (62.5 g ai/100 kg seed). Bean leaf beetle damage alone cannot explain the yield differences observed. We do not report on soil-inhabiting insects or bean pod mottle virus incidence; if these pests were not an issue, then higher plant stands and enhanced plant vigour may have led to the slightly higher yields observed in these treatments.

Table 1. Mean plant population and vigour of soybeans treated with seed-applied insecticide combinations for control of foliar soybean pests at Ridgetown, ON in 2009.

Treatment	Rate (g ai/100 kg seed)	Mean plant population (# plants/m2)			Mean plant vigour1 (0-100%)		
		29 May (VE)	5 June (VC)	12 June (V1)	29 May (VE)	5 June (VC)	12 June (V1)
Apron Maxx RFC	6.25	5.4 b2	11.4 b	12.8 c	72.5 b	81.3 bc	76.3 c
Cruiser Maxx Beans	56.25	12.8 a	23.7 a	25.1 a	100.0 a	100.0 a	100.0 a
Trilex AL + Gaucho 480 FS	9.0 62.5	6.9 b	14.9 b	18.0 b	71.3 b	77.5 c	88.8 b
Trilex AL + Gaucho 480 FS	9.0 125.0	7.5 b	17.1 b	18.9 b	76.3 b	87.5 b	91.3 b
se		2.086	2.679	0.716	5.796	2.577	2.311
Pr >F		0.032	0.009	0.003	0.021	0.001	0.001

[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. Mean percent defoliation by bean leaf beetle of soybeans treated with seed-applied insecticide combinations for control of foliar soybean pests at Ridgetown, ON in 2009.

Treatment	Rate (g ai/100 kg seed)	Mean percent defoliation per plant by bean leaf beetle (0-100%)						
		5 June (VC)	12 June (V1)	25 June (V4)	3 July (V7)	8 July (V7)	16 July (V8 R1)	23 July (V14 R2)
Apron Maxx RFC	6.25	0.0	3.8 b1,2	2.1 b	0.5 a	0.5 a	0.0 a	0.1 a
Cruiser Maxx Beans	56.25	0.0	0.3 a	0.4 ab	0.3 a	0.4 a	0.0 a	0.0 a
Trilex AL + Gaucho 480 FS	9.0 62.5	0.0	2.0 b	0.9 ab	0.6 a	0.5 a	0.2 a	0.1 a
Trilex AL + Gaucho 480 FS	9.0 125.0	0.0	1.1 a	0.2 a	0.5 a	0.3 a	0.2 a	0.1 a
se			0.200	0.192	0.076	0.089	0.042	0.045
Pr >F			0.008	0.118	0.262	0.741	0.185	0.783

[1] Data were analyzed following a square root + 0.5 transformation; reported means are back transformed
[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 3. Mean counts of soybean aphids per plant on soybeans treated with seed-applied insecticide combinations for control of foliar soybean pests at Ridgetown, ON in 2009.

Treatment	Rate (g ai/100 kg seed)	Mean number of soybean aphids per plant1						
		12 June (V1)	25 June (V4)	3 July (V7)	8 July (V7)	16 July (V8 R1)	23 July (V14 R2)	4 Aug (V21 R3)
Apron Maxx RFC	6.25	0.0	0.0	0.0	0.0	0.3 a2	0.8 a	6.7 a
Cruiser Maxx Beans	56.25	0.0	0.0	0.0	0.0	0.2 a	1.1 a	2.4 a
Trilex AL + Gaucho 480 FS	9.0 62.5	0.0	0.0	0.0	0.0	0.3 a	0.8 a	3.3 a
Trilex AL + Gaucho 480 FS	9.0 125.0	0.0	0.0	0.0	0.0	0.2 a	1.2 a	1.2 a
se						0.059	0.190	0.154
Pr >F						0.697	0.983	0.089

[1] Data were analyzed following transformation with log10(x+0.5); reported means are back transformed.
[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. Mean plant stage, height, fresh weight and yield of soybeans treated with seed-applied insecticide combinations for control of foliar soybean pests at Ridgetown, ON in 2009.

Treatment	Rate (g ai/100 kg seed)	Mean plant stage	Mean plant height (cm)	Mean fresh weight per plant (g)	Mean yield (T/ha)	Mean 1000 seed weight (g)
		8 July (V7)			23 October (R8)	
Apron Maxx RFC	6.25	7.0 a1	35.0 b	15.3 a	2.8 ab	154.1 a
Cruiser Maxx Beans	56.25	7.1 a	40.4 a	16.2 a	3.1 a	159.4 a
Trilex AL + Gaucho 480 FS	9.0 62.5	7.6 a	37.1 b	16.5 a	2.7 b	155.4 a
Trilex AL + Gaucho 480 FS	9.0 125.0	7.8 a	38.7 a	17.7 a	3.1 a	157.0 a
se		0.451	1.003	1.091	0.155	1.481
Pr >F		0.508	0.004	0.504	0.041	0.135

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

2009 PMR REPORT # 11 **SECTION I: ENQUÊTES PHYTOSANITAIRES ET INFESTATIONS**

Culture: Pommes
Ravageurs: carpocapse de la pomme, Cydia pomonella (L.), Charançon de la prune, Conotrachelus nenuphar (Herbst), hoplocampe des pommes, Hoplocampa testudinea Klug, mineuse marbrée, Phyllonorycter blancardella (F.), mouche de la pomme, Rhagoletis pomonella (Walsh), noctuelle du fruit vert, Orthosia hibisci (Gn.), punaise terne, Lygus lineolaris P. de B, sésie du cornouiller, Synanthedon scitula (Harris), tordeuse à bandes obliques, Choristoneura rosaceana (Harris), tordeuse à bandes rouges, Argyrotaenia velutinana (Walker), tordeuse orientale du pêcher, Grapholita molesta (Busck),

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Titre: **Les ravageurs des vergers de pommiers du québec en 2006, 2007, 2008 et 2009**

Méthodes: Dans 8 (2006, 2007) ou 9 (2008, 2009) vergers de pommiers commerciaux et un verger à régie biologique, une parcelle de 1-2 ha a été mise à la disposition du Réseau d'avertissements phytosanitaires du Québec pour dépister les insectes et acariens nuisibles aux pommiers et évaluer leur importance. Dans chacun de ces vergers pilotes, le dépistage des lépidoptères a été réalisé à l'aide de pièges à phéromones sexuelles Phérocon ou Multi-pher. Pour chaque lépidoptère, deux pièges ont été disposés de part et d'autre du centre de la parcelle. Pour dépister la punaise terne et l'hoplocampe des pommes, deux cartons blancs englués (15 x 20 cm) ont été placés dans les pommiers, respectivement à 70 et 150 cm au-dessus du sol à chacun des coins de la parcelle. Le charançon de la prune a été dépisté grâce à quatre pièges pyramidaux (Tedders, 1994) (h : 122 cm ; l : 55 cm) par verger, disposés à chacun des coins de la parcelle, au pied du premier arbre de chaque extrémité des rangées extérieures. Une pièce collectrice en entonnoir surmontée d'un cylindre collecteur en plastique transparent était installée au sommet du piège pour capturer les adultes de cette espèce. La mouche de la pomme a été dépistée à l'aide de sphères rouges englués placées à 150 cm du sol dans un pommier de chacun des coins de la parcelle. Les pièges ont été installés entre le 3 avril et le 5 juin, le 10 avril et le 11 juin, le 14 avril et le 2 juin et le 1er avril et le 15 juin respectivement en 2006, 2007, 2008 et 2009. La présence et le nombre d'insectes capturés ont été relevés à toutes les semaines respectivement jusqu'au 5, 3, 1er et 8 septembre pour les années 2006, 2007, 2008 et 2009. Les pièges collants ont été nettoyés ou remplacés au besoin et les diffuseurs à phéromone ont été remplacés à toutes les 4 ou 5 semaines. Les dommages à la récolte ont été évalués dans chacune des parcelles à la fin août ou au début septembre en échantillonnant 500 pommes récoltées aléatoirement dans 50 à 100 arbres par parcelle. Ce bilan reflète la situation générale des ravageurs observés dans l'ensemble des régions pomicoles du Québec pour les années 2006 à 2009.

Résultats: Voir les tableaux ci-dessous.
conclusions: Les captures moyennes de carpocapses de la pomme ont dépassé de 2 (2007, 2008) à 3 (2006) fois les captures normales et étaient proches de la normale en 2009. Les captures moyennes des vergers de Saint-Paul ou Rougemont ont atteint de 3 (2009) à 9 (2006) fois les captures moyennes normales. Les captures élevées se sont reflétées sur les dommages qui ont atteint en moyenne 0,9 et 1,0% en 2006 et 2007 pour redescendre à 0,4 % en 2008 et 2009. Les captures de tordeuses à bandes obliques sont passées sous la normale en 2007, 2008 et 2009 comparativement à 2006 dans tous les vergers sauf à

Saint-Paul d'Abbotsford où les captures ont régressé mais dépassaient toujours la normale en 2008 et sont passés sous la normale en 2009. Les dégâts occasionnés par les tordeuses et autres chenilles dans les vergers commerciaux ont été réduits de moitié entre 2006 et 2008 pour les chenilles et étaient même absents des échantillons en 2008 pour la tordeuse à bandes obliques. Les dégâts du charançon de la prune qui étaient proches de la normale dans les vergers commerciaux sont restés le principal problème dans le verger biologique avec jusqu'à 22 % du total des dégâts d'insectes en 2006. Les captures de mineuses marbrées, de noctuelles du fruit vert, de punaises ternes, de tordeuses à bandes rouges, d'hoplocampes des pommes et de mouches de la pomme étaient proches ou en-dessous de la normale pour toutes les années. Les dégâts d'hoplocampes des pommes étaient plus élevés que la normale en 2008 malgré des captures proches de la normale. La tordeuse orientale du pêcher, un nouveau ravageur des pommiers pour le Québec a été capturé en quantités de plus en plus grandes d'année en année en 2006, 2007 et 2009 avec des captures de 1, 23 et 195 captures respectivement à Rougemont et de 1,12 et 21 captures à Franklin. Nous ne pouvons pas nous prononcer sur l'incidence de ce ravageur sur les dégâts car ils peuvent être confondus avec ceux occasionnés par le carpocapse de la pomme. Des dégâts atteignant en 2007 une moyenne 1,1 % des pommes ont été attribués à des punaises phytophages (excluant la punaise terne). Les dégâts totaux d'insectes dans les vergers commerciaux ont régressé entre 2006 et 2009 en passant de 4,5 % à 3,2 % qui est sous la normale de 4,9 % des 18 dernières années.

Référence: Tedders, W. L. et B. W. Wood. 1994. A new technique for monitoring pecan weevil emergence (Coleoptera: Curculionidae). J. Entomol. Sci. 29(1):18-30.

Tableau 1. Total des captures d'adultes par piège dans les vergers-pilotes du Québec en 2006, 2007, 2008 et 2009.

Vergers	Ravageurs[1]											
	CARPO				CHA				HOP			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Compton	77	38	60	20	ND	ND	ND	ND	11,8	7,8	33,8	9,3
Dunham	ND	ND	8	3	ND	ND	ND	ND	ND	ND	5,0	0,8
Franklin	108	166	96	39	0,0	1,5	0,0	0,0	0,5	0,3	1,5	0,5
Hemmingford	31	25	19	12	1,0	0,0	0,0	0,0	18,3	2,3	27,3	19,8
Oka	19	20	120	37	ND	ND	ND	ND	1,5	0,8	5,5	1,5
Rougemont	323	405	341	189	0,0	0,3	0,0	0,0	8,5	4,3	2,8	17,3
Saint-Joseph-du-lac	57	71	338	64	ND	ND	ND	ND	17,0	6,3	6,0	11,3
Saint-Paul d'Abbotsford	410	192	281	244	0,0	0,0	0,0	0,0	0,3	1,0	1,5	0,5
Sainte-Famille (I.O.)	8	6	1	4	ND	ND	0,0	ND	2,8	1,0	0,5	0,8
Verger biologique[2]	46	33	34	27	3,0	3,0	1,0	2,3	31,5	2,5	36,0	58,0
Cumul moyen (v. commerciaux)	146	115	140	68	0,3	0,5	0,0	0,0	8,3	3,0	9,3	6,9
Normale moyenne (v. commerciaux)[3]	46	54	62	72	ND	ND	0,4	0,3	11,0	10,9	1,2	9,5
Période de dépistage	24 avr.- 5 sept.	23 avr.- 3 sept.	21 avr. 1 sept.	14 avr.- 8 sept.	18 avr.- 17 juil.	23 avr.- 16 juil.	14 avr.- 21 juil.	14 avr.- 13 juil.	24 avr.- 19 juin	23 avr.- 18 juin	21 avr.- 16 juin	14 avr.- 29 juin
Type de piège[4]	MP-1				PyrN				CBE			
Phéromone	Trécé											

Vergers	Ravageurs[1]											
	MIN				MOU				NFV			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Compton	3472	4354	1459	3730	4,0	1,5	3,0	7,3	9	20	71	74
Dunham	ND	ND	4375	15204	ND	ND	0,5	2,3	ND	ND	8	48
Franklin	9543	2936	2808	3369	5,0	1,5	2,0	6,3	24	18	9	189
Hemmingford	12951	23429	14370	10785	5,5	3,5	6,0	22,5	9	2	10	93
Oka	9254	10575	6148	5796	1,5	0,3	1,8	0,8	4	15	23	57
Rougemont	27986	30740	10249	4863	2,3	3,3	30,8	19,8	9	12	15	50
Saint-Joseph-du-lac	12093	5003	3302	858	2,3	2,8	1,0	3,8	2	29	11	107
Saint-Paul d'Abbotsford	44283	25169	10514	12354	1,8	0,8	2,3	5,3	14	16	16	242
Sainte-Famille (I.O.)	7183	9122	1499	8554	0,0	0,0	0,3	0,0	3	5	0	7
Verger biologique[2]	12368	6989	3984	2501	8,0	6,5	11,0	33,8	5	7	11	22
Cumul moyen (v. commerciaux)	17083	13916	6080	7279	3,2	1,7	5,3	7,6	10	14	18	96
Normale moyenne (v. commerciaux)[3]	21837	18823	18962	17966	6,4	5,9	5,6	5,7	160	117	111	111
Période de dépistage	10 avr.- 5 sept.	10 avr.- 3 sept.	14 avr.- 1 sept.	6 avr.- 8 sept.	5 juin- 5 sept.	11 juin- 3 sept.	2 juin- 1 sept.	1 juin- 8 sept.	3 avr.- 19 juin	10 avr.- 4 juin	14 avr.- 9 juin	1 avr.- 22 juin
Type de piège[4]	MP-2				SRE				MP-1			
Phéromone	Trécé								Scentry			

Vergers	Ravageurs[1]											
	PUN				SEC				TBO			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Compton	6,3	0,8	2,8	2,3	8	2	0	1	33	22	11	17
Dunham	ND	ND	9,0	2,3	ND	ND	48	17	ND	ND	40	16
Franklin	2,8	5,0	8,8	2,8	42	12	149	6	312	126	121	93
Hemmingford	8,3	6,0	6,0	1,8	12	2	92	71	172	81	130	38
Oka	5,5	8,5	11,3	3,0	25	11	54	15	136	68	130	45
Rougemont	2,3	7,8	2,5	5,3	3	1	1	11	311	153	100	139
Saint-Joseph-du-lac	1,5	3,0	4,0	4,8	8	53	91	0	234	31	78	43
Saint-Paul d'Abbotsford	2,0	8,3	12,0	4,3	14	29	19	150	542	270	176	124
Sainte-Famille (I.O.)	0,5	1,0	0,5	0,3	0	0	2	0	49	19	24	4
Verger biologique[2]	2,8	3,3	2,0	5,3	0	1	10	1	187	34	112	52
Cumul moyen (v. commerciaux)	4,1	5,1	6,3	3,0	16	13	50	30	248	96	90	58
Normale moyenne (v. commerciaux)[3]	4,4	4,1	4,2	4,5	39	33	26	27	148	159	163	163
Période de dépistage	3 avr.- 12 juin	10 avr.- 11 juin	14 avr.- 9 juin	1 avr.- 29 juin	15 mai- 5 sept.	14 mai- 3 sept.	12 mai- 1 sept.	20 avr.- 8 sept.	15 mai- 5 sept.	14 mai- 3 sept.	12 mai- 1 sept.	20 avr.- 8 sept.
Type de piège[4]	CBE				MP-3				PH-1C			
Phéromone					Scentry				Trécé			

Vergers	Ravageurs[1]						
	TBR				TOP		
	2006	2007	2008	2009	2006	2007	2009
Compton	812	682	209	234	ND	ND	ND
Dunham	ND	ND	180	295	ND	ND	ND
Franklin	425	229	79	137	4	12	21
Hemmingford	491	708	402	295	0	0	0
Oka	197	121	172	119	ND	ND	ND
Rougemont	170	123	96	187	1	23	195
Saint-Joseph-du-lac	106	64	39	38	ND	ND	ND
Saint-Paul d'Abbotsford	379	307	108	207	0	0	0
Sainte-Famille (I.O.)	56	90	15	18	ND	ND	ND
Verger biologique[2]	492	357	235	180	0	0	0
Cumul moyen (v. commerciaux)	368	290	144	170	1	9	54
Normale moyenne (v. commerciaux)[3]	385	320	340	303	ND	ND	ND
Période de dépistage	3 avr.-5 sept.	10 avr.-3 sept.	14 avr.-1 sept.	1 avril-8 sept.	8 mai-5 sept.	7 mai-3 sept.	6 avr.-8 sept.
Type de piège[4]	MP-3				PH-1C		
Phéromone	Trécé				Trécé		

Tableau 2. Dommages à la récolte (%) dans les vergers-pilotes du Québec en 2006, 2007, 2008 et 2009.

Vergers	Année	Ravageurs								
		CARPO	HOP	MOU	CHE	TBO 2e gén.	CHA	PUN	APP	Pression totale
commerciaux [5] (±E.T.)	2006	0,9 (1,2)	0,6 (0,7)	0,0 (0,1)	1,2 (0,9)	0,4 (0,5)	0,1 (0,3)	1,0 (1,0)	0,3 (0,6)	4,5 (2,3)
	2007	1,0 (1,2)	0,4 (0,5)	0,0 (0,1)	0,6 (0,4)	0,2 (0,2)	0,2 (0,3)	1,2 (0,5)	1,1 (1,7)	4,7 (2,3)
	2008	0,4 (1,1)	0,9 (1,2)	0,1 (0,2)	0,6 (1,0)	0,0 (0,0)	0,2 (0,4)	0,4 (0,4)	0,5 (0,7)	3,3 (3,1)
	2009	0,4 (0,8)	0,4 (0,7)	0,0 (0,1)	1,0 (0,8)	0,1 (0,2)	0,1 (0,2)	0,8 (1,0)	0,4 (0,3)	3,2 (2,2)
moy. 1991-2008 (±E,T.)		0,2 (0,3)	0,7 (0,7)	0,1 (0,1)	1,1 (0,5)	0,4 (0,4)	0,3 (0,3)	1,5 (1,0)	0,4 (0,3)	4,9 (1,6)
biologique[2]	2006	4,4	8,0	0,8	7,6	0,0	22,4	1,0	1,6	64,0
	2007	1,0	0,8	2,6	8,4	0,0	6,2	6,8	5,4	74,6
	2008	5,2	8,0	1,2	6,2	0,6	19,6	2,8	5,6	73,2
	2009	0,2	4,4	0,0	9,4	0,6	20,2	2,8	5,4	53,4

[1]CARPO: Carpocapse de la pomme; CHA: Charançon de la prune; HOP: Hoplocampe des pommes; MIN: Mineuse marbrée; MOU: Mouche de la pomme; NFV: Noctuelle du fruit vert; PUN: Punaise terne; SEC: Sésie du cornouiller; TBO: Tordeuse à bandes obliques; TBR: Tordeuse à bandes rouges; CHE: Chenilles; APP : Autres punaises phytophages; ND : non disponible.
[2]Verger situé à Henryville.
[3] Normales basées sur 10 ans en date du 8 septembre 2009.
[4]PH-1C= Phérocon 1C; C B E= Carton blanc englué; MP - 1., 2 ou 3= Multi-pher (1, 2 ou 3); S R E= sphère rouge engluée; PyrN: piège pyramidal noir en bois.
[5]Dégâts observés dans 8 (2006, 2007) ou 9 (2008, 2009) vergers.

2009 PMR Report # 12 **SECTION K: FRUIT – Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 BOSCALID/PYRACLOSTROBIN AND PYRIMETHANIL APPLICATION FOR THE CONTROL OF POSTHARVEST BLUE AND GRAY MOLD ON 'EMPIRE' APPLES. 2008-09.

MATERIALS: PRISTINE (25.2% Boscalid & 12.8% Pyraclostrobin), SCALA SC (Pyrimethanil 400 g ai/L), MERTECT (45 % Thiabendazole), and SCHOLAR (50% Fludioxonil).

METHODS: During the 2008 growing season a field trial was conducted at the Agriculture & Agri-Food Canada Farm in Jordan Station, ON. Apple cv. 'Empire' was maintained according to standard orchard practices. 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 23, 2008 and stored in cold storage at 0.5 - 2 ºC. On September 24 2008, 12 apples from each of the replicate plots 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 conidial suspension ($1x10^4$ conidia/ml of water) of thiabendazole-resistant (TBZ-R) *Penicillium expansum* isolate PS-1R or thiabendazole-resistant (TBZ-R) *Botrytis cinerea* isolate BC-34R and placed back in cold storage at 0.5 - 2 ºC for 168 days. Postharvest treatments on apples that were treated with preharvest PRISTINE or SCALA include: (SCHOLAR at 1.2 g/L and MERTECT at 1.15 g/L). Twelve fruit were used for each treatment and each treatment had four replicates. The fruit from the postharvest treatments were also incubated for 168 days at 0.5-2 °C. After incubation 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 a growth chamber for a shelf-life study at 20 ºC (85 % RH) for 7 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 and 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 28 days and then disease increased to 37.5% at 56 days and 81.3% at 84 days and 100% at 140 days. Similarly in the SCALA treated apples, for the first 28 days the disease was completely controlled and 50%, 70.8%, 81.3%, 83.3%, 100% disease was observed after 56 days, 84 days, 111 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, even on the apples that were treated with preharvest application of SCALA or PRISTINE.

Effect on postharvest gray mold of apples (Table 2): When inoculum was introduced in the wounds of the PRISTINE preharvest treated apples, complete control was observed up to 28 days and then the disease increased to 54.2%, 70.8%, 79.1% and 100% by 56, 84, 111 and 140 days respectively. The combination of MERTECT on apples that were treated with preharvest application PRISTINE also showed 77.1% at 56 and 84 days and 100% disease by day 111. 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 gray 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 *B. cinerea* on apples, even on apples that had preharvest application of SCALA or PRISTINE.

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 (*Penicillium expansum)* in 'Empire' apples, 2008-09.

Preharvest Application	Postharvest Treatment	Percentage incidence of blue mold (*Penicillium expansum* TBZ-R) at 0.5 - 2 °C after[1]						168 days at 0.5 - 2 °C + 7 days at 20 °C
		28 days	56 days	84 days	111 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	2.1 b	2.1 b	2.1 b	8.3 c	8.3 c
Control	*P. expansum* 1 x 10^4 conidia/ml	2.1 b	100.0 f	100.0 g	100.0 e	100.0 d	100.0 d	100.0 d
Control	*P. 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
Control	*P. expansum* + MERTECT 1.15 g/L	0.0	100.0 f	100.0 g	100.0 e	100.0 d	100.0 d	100.0 d
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	*P. expansum* 1 x 10^4 conidia/ml	0.0 a	37.5 b	81.3 d	91.7 d	100.0 d	100.0 d	100.0 d
PRISTINE	*P. 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	*P. expansum* + MERTECT 1.15 g/L	6.3 c	47.9 c	83.3 e	85.4	91.7 d	100.0 d	100.0 d
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	2.1 b	2.1 b
SCALA	*P. expansum* 1 x 10^4 conidia/ml	0.0 a	50.0 d	70.8 c	81.3 c	83.3 c	100.0 d	100.0 d
SCALA	*P. 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	*P. expansum* + MERTECT 1.15 g/L	0.0 a	81.3 e	93.5 f	100.0 e	100.0 d	100.0 d	100.0 d

[1] 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, 111, 140 and 168 days, then removed from cold storage and incubated for 7 days at 20 °C.

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

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 (*Botrytis cinerea*)in 'Empire' apples, 2008-09.

Preharvest Application	Postharvest Treatment	Percentage incidence of gray mold (*Botrytis cinerea* TBZ-R) at 0.5 - 2 °C after						168 days at 0.5 - 2 °C + 7 days at 20 °C
		28 days	56 days	84 days	111 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	2.1 b	2.1 b	2.1 b	8.3 c	8.3 c
Control	*B. cinerea* 1 x 10^4 conidia/ml	79.2 d	100.0 f	100.0 g	100.0 f	100.0 d	100.0 d	100.0 d
Control	*B. 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
Control	*B. cinerea* + MERTECT 1.15 g/L	100.0 e	100.0 f	100.0 g	100.0 f	100.0 d	100.0 d	100.0 d
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	*B. cinerea* 1 x 10^4 conidia/ml	0.0 a	54.2 d	70.8 e	79.1 e	100.0 d	100.0 d	100.0 d
PRISTINE	*B. 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
PRISTINE	*B. cinerea* + MERTECT 1.15 g/L	0.0 a	77.1 e	77.1 f	100.0 f	100.0 d	100.0 d	100.0 d
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	2.1 b	2.1 b
SCALA	*B. cinerea* 1 x 10^4 conidia/ml	6.3 b	33.3 c	41.6 c	41.6 c	45.8 c	100.0 d	100.0 d
SCALA	*B. 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	*B. cinerea* + MERTECT 1.15 g/L	20.8 c	29.2 b	56.3 d	58.3 d	100.0 d	100.0 d	100.0 d

[1] 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, 111, 140 and 168 days, then removed from cold storage and incubated for 7 days at 20 °C.

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

2009 PMR REPORT # 13 **SECTION K: FRUIT – Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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

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TITLE: EFFECT OF DIFENOCONAZOLE PROTECTIVE DRENCH ON CONTROL OF POSTHARVEST BLUE MOLD AND GRAY MOLD ON 'MCINTOSH' APPLES, 2008.

MATERIALS: DIFENOCONAZOLE (360 g a.i. Difenoconazole), SCHOLAR 50 WG (50% Fludioxinil) and MERTECT (45% Thiabendzole).

METHODS: A trial was conducted to determine the effect of fungicides DIFENOCONAZOLE (Difenoconazole), MERTECT (Thiabendazole) and SCHOLAR (Fludioxinil) as a protective drench, for the control of postharvest blue mold (*Penicillium expansum*) and gray mold (*Botrytis. cinerea*) in wounded 'McIntosh' apples. Fruit were harvested September 23 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Vineland, Ontario, and stored at 0.5-2 ˚C. The fungicide treatments were tested on October 22 (Experiment 1) and on October 29 (Experiment 2). The fruit were wounded by puncturing the apple once with a nail-like probe (5mm diameter) to a depth of 4 mm. The fruit were drenched with two concentrations of the fungicide DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L, SCHOLAR at1.6 g /L and MERTECT at 1.15 g/L. The control was drenched with water. Fruit were left to dry overnight at 0.5-2 ˚C. The following day, the fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or *B. cinerea* isolate BC-34R at a concentration of 1 x 10^4 conidia/ml. Each treatment had 4 replicates with 12 fruit per replicate. Fruit were stored for 140 days at 0.5-2 ˚C and then for 7 days at 20 ˚C for the shelf-life study. The fruit were evaluated for blue mold or gray mold incidence at 4 week intervals. 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: Data is presented in Table 1 for blue mold control and Table 2 for gray mold control.

CONCLUSIONS: One concentration of SCHOLAR and two concentrations of DIFENOCONAZOLE gave complete control of blue and gray mold for up to 140 days in cold storage. Disease incidence of both blue and gray mold increased minimally in Experiment 1 for the shelf-life study. An increase in the disease incidence of blue and gray mold in the shelf-life study in the Experiment 2 was possibly due to malfunctioning of the 20 °C growth chamber.

Table 1. Effect of fungicide protective drench on control of postharvest blue mold (*Penicillium expansum)* on 'McIntosh' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 ˚C after					140 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	82 days	112 days	140 days	
Experiment 1						
Penicillium 1 x 10^4 conidia /ml	0.0 a[1,2]	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c
DIFENOCONAZOLE 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.1 b
DIFENOCONAZOLE 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.1 b
SCHOLAR 1.6 g/L	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 b	100.0 c
Experiment 2						
Penicillium 1 x 10^4 conidia /ml	0.0 a	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d
DIFENOCONAZOLE 0.6 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	29.2 c
DIFENOCONAZOLE 1.2 g/L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	27.1 b
SCHOLAR 1.6 g/L	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 d

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

Table 2. Effect of fungicide protective drench on the control of postharvest gray mold (*Botrytis cinerea)* on 'McIntosh' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 ˚C after					140 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	82 days	112 days	140 days	
Experiment 1						
Botrytis 1 x 10^4 conidia /ml	0.0 a[1,2]	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c
DIFENOCONAZOLE 0.6 g /L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	6.3 b
DIFENOCONAZOLE 1.2 g /L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
SCHOLAR 0.6 g /L	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 b	100.0 c
Experiment 2						
Botrytis 1 x 10^4 conidia /ml	0.0 a	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d
DIFENOCONAZOLE 0.6 g /L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	35.4 c
DIFENOCONAZOLE 1.2 g /L	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	18.8 b
SCHOLAR 0.6 g /L	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 b	100.0 d

[1] Data represent the mean of four replicates.

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

2009 PMR REPORT # 14 **SECTION K: FRUIT – Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 DIFENOCONAZOLE PROTECTIVE DRENCH ON CONTROL OF POSTHARVEST BLUE MOLD AND GRAY MOLD ON 'EMPIRE' APPLES, 2008.

MATERIALS: DIFENOCONAZOLE (360 g a.i. Difenoconazole) and MERTECT (45% Thiabendzole).

METHODS: A trial was conducted to determine the effect of fungicides DIFENOCONAZOLE and MERTECT, as a protective drench, for the control of postharvest blue mold (*Penicillium expansum*) and gray mold (*Botrytis cinerea*) in wounded 'Empire' apples. Fruit were harvested September 26 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Vineland, Ontario, and stored at 0.5-2 ˚C. The fungicide treatments were tested on October 22 (Experiment 1) and on October 29 (Experiment 2). The fruit were wounded by puncturing the apple once with a nail-like probe (5mm diameter) to a depth of 4 mm. The fruit were drenched with the fungicide DIFENOCONAZOLE at 0.6 g/L and MERTECT at 1.15 g/L. The control was drenched with water. Fruit were left to dry overnight at 0.5-2 ˚C. The following day, the fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or *B. cinerea* isolate BC-34R at a concentration of 1×10^4 conidia/ml. Each treatment had 4 replicates with 12 fruit per replicate. Fruit were stored for 7 days at 20 ˚C. The fruit were evaluated for blue mold or gray mold incidence. Fruit were considered decayed when a lesion developed on the fruit. The experiment was repeated once. The data obtained were analyzed by analysis of variance (ANOVA) using appropriate transformations and significance between means was separated by the Tukey test.

RESULTS: Data are presented in Tables 1 and 2.

CONCLUSIONS: DIFENOCONAZOLE gave complete control of blue mold caused by thiabendazole-resistant *P. expansum* and gray mold caused by thiabendazole-resistant *B. cinerea* after7 days at 20 °C. As expected, MERTECT was not effective against blue mold and gray mold caused by thiabendazole-resistant *P. expansum* or *B. cinerea*, respectively.

Table 1. Effect of Difenoconazole on blue mold *(Penicillium expansum)* on 'Empire' apples, 2008.

Treatment	% Blue mold incidence after 7 Days at 20 ˚C	
	Experiment 1	Experiment 2
Control (*Penicillium* 1 x 10^4 conidia/ml)	100.0 b[1,2]	100.0 b
MERTECT at 1.15 g/L	100.0 b	100.0 b
DIFENOCONAZOLE at 0.6 g/L	0.0 a	0.0 a

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

Table 2. Effect of Difenoconazole on gray mold (*Botrytis cinerea)* on 'Empire' apples, 2008.

Treatment	% Gray mold incidence after 7 Days at 20 ˚C	
	Experiment 1	Experiment 2
Control (*Botrytis* 1 x 10^4 conidia/ml)	100.0 b[1,2]	100.0 b
MERTECT at 1.15 g/L	100.0 b	100.0 b
DIFENOCONAZOLE 0.6 g /L	0.0 a	0.0 a

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

2009 PMR REPORT # 15 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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, 2008-09**.

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 03 September, 2008 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 17 November, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 18 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 and inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R, then water drenched the next day. 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* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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 156 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 (Table 2) 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 at 0.6 g/L and PENBOTEC at 1.16 g/L) gave complete control of blue mold for 156 days in cold storage with an increase of 19.4% for SCHOLAR and 16.7% in PENBOTEC in the shelf-life study. In the gray mold study, both SCHOLAR at 0.6 g/L and PENBOTEC at 1.16 g/L gave complete control including 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 control of postharvest blue mold with fungicides on 'Silken' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						156 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	84 days	110 days	138 days	156 days	
Control 1, no wound + no inoculum	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	50.0 c
Control 2, wound + no inoculum	0.0 a	8.3 b	16.7 b	16.7 b	16.7 b	16.7 b	77.8 d
Control 3, inoculum + water drench	0.0 a	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 e
Pathogenicity							
P. expansum 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 e
P. expansum 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 e
P. expansum 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 e
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	19.4 b
P. expansum + PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	16.7 a
P. expansum + MERTECT at 1.15 g/L[3]	0.0 a	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 e

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *P. expansum* 1 x 10^4 conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'Silken' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						156 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	84 days	110 days	138 days	156 days	
Control 1 no wound + no inoculum	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	22.2 b
Control 2 wound + no inoculum	0.0 a	2.8 b	2.8 b	8.3 b	8.3 b	8.3 b	61.1 c
Control 3 inoculum + water drench	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							
B. cinerea + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + MERTECT at 1.15 g/L[3]	100.0 b	100.0 c	100.0 c	100.0 c	100.0 c	100.0 c	100.0 d

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *B. cinerea* 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 16 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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, 2008-09.

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 '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, 2008 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2˚C. On 24 November, the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 25 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 and inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R, then water drenched the next day. 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 at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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 incidence (Table 2) 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 at 0.6 g/L and PENBOTEC at 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 control of postharvest blue mold with fungicides on 'Gala' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 ˚C after						168 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	57 days	84 days	112 days	140 days	168 days	
Control 1, no wound and inoculum	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 2, wound and inoculum	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 3, inoculum and water drench	0.0 a	86.1 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	0.0 a	58.3 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b
P. expansum 1 x 10^4 conidia/ml	19.4 b	100.0 d	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b
P. expansum 1 x 10^5 conidia/ml	69.4 c	100.0 d	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + MERTECT at 1.15g /L[3]	100.0 d	100.0 d	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *P. expansum* at 1 x 10^4 conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'Gala' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 ˚C after						168 days at 0.5-2 °C+ Shelf-life at 7 days
	28 days	57 days	84 days	112 days	140 days	168 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 2, wound and water	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 3, inoculum and water drench	2.8 b	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	50.0 d	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
B. cinerea 1 x 10^4 conidia/ml	100.0 e	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
B. cinerea 1 x 10^5 conidia/ml	100.0 e	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
Fungicide efficacy							
B. cinerea + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 b
B. cinerea + PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b	0.0 b
B. cinerea + MERTECT at 1.15g /L[3]	11.1 c	36.1 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 17 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

CROP Apples (*Malus domestica* Borkh.) cv. McIntosh
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 ON 'MCINTOSH' APPLES, 2008-09.**

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil), MERTECT (45% Thiabendazole), and DIFENOCONAZOLE (360 g a.i. Difenoconazole).

METHODS: Pathogenicity of *Penicillium expansum* and *Botrytis cinerea* was tested on 'McIntosh' apples. A trial was conducted to determine the effect of fungicides, SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil) MERTECT (45% Thiabendazole) and DIFENOCONAZOLE (360 g a.i. Difenoconazole) for the control of postharvest blue mold (*P. expansum*) and gray mold (*B. cinerea*) in wounded 'McIntosh' apples. Fruit were harvested on 12 September, 2008 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 15 December, 2008 the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 16 December, 2008 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 and inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R, then water drenched the next day. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate 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* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R at 1×10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR at 0.6 g/L, PENBOTEC at 1.16 g/L, MERTECT at 1.15 g/L, or DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L. Each treatment had 3 replicates with 12 fruit per replicate. All fruit were stored at 0.5-2 °C for up to 140 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: Blue mold control: The inoculated control had the highest blue mold incidence (Table

1) in ‘McIntosh’ apples. The thiabendazole-resistant *P. expansum* was pathogenic on apples at all three spore concentrations (1×10^3, 1×10^4, and 1×10^5 conidia/ml) tested. The test fungicide treatment SCHOLAR at 0.6 g/L gave complete control of blue mold for 140 days in cold storage and subsequent shelf-life. PENBOTEC at 1.16 g/L, had 5.6% disease at day 112, increasing to 13.9% at shelf-life. Both concentrations of DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L gave control up to day 84. The low concentration (0.6 g/L) increased to 13.9%, 19.4 % and 30.5% at days 112, 114 and shelf-life respectively. The high concentration of DIFENOCONAZOLE (1.2 g/L) showed 16.7% at days 112 and 140 and 27.8% at shelf-life. As expected, MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium.*

Gray mold control: The inoculated control had the highest gray mold incidence (Table 2) in ‘McIntosh’ apples. The thiabendazole-resistant *B. cinerea* was pathogenic on apples at all three spore concentrations (1×10^3, 1×10^4, and 1×10^5 conidia/ml) tested. The test fungicide treatment SCHOLAR at 0.6 g/L gave complete control of gray mold for 140 days in cold storage and subsequent shelf-life. PENBOTEC at 1.16 g/L, had 8.3 % disease at day 112, increasing to 11.1% at shelf-life. Both concentrations of DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L gave complete control of gray mold up to and including shelf-life at day 140. MERTECT was not effective against thiabendazole-resistant isolates of *Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and control of postharvest blue mold with fungicides on 'McIntosh' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after					140 days at 0.5-2 °C + Shelf-life at 7 days
	27 days	56 days	84 days	112 days	140 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	8.3 c	11.1 c	19.4 c
Control 2, wound and water	0.0 a	0.0 a	0.0 a	5.6 b	5.6 b	22.2 d
Control 3, inoculum and water drench	33.3 d	100.0 c	100.0 b	100.0 f	100.0 f	100.0 g
Pathogenicity						
P. expansum 1x10[3] conidia/ml	16.7 b	100.0 c	100.0 b	100.0 f	100.0 f	100.0 g
P. expansum 1x10[4] conidia/ml	30.6 c	94.4 b	100.0 b	100.0 f	100.0 f	100.0 g
P. expansum 1x10[5] conidia/ml	94.4 e	100.0 c	100.0 b	100.0 f	100.0 f	100.0 g
Fungicide efficacy						
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + PENBOTEC at1.16 g/L[3]	0.0 a	0.0 a	0.0 a	5.6 b	5.6 b	13.9 b
P. expansum + MERTECT at 1.15 g/L[3]	94.4 f	100.0 c	100.0 b	100.0 f	100.0 f	100.0 g
P. expansum+ DIFENOCONAZOLE at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	13.9 d	19.4 e	30.5 f
P. expansum + DIFENOCONAZOLE at 1.2 g/L[3]	0.0 a	0.0 a	0.0 a	16.7 e	16.7 d	27.8 e

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *P. expansum* at 1 x 10[4] conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'McIntosh' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after					140 days at 0.5-2 °C + Shelf-life at 7 days
	27 days	56 days	84 days	112 days	140 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	8.3 b	8.3 b	16.7 c
Control 2, wound and water	0.0 a	0.0 a	16.7 b	16.7 c	16.7 d	11.1 b
Control 3, inoculum and water drench	61.1 b	100.0 b	100.0 c	100.0 d	100.0 e	100.0 d
Pathogenicity						
B. cinerea 1x10^3 conidia/ml	91.7 d	100.0 b	100.0 c	100.0 d	100.0 e	100.0 d
B. cinerea 1x10^4 conidia/ml	100.0 e	100.0 b	100.0 c	100.0 d	100.0 e	100.0 d
B. cinerea 1x10^5 conidia/ml	100.0 e	100.0 b	100.0 c	100.0 d	100.0 e	100.0 d
Fungicide efficacy						
B. cinerea + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + PENBOTEC at1.16 g/L[3]	0.0 a	0.0 a	0.0 a	8.3 b	11.1 c	11.1 b
B. cinerea + MERTECT at 1.15 g/L[3]	88.9 c	100.0 b	100.0 c	100.0 d	100.0 e	100.0 d
B. cinerea + DIFENOCONAZOLE at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + DIFENOCONAZOLE at 1.2 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 18 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 ON 'HONEY CRISP' APPLES, 2008-09**.

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 12 September 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 ˚C. On 05 December, 2008 the fruit were disinfested with a 1% bleach solution and rinsed in reverse osmosis water. On 08 December, 2008 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 and inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R, then drenched with water the next day. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate 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 at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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: Thiabendazole-resistant *P. expansum* (Table 1) was pathogenic on 'Honey Crisp' apples at a spore concentration of 1×10^5 conidia/ml from Day 28. Spore concentrations of 1×10^3 1×10^4

conidia/ml didn't show disease until Day 56. The test fungicide treatments SCHOLAR and PENBOTEC gave complete control of blue mold for up to 168 days in cold storage and after a shelf-life of 7 days. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium* Thiabendazole-resistant *B. cinerea* (Table 2) was pathogenic on 'Honey Crisp' apples at all three spore concentrations (1 x 10^3, 1 x 10^4, and 1 x 10^5 conidia/ml) The test fungicide treatment SCHOLAR gave complete control of gray mold for up to 168 days in cold storage and after a shelf-life of 7 days. The fungicide PENBOTEC gave control up to 168 days in cold storage and showed 5.5% disease in the subsequent shelf-life study. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and control of postharvest blue mold with fungicides on 'Honey Crisp' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + 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[1,2]	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	0.0 a	0.0 a	0.0 a	0.0 a	13.9 b	0.0 a
Control 3, inoculum and water drench	0.0 a	80.6 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
Pathogenicity							
P. expansum 1 x 10^3 conidia/ml	0.0 a	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
P. expansum 1 x 10^4 conidia/ml	0.0 a	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
P. expansum 1 x 10^5 conidia/ml	100.0 b	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + PENBOTEC at 1.16 g./L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + MERTECT at 1.15 g/L[3]	100.0 b	100.0 c	100.0 b	100.0 b	100.0 b	100.0 c	100.0 b

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *P. expansum* at 1 x 10^4 conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'Honey Crisp' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + 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[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b
Control 2 wound and no inoculum	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.5 b	27.8 d
Control 3 inoculum and water drench	94.4 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
Pathogenicity							
B. cinerea 1 x 10^3 conidia/ml	100.0 c	100.0. b	100.0. b	100.0. b	100.0 .b	100.0 c	100.0 e
B. cinerea 1 x 10^4 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e
B. cinerea 1 x 10^5 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
Fungicide efficacy							
B. cinerea +SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea +PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.5 c
B. cinerea + MERTECT at 1.15 g/L[3]	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 19 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 ON 'AMBROSIA' APPLES, 2008-09**.

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 08 October 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 ˚C. On 05 December, 2008 the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 08 December, 2008 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 and inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R, then drenched with water the next day. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R at concentrations of 1 x 10^3, 1 x 10^4, and 1 x 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 x 10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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 at 0.6 g/L and PENBOTEC at 1.16 g/L) gave complete control of blue mold for up to 140 days and 2.8% at 168 days. SCHOLAR showed 5.6% incidence after 7 days shelf-life and PENBOTEC, 2.8%. For gray mold, the fungicide SCHOLAR gave control up to 168 days and 2.8% at shelf-life. PENBOTEC controlled gray mold up to 140 days and showed 5.6% incidence at 168 days and 8.3% at shelf-life.

Table 1.Pathogenicity of *Penicillium expansum* and control of postharvest blue mold with fungicides on 'Ambrosia' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	84 days	112 days	140 days	168 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
Control 2, wound and water	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	33.3 c	61.1 d
Control 3, inoculum and water drench	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e
Pathogenicity							
P. expansum 1x 10^3 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e
P. expansum 1x 10^4 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e
P. expansum 1x 10^5 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	5.6 c
P. expansum + PENBOTEC at 1.16 g/L [3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	2.8 b
P. expansum + MERTECT at1.15 g/L[3]	58.3 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 e

[1] Data represent the mean of three replicates.

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

[3] *P. expansum* at 1 x 10^4 conidia/ml was used.

Table 2 .Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'Ambrosia' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + Shelf-life at 7 Days
	28 days	56 days	84 days	112 days	140 days	168 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.5 b
Control 2, wound and water	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	27.8 d
Control 3, inoculum and water drench	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
Pathogenicity							
B. cinerea 1x 10^3 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
B. cinerea 1x 10^4 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
B. cinerea 1x 10^5 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e
Fungicide efficacy							
B. cinerea SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 a
B. cinerea PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b	8.3 c
B. cinerea MERTECT at1.15 g/L[3]	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 e

[1] Data represent the mean of three replicates.

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

[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 20 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 ON 'GOLDEN DELICIOUS' APPLES, 2008-09**.

MATERIALS: SCHOLAR 50 WG (50% Fludioxonil) and PENBOTEC 400 SC (37.5% Pyrimethanil), and 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 12 September 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 10 December, 2008 the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 11 December, 2008 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 and inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R, then drenched with water the next day. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate 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 at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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 incidence (Table 2) 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 at 0.6 g/L and PENBOTEC at 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 control of postharvest blue mold with fungicides on 'Golden Delicious' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + Shelf-life at 7 days
	28 days	56 days	84 days	112 days	140 days	168 days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	11.1 b
Control 2, wound and water	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	8.3 b	33.3 c
Control 3, inoculum and water drench	33.3 d	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d
Pathogenicity							
P. expansum 1x 10^3 conidia/ml	8.3 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d
P. expansum 1x 10^4 conidia/ml	100.0 e	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d
P. expansum 1x 10^5 conidia/ml	100.0 e	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
P. expansum + MERTECT at1.15 g/L[3]	27.8 c	100.0 b	100.0 b	100.0 b	100.0 b	100.0 c	100.0 d

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *P. expansum* at 1 x 10^4 conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and control of postharvest gray mold with fungicides on 'Golden Delicious' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + Shelf-life at 7 days
	28 Days	56 Days	84 Days	112 days	140 Days	168 Days	
Control 1, no wound and water	0.0 a[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	13.9 b
Control 2, wound and water	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	8.3 c	30.6 c
Control 3, inoculum and water drench	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d
Pathogenicity							
B. cinerea 1x 10^3 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d
B. cinerea 1x 10^4 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d
B. cinerea 1x 10^5 conidia/ml	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d
Fungicide efficacy							
B. cinerea + SCHOLAR at 0.6 g/L [3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + PENBOTEC at 1.16 g/L [3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + MERTECT at1.15 g/L [3]	100.0 b	100.0 b	100.0 b	100.0 b	100.0 b	100.0 d	100.0 d

[1] Data represent the mean of three replicates.
[2] Means within the column followed by the same letter are not significantly different according to the Tukey test at $P = 0.05$.
[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT # 21 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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 ON 'FUJI' APPLES, 2008-09**.

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 '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 12 September 2008, from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. On 10 December, 2008 the fruit were disinfested with a 1% bleach solution and rinsed with reverse osmosis water. On 11 December, 2008 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 and inoculated with thiabendazole-resistant *P. expansum* PS-1R or thiabendazole-resistant *B. cinerea* BC-34R, then drenched with water the next day. For the pathogenicity test, the wounded fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or thiabendazole-resistant *B. cinerea* isolate BC-34R at concentrations of 1 x 10^3, 1 x 10^4, and 1 x 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 x 10^4 conidia/ml and incubated overnight at 13 °C. The next day, the inoculated fruit were drenched with SCHOLAR at 0.6 g/L, PENBOTEC at 1.16 g/L or MERTECT at 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 (1×10^3, 1×10^4, and 1×10^5 conidia/ml) tested. The test fungicide treatments (SCHOLAR at 0.6 g/L and PENBOTEC at 1.16 g/L) gave complete control of blue mold for up to 168 days. Shelf-life study had slightly higher incidence in SCHOLAR and PENBOTEC treated apples. The test fungicide treatment SCHOLAR at 0.6 g/L gave complete control up to and including shelf-life. PENBOTEC at 1.16 g/L gave complete control of gray mold for up to 140 days. In the subsequent shelf-life study, PENBOTEC increased incidence to 8.3%. As expected MERTECT was not effective against thiabendazole-resistant isolates of *Penicillium* or *Botrytis.*

Table 1. Pathogenicity of *Penicillium expansum* and control of postharvest blue mold with fungicides on 'Fuji' apples, 2008-09.

Treatment	% Blue mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °c + 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[1,2]	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	0.0 a	0.0 a	2.8 b	2.8 b	5.6 b	25.0 c
Control 3, inoculum and water drench	91.6 b	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d
Pathogenicity							
P. expansum 1x 10^3 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d
P. expansum 1x 10^4 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d
P. expansum 1x 10^5 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d
Fungicide efficacy							
P. expansum + SCHOLAR at 0.6 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
P. expansum +PENBOTEC at 1.16 g/L[3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	5.6 b
P. expansum + MERTECT at1.15 g/L[3]	94.4 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 c	100.0 d

[1] Data represent the mean of three replicates.

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

[3] *P. expansum* at 1 x 10^4 conidia/ml was used.

Table 2. Pathogenicity of *Botrytis cinerea* and the control of postharvest gray mold with fungicides on 'Fuji' apples, 2008-09.

Treatment	% Gray mold incidence in cold storage at 0.5-2 °C after						168 days at 0.5-2 °C + 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[1,2]	0.0 a	0.0 a	0.0 a	0.0 a	11.1 c	22.2 c
Control 2, wound and no inoculum	0.0 a	0.0 a	0.0 a	5.5 b	11.1 b	22.2 d	41.7 d
Control 3, inoculum and water drench	83.3 b	100.0b	100.0 b	100.0 c	100.0 c	100.0 e	100.0 e
Pathogenicity							
B. cinerea 1x 10^3 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 e	100.0 e
B. cinerea 1x 10^4 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 e	100.0 e
B. cinerea 1x 10^5 conidia/ml	100.0 c	100.0 b	100.0 b	100.0 c	100.0 c	100.0 e	100.0 e
Fungicide efficacy							
B. cinerea + SCHOLAR at 0.6 g/L [3]	0.0 a	0.0a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
B. cinerea + PENBOTEC at 1.16 g/L [3]	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.8 b	8.3 b
B. cinerea + MERTECT at1.15 g/L [3]	0.0 a	100.0b	100.0 b	100.0 c	100.0 c	100.0 e	100.0 e

[1] Data represent the mean of three replicates.

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

[3] *B. cinerea* at 1 x 10^4 conidia/ml was used.

2009 PMR REPORT# 22 **SECTION K: FRUIT - Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

CROP: Apples (*Malus domestica* Borkh.) cv. McIntosh
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 ON 'MCINTOSH' APPLES, 2008-09.

MATERIALS: SMARTFRESH™ (1-methylcyclopropene), SCHOLAR 50 WG (50% Fludioxonil), PENBOTEC 400 SC (37.5% Pyrimethanil), VANGARD 75 WG (75% Cyprodinil), BIOSAVE (*Pseudomonas syringae*, ESC10) and 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 21 September, 2008. 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 storage for 140 days. (21 September, 2008 to 9 February, 2009). Following the 140 day storage in CA, the 1-MCP treated fruit were wounded then co-treated with fungicides and inoculum and incubated for 7 days at 20 °C. A total of 5 fungicide treatments (SCHOLAR at 1.2 g/L, PENBOTEC at 1.16 g/L,

VANGARD at 0.8 g/L, BIOSAVE at 1.59 g/L, MERTECT at 1.15 g/L) and a control without fungicide treatment were included. For inoculum, thiabendazole-resistant *P. expansum* isolate 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, TBZ and Biosave had the higher blue mold (Table 1) and gray mold (Table 2) incidence. The test fungicide treatments (SCHOLAR at 1.2 g/L, PENBOTEC at 1.16 g/L and VANGARD at 0.8 g/L) gave complete control with or without 1-MCP treatments. As expected MERTECT was not effective against TBZ-resistant isolates of *P. expansum* or *B. cinerea*. 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 at 1.2 g/L, PENBOTEC at 1.16 g/L, and VANGARD at 0.8 g/L and stored in CA prior to the testing.

Table 1. Control of postharvest blue mold (*Penicillium expansum*) with fungicides on 'McIntosh' apples that were 1-MCP treated and stored in CA storage for 140 days and then co-treated with fungicides and inoculum, 2008-09.

Treatment	% Blue mold incidence after 7 days at 20˚C	
	NO 1-MCP	WITH 1-MCP
INOCULUM ONLY	100.0 b[1,2]	100.0 b
SCHOLAR at 1.2 g/L	0.0 a	0.0 a
PENBOTEC at 1.16 g/L	0.0 a	0.0 a
VANGARD at 0.8 g/L	0.0 a	0.0 a
BIOSAVE at 1.59 g/L	100.0 b	100.0 b
MERTECT at 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 on 'McIntosh' apples that were 1-MCP treated and stored in CA storage for 140 days and then co-treated with fungicides and inoculum, 2008-09.

Treatment	% Gray mold incidence after 7 days at 20˚C	
	NO 1-MCP	WITH 1-MCP
INOCULUM ONLY	100.0 b[1,2]	100.0 b
SCHOLAR at 1.2 g/L	0.0 a	0.0 a
PENBOTEC at 1.16 g/L	0.0 a	0.0 a
VANGARD at 0.8 g/L	0.0 a	0.0 a
BIOSAVE at 1.59 g/L	100.0 b	100.0 b
MERTECT at 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.

2009 PMR REPORT # 23 **SECTION K: FRUIT – Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

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

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TITLE: EFFECT OF DIFENOCONAZOLE PROTECTIVE DRENCH ON CONTROL OF POSTHARVEST BLUE MOLD AND GRAY MOLD ON 'RED DELICIOUS' APPLES, 2009.

MATERIALS: DIFENOCONAZOLE (360 g a.i. Difenoconazole), and MERTECT (45% Thiabendzole).

METHODS: A trial was conducted to determine the effect of fungicides, DIFENOCONAZOLE (Difenoconazole) and MERTECT (Thiabendazole) for the control of postharvest blue mold (*Penicillium expansum*) and gray mold (*Botrytis cinerea*) in wounded 'Red Delicious' apples. Fruit were harvested 16 October, 2008 from Agriculture and Agri-Food Canada research farm in Jordan Station, Vineland, Ontario and stored at 2 ˚C. On 09 March, 2009 (and March 23 for repeat experiment) fruit were wounded by puncturing the apple once with a nail-like probe (5mm diameter) to a depth of 4 mm. The fruit were drenched with two concentrations of the fungicide DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L and MERTECT at 1.15 g/L. The control fruit was drenched with water. Fruit were left to dry overnight at 0.5-2 ˚C. The following day, the fruit were drop inoculated with thiabendazole-resistant *P. expansum* isolate PS-1R or *B. cinerea* isolate BC-34R at a concentration of 1×10^4. Each treatment had 4 replicates with 12 fruit per replicate. Fruit were stored for 7 days at 20 ˚C. The fruit were evaluated for blue mold or gray mold incidence. The experiment was repeated 2 weeks later. Fruit were considered decayed when a lesion developed on the fruit.

RESULTS: Data is presented in Tables 1 and 2.

CONCLUSIONS: Two concentrations of the fungicide DIFENOCONAZOLE at 0.6 g/L and 1.2 g/L gave complete control of blue and gray mold for 7 days at 20 °C. As expected, MERTECT was not effective against thiabendazole-resistant isolates of *P. expansum* or *B. cinerea.*

Table 1. Effect of fungicide protective drench on control of *Penicillium expansum* on 'Red Delicious' apples, 2008-09.

Treatment	% blue mold incidence in 20 ˚C after 7 Days	
	Experiment 1	Experiment 2
Penicillium 1 x 10^4 conidia/ml	100.0 b[1,2]	100.0 b
MERTECT at 1.15 g/L	100.0 b	100.0 b
DIFENOCONAZOLE at 0.6 g/L	0.0 a	0.0 a
DIFENOCONAZOLE at 1.2 g/L	0.0 a	0.0 a

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

Table 2. Effect of fungicide protoective drench on control of *Botrytis cinerea* on 'Red Delicious' apples, 2008-09.

Treatment	% gray mold incidence in 20 ˚C after 7 Days	
	Experiment 1	Experiment 2
Botrytis 1 x 10^4 conidia/ml	100.0 b[1,2]	100.0 b
MERTECT at 1.15 g/L	100.0 b	100.0 b
DIFENOCONAZOLE at 0.6 g/L	0.0 a	2.1 b
DIFENOCONAZOLE at 1.2 g/L	0.0 a	0.0 a

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

2009 PMR REPORT # 24 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

CROP: Peach (*Prunus persica*) cv. Harrow Diamond
PEST: Brown rot (*Monilinia fructicola*)

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TITLE: EFFECT OF LIME SULPHUR ON THE CONTROL OF POSTHARVEST BROWN ROT, *Monilinia fructicola* ON 'HARROW DIAMOND' PEACHES, 2009.

MATERIALS: LIME SULPHUR (23% Lime sulphur)

METHODS: Immature fruit (14 days pre-commercial harvest) were harvested on 16 July, 2009 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. Mature fruit were harvested from the same plot on 30 July, 2009. On 31 July,2009 the fruit were placed into plastic fruit inserts within a plastic tote and wounded by puncturing the peach once with a needle to a depth of 10 mm. Peaches were then inoculated with 15 µl of *Monilinia fructicola* ($1x10^4$ conidia/mL). After 5, 10 and 24 hours, the peaches were sprayed with a 3.45 a.i. lime sulphur solution. The fruit were incubated at 20 °C for 5 days. There were 8 fruit per replicate and 6 replicates per treatment. At the end of the incubation period, the following measurements, disease incidence, lesion diameter, percent lesion area with conidia were recorded. Conidia numbers within the lesion area were calculated. 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.

CONCLUSIONS: LIME SULPHUR treated peaches had significantly less brown rot than the untreated control (Table 1). The comparison between immature and mature fruit showed that the mature fruit had higher disease incidence in both control and LIME SULPHUR treated peaches. There was no significant difference in brown rot incidence among LIME SULPHUR treatments, when comparing the different application times 5, 10, 24 hours after inoculation. Conidia numbers were significantly lower in the treatments that had LIME SULPHUR application.

Table 1. Effect of lime sulphur on control of postharvest brown rot (*Monilinia fructicola*) on immature and mature fruit of 'Harrow Diamond' peach, 2009.

Treatment post inoculation	Brown rot after 7 days			
	Immature fruit		Mature fruit	
	Brown rot incidence	No. of conidia per lesion	Brown rot incidence	No. of conidia per lesion
Control, water only after 5 hours	60.4 b	77.2 b	75.0 b	169.1 b
Control, water only after 10 hours	72.9 b	139.2 b	89.6 b	339.7 b
Control, water only after 24 hours	72.9 b	150.9 b	79.2 b	649.0 c
LIME SULPHUR at 15 ml/L after 5 hours	2.1 a	0.0 a	12.5 a	4.1 a
LIME SULPHUR at 15 ml/L after 10 hours	4.2 a	0.0 a	12.5 a	5.4 a
LIME SULPHUR at 15 ml/L after 24 hours	6.3 a	0.0 a	16.7 a	10.1 a

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

2009 PMR REPORT # 25 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

CROP: Peach (*Prunus persica*) cv. Loring
PEST: Brown rot (*Monilinia fructicola*)

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TITLE: EFFECT OF LIME SULPHUR ON THE CONTROL OF POSTHARVEST BROWN ROT *(Monilinia fructicola*) ON 'LORING' PEACHES, 2008.

MATERIALS: LIME SULPHUR (23% Lime sulphur)

METHODS: Immature fruit (14 days pre commercial harvest) were harvested on 04 August, 2008 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. Mature fruit were harvested from the same plot on 18 August, 2008. On 20 August, 2008 the fruit were placed into plastic fruit inserts within a plastic tote and wounded by puncturing the peach once with a needle to a depth of 10 mm. Peaches were then inoculated with 15 µl of *Monilinia fructicola* ($1x10^4$ conidia/mL). After 5, 10 and 24 hours of inoculation, the peaches were sprayed with a 3.45 a.i. LIME SULPHUR solution. The fruit were incubated at 20 °C for 5 days. There were 8 fruit per replicate and 6 replicates per treatment. At the end of the incubation period, the following measurements, disease incidence, lesion diameter, percent lesion area with conidia were recorded. Conidia numbers within the lesion area were calculated. 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 Table 1.

CONCLUSIONS: LIME SULPHUR treated peaches had significantly less brown rot than the untreated control. The comparison between immature and mature fruit showed that the mature fruit had higher disease incidence in both control and LIME SULPHUR treated peaches. Conidia numbers were significantly lower in the treatments that had LIME SULPHUR application. There was no significant difference in brown rot incidence among LIME SULPHUR treatments, when comparing the different application times 5, 10, 24 hours after inoculation.

Table 1. Effect of lime sulphur on control of postharvest brown rot *Monilinia fructicola* on immature and mature fruit of 'Loring' peach. 2009.

Treatment post inoculation	Brown rot after 7 days			
	Immature fruit		Mature fruit	
	Brown rot Incidence	No. of conidia per lesion	Brown rot Incidence	No. of conidia per lesion
Control, water only after 5 hours	85.4 b	1228 b	100.0 b	1095 b
Control, water only after 10 hours	83.3 b	1356 b	97.9 b	940 b
Control, water only after 24 hours	85.4 b	933 b	100.0 b	892 b
LIME SULPHUR at 15 ml/L after 5 hours	0	0	47.9 a	164 a
LIME SULPHUR at 15 ml/L after 10 hours	0	0	47.9 a	526 a
LIME SULPHUR at 15 ml/L after 24 hours	0	0	42.6 a	415 a

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

2009 PMR REPORT # 26 **SECTION K: FRUIT- Diseases**
STUDY DATA BASE: WBSE- T.1206.QM

CROP: Peach (*Prunus persica*) cv. Red Haven
PEST: Brown rot (*Monilinia fructicola*)

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TITLE: EFFECT OF LIME SULPHUR ON THE CONTROL OF POSTHARVEST BROWN ROT *Monilinia fructicola* ON 'RED HAVEN' PEACH, 2009.

MATERIALS: LIME SULPHUR (23% Lime sulphur)

METHODS: Immature fruit (14 days pre commercial harvest) were harvested on 04 August, 200 from Agriculture and Agri-Food Canada research farm in Jordan Station, Ontario and stored at 0.5-2 °C. Mature fruit were harvested from the same plot on 18 August, 2009. On 20 August, 2009 the fruit were placed into plastic fruit inserts within a plastic tote and wounded by puncturing the peach once with a needle to a depth of 10 mm. Peaches were then inoculated with 15 µl of *Monilinia fructicola* ($1x10^4$ conidia/mL). After 5, 10 and 24 hours after inoculation, the peaches were sprayed with a 3.45 a.i. lime sulphur solution. The fruit were incubated at 20 °C for 5 days. There were 8 fruit per replicate and 6 replicates per treatment. At the end of the incubation period, the following measurements, disease incidence, lesion diameter, percent lesion area with conidia were recorded. Conidia numbers within the lesion area were calculated. 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 Table 1.

CONCLUSIONS: LIME SULPHUR treated peaches had significantly less brown rot than the untreated control (Table 1). The comparison between immature and mature fruit showed that the mature fruit had higher disease incidence in both control and LIME SULPHUR treated peaches. There was no significant difference in brown rot incidence among LIME SULPHUR treatments, when comparing the different application times 5, 10, 24 hours after inoculation. Conidia numbers were significantly lower in the treatments that had LIME SULPHUR application (Tables 1).

Table 1. Effect of lime sulphur on control of postharvest brown rot *Monilinia fructicola* on immature and mature fruit of 'Red Haven' peach. 2009.

Treatment post inoculation	Brown rot after 7 days			
	Immature fruit		Mature fruit	
	Brown rot Incidence	No. of conidia per lesion	Brown rot Incidence	No. of conidia per lesion
Control, water only after 5 hours	91.7 b	41.6 b	100.0 b	154.2 b
Control, water only after 10 hours	89.6 b	71.9 b	100.0 b	198.7 c
Control, water only after 24 hours	100.0 b	93.5 b	100.0 b	606.3 d
LIME SULPHUR at 15 ml/L after 5 hours	4.2 a	0.0 a	14.6 a	0.0 a
LIME SULPHUR at 15 ml/L after 10 hours	6.3 a	0.0 a	10.4 a	0.0 a
LIME SULPHUR at 15 ml/L after 24 hours	10.4 a	0.0 a	14.6 a	2.9 a

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

2009 PMR REPORT # 27 **SECTION L: VEGETABLES and SPECIALTY CROPS - Diseases**

CROPS: Cabbage (*Brassica oleracea var.capitata*) cvs. Kilaton, Kilaxy, Tekila, Kilaherb & Bronco Napa (*Brassica rapa* subsp. *pekinensis*) cvs. Bilko, Mirako, Yuki, & Deneko
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: COMPARISON OF VARIOUS GREEN AND NAPA CABBAGE CULTIVARS FOR RESISTANCE AND SUSCEPTIBILITY TO CLUBROOT, 2009

MATERIALS: 4 napa cabbage cultivars Yuki, Deneko, Bilko, and Mirako, 5 green cabbage cultivars Kilaton, Tekila, Kilaxy, Kilaherb and Bronco, ALLEGRO (fluazinam 40%)

METHODS: Several new green and napa cabbage cultivars are available with resistance to the clubroot pathogen. The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (organic matter ≈ 72.0%, pH ≈ 6.3) naturally infested with *Plasmodiophora brassicae*. On 8 May, green and napa cabbage cultivars, Kilaton, Kilaxy, Tekila, Kilaherb, Bronco, Bilko, Mirako, Yuki and Deneko were seeded into plug trays. On 1 June each cultivar was hand transplanted into 3 7.5 m rows, 55 cm apart and 2 7.5 m rows 86 cm apart for napa and green cabbage respectively. A randomized complete block arrangement with four replicates per treatment was used. ALLEGRO fungicide was applied as a drench immediately following transplanting to cultivar Bronco as a commercial standard treatment. Recommended control procedures for weeds and insects were followed. On 17 July (Bilko, Mirako, Yuki and Deneko, 6 (Bronco), 12 (Tekila), and 27 (Kilaton, Kilaxy and Kilaherb) August, mature heads of each crop were harvested, weighed and roots examined for clubroot incidence and severity using a scale of 0 to 3: 0 = no clubbing, 1 =<1/3 of root clubbed, 2 = 1/3 – 2/3 of roots clubbed and 3 = > 2/3 of roots clubbed. Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \text{ x100}$$

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 and 2

CONCLUSIONS: Clubroot incidence and severity was high on the susceptible cultivars in this trial. Significant differences were found among cultivars of napa cabbage in susceptibility to clubroot. The three resistant napa cabbage cultivars Yuki, Deneko and Bilko had significantly less clubroot than Mirako, the susceptible cultivar. Cultivar Yuki had no incidence of disease. Significant differences were also found in the disease severity of clubroot among the cultivars. All resistant cultivars had significantly

lower disease severity than then susceptible cultivar Mirako (Table1). No differences were found in harvest weights among cultivars. The three resistance cultivars tested had high levels of resistance to clubroot

In green cabbage, significant differences were found among cultivars in disease incidence, disease severity and yield. The four clubroot resistant cultivars, Kilaton, Tekila, Kilaxy and Kilaherb had significantly less clubroot than Bronco, the susceptible check. Cultivar Kilaton had no disease, other resistant cultivars had 1 -4% disease. All resistant cultivars also had significantly lower disease incidence than Bronco treated with a drench of fungicide ALLEGRO. However, Bronco treated with ALLEGRO had significantly less disease and lower disease severity than the untreated Bronco. Differences in harvest weight were also observed among the cultivars; however, differences were attributed to the type of cabbage either storage or early season cultivars, rather than clubroot severity (Table 2).

ACKNOWLEDGMENTS: Funding for this project was supplied by the OMAFRA/University of Guelph Sustainable Production Systems Program and Fresh Vegetable Growers of Ontario through the Province of Ontario under Canada-Ontario Research & Development (ORD) program, an initiative of the federal-provincial-territorial Agricultural Policy Framework designed to position Canada's agri-food sector as a world leader. The Agricultural Adaptation Council administers the ORD program on behalf of the province.

Table 1. Comparison of various napa cabbage cultivars for susceptibility to clubroot grown in soil naturally infested with clubroot pathogen at Muck Crops Research Station, Holland Marsh, ON, 2009.

Cultivar	Clubroot Incidence (%)	DSI[1]	Harvest Weight (kg)
Yuki	0.0 a[2]	0.0 a	2.6 ns[3]
Deneko	4.2 a	2.1 a	2.6
Bilko	13.5 a	5.6 a	2.1
Mirako	87.5 b	43.4 b	2.5

[1]Disease severity index (DSI) was determined using the following equation:

$$DSI = \frac{\sum[(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes} - 1)} \times 100$$

[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.

Table 2. Comparison of various green cabbage cultivars for susceptibility to clubroot grown in soil naturally infested with clubroot pathogen at Muck Crops Research Station, Holland Marsh, ON, 2009.

Cultivar	Clubroot Incidence (%)	DSI[1]	Harvest Weight (kg)
Kilaton	0.0 a[2]	0.0 a	2.4 b
Tekila	1.3 a	0.4 a	2.5 b
Kilaxy	1.3 a	0.4 a	1.8 c
Kilaherb	3.8 a	2.9 a	3.7 a
Bronco + Allegro	63.8 b	27.1 b	2.6 b
Bronco	86.3 c	41.7 c	2.4 b

[1]Disease severity index (DSI) was determined using the following equation:

$$\text{DSI} = \frac{\sum[(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes} - 1)} \times 100$$

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

2009 PMR REPORT # 28 **SECTION L: VEGETABLES and SPECIALTY CROPS - Diseases**

CROP: Carrot (*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.) cv. Envy
PEST: Sclerotinia rot of carrot, (*Sclerotinia sclerotiorum* (Lib.) de Bary)

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TITLE: **EVALUATION OF POST-HARVEST FUNGICIDE TREATMENTS TO CONTROL SCLEROTINIA SCLEROTIORUM IN STORED CARROTS, 2008-09**

MATERIALS: SCHOLAR (fludioxinil 50%), MERTECT (thiabendazole 50%)

METHODS: Carrots, cv. Envy, grown in muck soil at Muck Crops Research Station, Holland Marsh, Ontario, were washed and graded on 10 November 2008 at a commercial packing facility. Each experimental unit consisted of one plastic bag containing 30 carrots. Treatments were: Scholar at the rates of 65.6, 131.2 and 250.6 mL, Mertect at 108.4 mL and Scholar + Mertect at 131.2 mL + 108 mL per100L, respectively, of water used as dip treatments, and Scholar at the rate of 131.2 mL/100L of water applied as a drench. Untreated non-inoculated and inoculated checks were also included. *Sclerotinia sclerotiorum* taken from a diseased carrot was plated onto PDA amended with Streptomycin sulphate and allowed to grow from one week until mycelium filled the plate. Carrots were surface sterilized with 1% sodium hypochloride and were wounded then inoculated with 5 mm plugs taken from the edge of actively growing cultures, 3 plugs per carrot and kept at 21˚C for 10 days. On 17 November 2008, carrots in mesh bags were immersed for 30 seconds for dip treatments. The drench application was applied by evenly spraying spread-out carrots using a CO_2 backpack sprayer equipped with an 8002 TeeJet nozzle. Carrots were allowed to dry, and then packed, 30 carrots per bag, into a plastic 35 x 70 cm (11.34 kg size) commercial carrot bag. An inoculated carrot was placed in the middle of each bag for all inoculated treatments. Carrot bags were placed in plastic tote boxes, stacked on pallets and stored in Filacell storage at ≈ 1° C, 95% RH. A complete randomized arrangement with four replicates per treatment was used. Four replicate bags from each treatment were assessed each month of the 6 month storage period. Carrots were assessed monthly for sclerotinia rot and sorted into classes based on a scale of 0 to 6 based on extent of visible mycelial colonization of the carrots where 0 = no rot, 1 = 1 - 5% rot, 2 = 6 – 10% rot, 3 = 11 – 25% rot, 4 = 26 – 50% rot, 5 = 51 – 75% rot and 6 = 76 - 100% rot on 16 December 2008, 16 January, 13 February, 17 March, 16 April and 14 May 2009. Numbers of carrots in each class were recorded and carrots were weighed. Percent diseased was calculated based on numbers of carrots diseased and disease severity (DSI) was calculated using the following equation:

$$\text{DSI} = \frac{\sum [(\text{rating class})(\text{no. of carrots in each rating class})]}{(\text{total no. of carrots rated})(\text{no. classes} - 1)} \times 100$$

RESULTS: Disease pressure increased over the six month storage period and significant differences were found among the treatments at the March through May assessments. At all assessment dates there

was higher disease incidence on the inoculated untreated check than the non-inoculated untreated check, demonstrating that the inoculation technique was effective.

At the March assessment, carrots treated with a dip application of any rate of Scholar or Scholar + Mertect had a significantly lower percent disease and disease severity index (DSI) than the inoculated, untreated check.

At the April assessment, carrots treated with a dip application of any rate of Scholar or Scholar + Mertect had a significantly lower percent disease than the inoculated untreated check, and carrots treated with a dip application of any rate of Scholar, Scholar + Mertect or the Scholar drench had a significantly lower DSI than the inoculated check.

At the May assessment, carrots dipped in Scholar at 250.3 and 131.2 mL/100 L water had a significantly lower percent disease than carrots treated with a drench application of Scholar, a dip application of Mertect and the inoculated check. Carrots treated with a dip application of Scholar at any rate or the Scholar + Mertect combination had a significantly lowerm DSI than carrots treated with Mertect alone. There was no significant difference in percent disease or disease severity between carrots treated with the Mertect dip and untreated, inoculated carrots.

Overall disease incidence in the inoculated check was significantly higher than the non-inoculated check at every assessment. Disease incidence in the inoculated check increased steadily over the six month trial period to a maximum of 74.2%.

CONCLUSIONS: Mertect applied as a dip at a rate of 108.4 mL/100L was not effective in reducing *Sclerotinia sclerotiorum* on carrots. Disease incidence and severity were always statistically equivalent to the untreated inoculated check. In the March, April and May assessments there were significant differences among fungicide treatments and all rates of Scholar applied as a dip effectively reduced disease incidence and severity. There was no advantage to adding Mertect with Scholar. Scholar applied as a drench reduced disease incidence and severity, as compared to the inoculated untreated check, in the April and May assessments, but not in the earlier assessments.

Table 1. Percentage of *Sclerotinia sclerotiorum* infection of carrot treated with SCHOLAR, inoculated with *S. sclerotiorum* and stored for various lengths of time in Filacell storage at Muck Crops Research Station, Holland Marsh, Ontario, 2008-09.

Treatment	Rate (mL/100L)	Application Method	% Disease					
			Dec	Jan	Feb	Mar	Apr	May
Non inoculated	--	--	0.0 a[2]	0.0 a	0.0 a	0.0 a	0.8 a	5.8 a
SCHOLAR	250.3	dip	13.3 ab	13.3 ab	24.2 b	18.3 ab	26.7 ab	20.8 a
SCHOLAR	131.2	dip	8.3 ab	11.7 ab	16.7 ab	19.2 ab	21.7 ab	20.8 a
SCHOLAR	65.6	dip	8.3 ab	15.8 ab	12.5 ab	13.3 ab	13.3 ab	25.8 ab
SCHOLAR + MERTECT	131.2 + 108.4	dip	6.7 ab	9.2 ab	20.8 ab	17.5 ab	20.8 ab	25.8 ab
SCHOLAR	131.2	drench	19.2 b	26.7 b	30.8 b	36.7 bc	32.5 b	45.8 bc
MERTECT	108.4	dip	12.5 ab	13.3 ab	25.8 b	40.8 bc	40.8 bc	65.8 cd
Inoculated	--	--	16.7 b	27.5 b	30.0 b	54.2 c	65.8 c	74.2 d

[1] Based on a scale of 1 to 6, where 0 = no rot, 1 = 0-5%, 2 = 6-10%, 3 = 11-25%, 4 = 26-50%, 5 = 51-75%, 6 = 76-100%.

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

Table 2. Disease severity index[1] of *Sclerotinia sclerotiorum* infection of various carrot treatments after various lengths of time in Filacell storage at Muck Crops Research Station, Holland Marsh, Ontario, 2008-09.

Treatment	Rate (mL/100L)	Application Method	DSI[1]					
			Dec	Jan	Feb	Mar	Apr	May
Non inoculated	--	--	0.0 a[2]	0.0 ns[3]	0.0 a	0.0 a	0.1 a	1.0 a
SCHOLAR	250.3	dip	2.6 ab	4.0	9.6 ab	5.6 a	9.0 ab	8.3 ab
SCHOLAR	131.2	dip	1.8 ab	4.6	5.3 ab	5.3 a	7.5 ab	8.6 ab
SCHOLAR	65.6	dip	1.5 a	7.8	3.5 ab	3.2 a	3.8 ab	11.3 ab
SCHOLAR + MERTECT	131.2 + 108.4	dip	1.4 a	2.6	8.8 ab	5.0 a	6.9 ab	11.8 ab
SCHOLAR	131.2	drench	5.8 b	9.4	15.1 a	15.4 ab	16.1 ab	25.8 bc
MERTECT	108.4	dip	2.9 ab	4.4	12.5 ab	18.1 ab	21.7 bc	46.7 cd
Inoculated	--	--	3.8 ab	10.6	11.3 ab	29.4 b	38.2 c	52.5 d

[1] Disease severity index (DSI) was determined using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of carrots in each class})]}{(\text{total no. of carrots per treatment})(\text{no. classes} - 1)} \times 100$$

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

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

2009 PMR REPORT # 29 **SECTION L: VEGETABLE and SPECIAL CROPS - Diseases**

CROP: Carrot (*Daucus carota* subsp. s*ativus* (Hoffm.) Arcang)
PEST: Sclerotinia rot of carrot (*Sclerotinia sclerotiorum* (Lib.) de Bary)

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TITLE: **DETECTION OF ASCOSPORES OF SCLEROTINIA SCLEROTIORUM PROVIDES ACCUTATE TIMING FOR MANAGING SCLEROTINIA ROT OF CARROT**

MATERIALS: LANCE (boscalid 70%), ELEXA-4 (chitosan 4%)

METHODS: The field trial was conducted at the Muck Crops Research Station in the Bradford Marsh in 2009 in organic soil naturally infested with sclerotinia rot of carrot. A split plot design with treatment as the main plot arranged as a randomised complete block with cultivar allocated to each replicate as the sub-plot was used. Each replicate consisted of 4 rows, 2 rows side-by–side of each cultivar, 5 m in length and 86 cm apart centre-to-centre having a 40 cm wide growing area. Carrot cultivars Envy and Nevada were seeded at a rate of 80 seeds m^{-1}. LANCE was applied when within field detected ascospores of *S. sclerotiorum* surpassed the sclerotinia forecast model threshold of 5 detected ascospores using the Blue Plate Test on sclerotinia semi-selective medium. ELEXA-4 was applied bi-weekly, beginning at carrot canopy closure on 31 July. Each chemical treatment was also combined with trimming the carrot canopy, which occurred on 12 August when ascospore counts surpassed the forecast threshold after canopy closure. The incidence of sclerotinia rot on carrot foliage was evaluated as the percentage of plants in the assessment area that had at least one lesion per leaf or petiole. The air temperatures were below the long term (10 year) average for June (16.5˚C), July (17.9˚C) and October (7.3˚C), and average for May (12.6˚C), August (19.4˚C) and September (14.9˚C). Monthly rainfall was below the long term (10 year) average for June (49 mm) and September (51 mm) and above average for May (117 mm), July (135 mm), August (89 mm) and October (62 mm). Data were analysed using the proc glm procedure of SAS version 9.1. Means separation was obtained using the Tukey's test with $P = 0.05$ level of significance.

RESULTS: As outlined in Table 1.

CONCLUSIONS: LANCE and ELEXA-4 were equally effective in reducing disease incidence when applied as a standalone treatment. Canopy trimming combined with ELEXA-4 or LANCE treatment significantly reduced disease incidence compared to either treatment alone. Disease developed in trimming treatments after the canopy closed and environmental conditions were conducive to disease development. The results demonstrate that managing sclerotinia rot of carrot is effective when accurately-timed according to the number of detected ascospores within the crop.

Table 1. Field evaluation of BOSCALID, ELEXA-4 and canopy trimming for management of sclerotinia rot of carrot, 2009.

Treatment	Number of Applications	AUDPC [1]
LANCE @ 441 g/ha and trimming	3	22 a [2]
ELEXA-4 @ 0.2% chitosan and trimming	5	70 a
LANCE @ 441 g/ha	3	215 b
ELEXA-4 @ 0.2% chitosan	5	252 b
Check	0	564 c
se		*27*

[1] Area under the disease progress curve.
[2] Numbers in a column followed by the same letter are not significantly different at P = 0.05, Tukey's Test.

2009 PMR REPORT # 30 **SECTION L: VEGETABLE and SPECIAL CROPS - Diseases**

CROP: Carrot (*Daucus carota* subsp. s*ativus* (Hoffm.) Arcang)
PEST: Sclerotinia rot of carrot (*Sclerotinia sclerotiorum* (Lib.) de Bary)

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TITLE: **DETECTION OF ASCOSPORES OF SCLEROTINIA SCLEROTIORUM CORRELATES AMONG SITES WITHIN A REGION AND TO DISEASE INCIDENCE**

MATERIALS: Blue Plate Test and Andersen N6 Impactor, both using Sclerotinia semi-selective medium

METHODS: This study is to improve methods to forecast disease risk by comparing selected spore-trapping methods to detect ascospores of the pathogen and comparing concentrations of ascospores at multiple sites within a region having a history of carrot production and sclerotinia rot of carrot. Ascospore trapping methods being evaluated are based on passive and active deposition of ascospores onto Sclerotinia selective medium using the Blue Plate Test and the Andersen N6 Impactor, respectively. Ascospore traps were located in the Bradford Marsh, Ontario at one and two sites of the Muck Crops Research Station in 2008 and 2009, respectively, and at two commercial fields in both years. Ascospore sampling began 29 and 8 July, continuing until 8 and 15 Oct in 2008 and 2009, respectively, and was conducted 2-3 times weekly. The Blue Plate Test consisted of exposing Petri dishes containing Sclerotinia selective medium placed on a covered stand 1 m above the soil at approximately 45 degrees facing the prevailing wind for 3 hr during the period 10 h to 14 h. The Blue Plate Test was conducted at 6 locations at each site. The N6 Impactor was placed 1 m above the soil and Petri dishes containing Sclerotinia selective medium placed inside the sampler were exposed for three 10 min intervals at one sampling location per site. The Petri dishes were incubated at room temperature for 72 h, at which time putative colonies of *S. sclerotiorum* were counted and marked. Colonies were confirmed as *S. sclerotiorum* after 7-10 days incubation by the presence of sclerotia. In 2008, the air temperatures 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). 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). In 2009, the air temperatures were below the long term (10 year) average for June (16.5˚C), July (17.9˚C) and October (7.3˚C), and average for May (12.6˚C), August (19.4˚C) and September (14.9˚C). Monthly rainfall was below the long term (10 year) average for June (49 mm) and September (51 mm) and above average for May (117 mm), July (135 mm), August (89 mm) and October (62 mm). All statistical analysis was performed using the proc corr procedure of SAS version 9.1 with P = 0.05 level of significance.

RESULTS: In 2008, ascospores were detected using the Blue Plate Test from 29 July to 8 October with average counts from six dishes per site ranging from 0 to 28.5 ascospores. Ascospores were consistently detected or not detected between the three sites on 13 of 20 total sampling dates. Detected ascospores between the three sites using the Blue Plate Test and N6 Impactor did not significantly correlate. In 2009, ascospores were detected from 15 July to 15 September with average counts from six dishes per site ranging from 0 to 45 ascospores. Ascospores were consistently detected or not detected between the four sites on 15 of 22 total sampling dates. Detected ascospores between the three sites using the Blue Plate Test and N6 Impactor significantly correlated in 9 of 21 possible site combinations (r = 0.56 – 0.86, P < 0.0001 – 0.0223). In both years, the N6 Impactor consistently detected fewer ascospores compared to the Blue Plate Test. Disease incidence one week after ascospore detection significantly correlated at all three sites and two of four sites in 2008 and 2009, respectively (2008: r = 0.78 – 0.87, P = 0.0026 – 0.0118; 2009: r = 0.74 and 0.88, P = 0.0097 and 0.0095, respectively).

CONCLUSIONS: Although ascospore counts did not significantly correlate between sites in 2008 using the Blue Plate Test or Andersen N6 Impactor, correlations between sites in previous years (Table 1) and in 2009 did significantly correlate using the Blue Plate Test. Despite insignificant correlations between ascospore counts and disease incidence at two sites in 2009, both were consistently low throughout the growing season. The results provide strong evidence that disease prediction is accurate, particularly when the number of detected ascospores is low.

Table 1. Correlations between detected ascospores of S*clerotinia sclerotiorum* using the Blue Plate Test and ascospore sampling sites in the Bradford Marsh from 2004 to 2007.

	Number of sampling sites	Correlation values	*P* values	Number of significant correlations among total possible site combinations
2004	5	0.70 – 0.99	< 0.0001 – 0.0451	11 of 15
2005	5	0.77	0.0084 – 0.0143	3 of 15
2006	2	ns [1]	ns [1]	0 of 1
2007	2	0.68	0.0004	1 of 1

[1] ns = no significant correlations were found between the sites (P = 0.05).

2009 PMR REPORT # 31 **SECTION L: VEGETABLES and SPECIALTY CROPS - Diseases**

CROP: Yellow cooking onions (*Allium cepa* L.)
PEST: Onion smut (*Urocystis colchici* var. *cepulae* Cooke)

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TITLE: EVALUATION OF VARIOUS SEED TREATMENTS FOR CONTROL OF ONION SMUT IN YELLOW COOKING ONIONS, 2009

MATERIALS: L 1785-A (experimental), PRO-GRO (thiram 50%, carboxin 30%), RAXIL (tebuconazole 28.4%), SEPRESTO (clothianidin 56.25%, imidacloprid 18.75%), THIRAM (thiram 42%), and ALLEGIANCE (metalaxyl 28.4%)

METHODS: Seed treatments for yellow cooking onions, cv. Arsenal, were evaluated in a field trial on organic soil (pH ≈ 6.5, organic matter ≈ 70.3%) naturally infested with *Urocystis colchici* at the Muck Crops Research Station, Holland Marsh, Ontario. Treatments were: PRO-GRO at 2.0 g ai/100 g seed, RAXIL at 250 mg ai/100 g seed, and L 1785-A at 125, 250, and 500 mg ai/100 g seed. An untreated check was also included. All seeds were treated with SEPRESTO 75WS at 6.15 g ai/100 g seed, THIRAM at 188 mg ai/100 g seed and ALLEGIANCE at 15 mg ai/100 g seed. Treatments were replicated four times in a randomized complete block design. Each experimental unit consisted of 4 rows (42 cm apart), 6 m in length. All seed treatments were seeded on 30 April using a push-cone seeder. Three random 2 m sections were staked out, and germination counts were conducted on 19 and 25 May to determine initial stands prior to the first generation assessment. Plants were examined for onion smut (OS) or damage caused by other pests within the staked-out sections on a weekly basis throughout June and July. Damaged plants were rogued out and the cause recorded. At one (5 June), and three (24 June) true leaves, one of the 2m sections was harvested and bulbs and leaves were visually evaluated for OS. The remaining 2 m section was evaluated throughout the season in the same manner until plants reached maturity (14 September) to assess OS losses for the total season. On 18 September a 2.33 m section was harvested and on 27 October removed from storage and bulbs counted and weighed to determine yield. 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 in percent onion smut losses at all growth stages (Table 1). Onions grown from seeds treated with 125, 250 and 500 mg ai/100 seeds of L 1785-A or 250 ai/100 seeds of RAXIL had significantly fewer OS losses compared to onions grown from seeds treated with PRO-GRO or the untreated check. There were no significant differences among the various rates of L 1785-A. Onion smut losses for onions grown from untreated seeds were high (53 to 76%), whereas onions grown from seeds treated with L 1785-A ranged from 0.6 to 6.2%. No significant differences were found in % OS losses among onions grown from seeds treated with the various rates of L 1785-A or RAXIL. Significant differences in bulbs per meter and weight per bulb were found among the treatments (Table 2). Onions grown from seeds treated with PRO-GRO and the untreated check had significantly fewer bulbs per meter and larger weights per bulb compared to onions grown from seeds treated with L 1785-A and RAXIL. Losses due to onion smut resulted in fewer onions per meter and therefore higher weights per bulb. No significant differences were found in total yield among the treatments. High variability between replications may have contributed to no differences in total yield.

ACKNOWLEDGMENTS: 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 which provided support to conduct field research as part of a larger US project on new chemistry seed treatments and 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 authors and do not necessarily reflect the views of Cornell University or those of Rutgers, State University of New Jersey.

Table 1. Percent onion smut (OS) for onions, cv. Arsenal, treated with various fungicides, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2009.

Treatment	Rate (mg ai/100 g seed)	% OS losses within assigned 2 m sections[1]		
		1st True Leaf[2]	3rd True Leaf	Bulb Maturity[4]
L 1785-A	500	0.3 a[3]	1.2 a	1.9 a
L 1785-A	250	6.2 a	0.8 a	4.2 a
L 1785-A	125	0.6 a	1.3 a	2.8 a
RAXIL	250	15.8 a	3.5 a	12.6 a
PRO-GRO	2,000	58.6 b	51.3 b	56.3 b
Check	--	75.5 b	52.8 b	53.1 b

[1] OS losses were recorded within separate 2 m sections until 5 June (1st leaf) and 24 June (3rd leaf).
[2] Includes smut only in the flag leaf
[3] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD test.
[4] Bulbs were assessed for smut at maturity on 14 September.

Table 2. Yield data for onions, cv. Arsenal, treated with various fungicides, grown at Muck Crops Research Station, Holland Marsh, Ontario, 2009.

Treatment	Rate (mg ai/100 g seed)	Bulbs/meter	Weight/Bulb (g)	Yield (t/ha)
L 1785-A	500	34.1 ab	90.4 b[1]	71.1 ns
L 1785-A	250	36.5 a	86.7 b	73.1
L 1785-A	125	37.3 a	68.5 b	60.1
RAXIL	250	29.2 b	101.0 b	68.1
PRO-GRO	2,000	14.2 c	140.1 a	44.7
Check	--	13.2 c	171.9 a	49.5

[1] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's protected LSD test.
[2] ns = no significant differences were found among the treatments

2009 PMR REPORT # 32 **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 FUNGICIDES FOR CONTROL OF DOWNY MILDEW (*PERONOSPORA DESTRUCTOR*) IN ONIONS, 2009

MATERIALS: RIDOMILGOLD MZ (metalaxyl -M + mancozeb 68 %,) ALIETTE WDG (fosetyl-al 80%), RANMAN 400 SC (cyazofamid 34.5%), REVUS (mandipropamid 23.3%), REASON 500 SC (fenamidone 50%), DITHANE DG (mancozeb 75 %), PRESIDIO (fluopicolide 39.5%), CABRIO EG (pyraclostrobin 20%)

METHODS: Onions, cv. Hamlet, were direct seeded (34 seeds/m) on 6 May using a Stan Hay Precision seeder into organic soil (organic matter ≈ 38.9 %, pH ≈ 7.4) at the Muck Crops Research Station, Holland Marsh, Ontario. A randomized complete block arrangement with four replicates per treatment was used. Each replicate consisted of eight rows (42 cm apart), 5 m in length. Treatments were applied on 21, 30 July, 6, 13 and 19 August using a pull type plot sprayer with TeeJet D-2 hollow cone nozzles at 690 kPa (boom) in 500 L/ha of water. The treatments were: RIDOMIL at 2.5 kg/ha, ALIETTE at 2.8 kg/ha, RANMAN at 200 mL/ha, REVUS + non-ionic adjuvant at 600 mL + 0.125 v/v, REASON at 400 mL/ha, RIDOMIL alternated with ALIETTE at 2.5 or 2.8 kg/ha, MANCOZEB at 3.25 kg/ha, PRESIDIO + MANCOZEB at 292 mL + 3.25 kg/ha, respectively, PRESIDIO at 146 mL/ha, PRESIDIO at 2.92 mL/ha and CABRIO at 840 g/ha. An untreated check was also included. Recommended control procedures for weeds and insects were followed. On 5 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:

$$DSI = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \times 100$$

On 11 September a 4.64 m yield sample was taken from each replicate. The onions were weighed and graded for size on 3 November. The air temperatures in were below the long term (10 year) average for June (16.5C) and July (17.9˚C) and average for May (12.6˚C), August (19.4˚C) and September (14.9˚C). The long term (10 year) average temperatures were: May 12.1˚C, June 18.2˚C, July 19.9˚C, August 19.3˚C and September 15.5˚C. Monthly rainfall was below the long term (10 year) average for June (49 mm) and September (51 mm), and above average for May (117 mm), July (135 mm) and August (89 mm). The long term (10 year) rainfall averages were: May 86 mm, June 74 mm, July 76 mm, August 57 mm, September and 72 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 Table 1

CONCLUSIONS: Significant differences were found among treatments in the number of downy mildew lesions per plant on 14 and 26 August assessment dates. Treatments of DITHANE, DITHANE + PRESIDIO and RIDOMIL had significantly less lesions than all other treatments except PRESIDIO at 142 ml/ha, RANMAN, RIDOMIL+ ALIETTE and REVUS at the 14 August assessment date. On the 26 August assessment all treatments containing either DITHANE or RIDOMIL had significantly lower downy mildew lesions than PRESIDIO at 146 and 292 ml/ha, ALIETTE and CABRIO. Significant differences were found in the number of green leaves per plant. The DITHANE, RIDOMIL and RIDOMIL +ALIETTE treatments had significantly more green leaves per plant than REASON, PRESIDIO at 146 and 292 ml/ha and ALIETTE. Differences in marketable yield were also observed. DITHANE alone, DITHANE + PRESIDIO, CABRIO and REASON treatments had significantly higher yield than the check and REVUS treatments. Treatments containing DITHANE had the lowest disease ratings and the highest yields in the trial. ALIETTE, REASON and CABRIO all registered downy mildew products had high disease in the trial. All products tested were non-phytotoxic on the crop.

Table 1. Evaluation of carious fungicides for control of downy mildew and the effect on marketable yield on onions, cv. Hamlet, grown at the Muck Crops Research Station, Holland Marsh, Ontario, 2009.

Treatment	Rate/ha	DM Lesions/ Plant			Green Leaves/ Plant	Marketable Yield (t/ha)
		5 August	14 August	26 August		
RIDOMIL	2.5 kg	0.1	0.0 a	0.2 a	5.8 a	49.7 abc
PRESIDIO + DITHANE	292 ml + 3.25 kg	0.2	0.2 a	0.3 a	5.6 ab	53.7 a
DITHANE	3.25 kg	0.2	0.1 a	0.3 ab	5.8 a	53.3 a
RANMAN	200 ml	0.2	0.8 abc	0.4 ab	5.4 abc	51.1 ab
REVUS + non-ionic adjuvant	600 ml + 0.125% v/v	0.1	0.4 ab	0.4 ab	5.3 abc	42.5 c
RIDOMIL alternated with ALIETTE	2.5 kg or 2.8 kg	0.2	0.6 abc	0.5 ab	5.8 a	52.0 ab
Check	--	0.3	2.0 de	0.7 abc	5.4 abc	44.8 bc
REASON	400 ml	0.3ns[1]	1.2 bcd[2]	1.0 bc	5.0 bc	54.0 a
CABRIO	840 g	0.2	1.5 cd	1.2 cd	5.5 ab	52.8 a
PRESIDIO	292 ml	0.4	1.7 d	1.2 cd	4.9 c	47.7 abc
PRESIDIO	146 ml	0.2	0.7 abc	1.3 cd	5.2 bc	48.0 abc
ALIETTE	2.8 kg	0.2	2.6 e	1.9 d	5.0 bc	46.7 abc

[1] ns indicates no significant differences were found among the treatments.
[2] Numbers in a column followed by the same letter are not significantly different at $P = 0.05$, Fisher's Protected LSD test.

2009 PMR REPORT # 33 **SECTION L: VEGETABLE and SPECIAL CROPS - Diseases**

CROP: Bell pepper (*Capsicum annuum*), cv. Redstart
PEST: *Xanthomonas gardneri* strain "Xg DC00T7A"

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TITLE: EVALUATION OF PRODUCTS FOR CONTROL OF BACTERIAL DISEASES IN PEPPERS, 2009

MATERIALS: KOCIDE 2000 (copper hydroxide 53.8%), RANMAN 400SC (cyazofamid 34.5%), TANOS 50DF (famoxadone 25%, cymoxanil 25%), ACTIGARD 50WG (acibenzolar-S-methyl 50%) and KASUMIN (kasugamycin hydrochloride hydrate 2.3%)

METHODS: A field trial was conducted in 2009 at the Simcoe Research Station – University of Guelph. Peppers were seeded on 15 May into 128 cell plastic plug trays filled with a commercial soil-less mix and were transplanted on 26 June using a mechanical transplanter. Fertilizers were applied according to Ontario recommendations. Weeds were controlled using a pre-plant application of napropamide at 1.12 kg/ha followed by chlorthal dimethyl at 6.75 kg/ha applied four weeks after transplanting. Plots were 6 m long and 2.25 m wide with 3 rows per plot. Rows were spaced 0.75 m apart and plants were spaced 0.45 m apart in the row. Soil type was a Berrien sandy loam (pH = 6.5). Plants were inoculated with bacterial spot (*Xanthomonas gardneri* strain DC00T7A) in the field on 16 July. The inoculum was prepared by culturing *X. gardneri* DC00T7A (provided by Dr. Cuppels, Agriculture and Agri-food Canada, London) on NBY agar plates incubated at ~25EC for 48 h. Two days old bacterial cells were transferred to flasks containing 500 mL sterile Luria-Bertani (LB) broth and flasks were incubated at 25EC overnight on a shaker (150 rpm). Bacterial cells were pelleted by centrifugation and re-suspended in sterile distilled water to 5 $x10^8$ CFU/ml, soon before field inoculations. Inoculum concentration was checked by serial diluting and plating the inoculum on NBY agar plates. Bacterial inoculum (5 $x10^8$ CFU/mL) was misted to the foliage using hand spray bottles (750 mL) until leaves were visibly wet. Treatments were: KOCIDE (3.2 kg/ha), RANMAN (200 mL/ha), TANOS (840g/ha), ACTIGARD (52.5 g/ha) and KASUMIN (1.167 L/ha) plus an untreated non-inoculated check and an untreated inoculated check. Treatments were arranged in a randomized complete block design with four replications. Products were applied using a CO_2 backpack sprayer equipped with three TeeJet XR8002 nozzles spaced 50 cm apart and calibrated to deliver 200 L/ha water at 220 kPa on 6, 13, 20, 27August. Plots were assessed for disease incidence and severity on 28 July, 5, 12, 19, 27 August, 2 and 10 September. A 4 m section of the center row of each plot was harvested on 15 September. Numbers and weights of marketable and unmarketable fruit were recorded. The severity and incidence of disease symptoms on the fruit were also recorded. Average air temperatures (^oC) were below normal in July (18.6), close to normal in June (17.9) and slightly above normal in August (20.6) and September (16.6). The 30-year normal mean temperatures were (^oC): June 18.1, July 20.5, August 19.5 and September 15.5. Monthly rainfall (mm) was below normal in September (18), above normal in August (95) and close to normal in June (80) and July (78). The 30-year normal rainfalls were (mm): June 82, July 77,

August 80 and September 89. Data were analyzed using the General Linear Model procedure of SAS ver. 9.1.

RESULTS: As outlined in Table 1.

CONCLUSIONS: Bacterial inoculum was needed to induce disease on peppers and symptoms occurred eight days after inoculation. Although there were no significant differences among the treatments for total yield, the marketable yield was significantly higher for the non-inoculated control, followed by KASUMIN treated plants (Table 1). Pepper leaf infection by bacterial spot as determined by disease incidence and disease severity index, was significantly lower on the untreated control followed by ACTIGARD treated plants. RANMAN and TANOS treatments resulted in significantly higher foliar disease incidence and severity. There were no significant differences in disease incidence and severity on pepper fruit among the treatments.

For the pepper trial, we expected to see bacterial spot control by the copper based product KOCIDE and by the antibiotic KASUMIN. KASUMIN provided better control of the disease than KOCIDE, since yields were higher with this treatment. Efficacy of KASUMIN may have been improved if application had commenced closer to the time of inoculation. Also, we expected to see some infection on the untreated control, because bacterial spot occurs naturally in this region or by the pathogen spread from the inoculated plots. The results indicate that there was disease on non-inoculated control as shown in Table 1 leaf disease incidence and severity. The fungicides RANMAN and TANOS had no effect on bacterial spot. No phytotoxicity was observed with the ACTIGARD treatment.

Table 1. Effects of fungicides and bactericides on the severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot at harvest as determined by total and marketable yield and disease incidence and severity for Redstart peppers grown at the Simcoe Research Station in 2009.

Treatment	Rate/ha	Yield (t/ha)		Disease Incidence (%)		Disease Severity Index[2]	
		Total	Marketable	Leaves	Fruit	Leaves	Fruit
CONTROL – non-inoculated	--	23.2 ns	18.6 a[1]	21.5 c	5.3 ns	5.4 c	1.1 ns
CONTROL – inoculated	--	21.2	13.9 bc	71.5 ab	9.6	27.9 ab	2.5
KOCIDE	3.2 kg	19.9	13.8 bc	62.5 ab	11.8	24.8 ab	2.6
ACTIGARD	52.5 g	19.6	13.5 bc	55.5 b	10.1	18.5 b	2.2
TANOS	840 g	20.3	13.6 bc	75.5 ab	13.8	34.3 a	3.1
KASUMIN	1.167 L	22.9	16.8 ab	69.0 ab	8.1	27.0 ab	1.6
RANMAN	200 mL	17.8	12.8 c	81.0 a	14.2	32.7 a	3.4

[1] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test; ns = not significant

[2] Leaf Disease Severity Index

$$\text{LDSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \times 100$$

Leaf Disease Severity Index

$$\text{FDSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \times 100$$

2009 PMR REPORT # 34 **SECTION L: VEGETABLES and SPECIAL CROPS - Diseases**

CROPS: Chinese flowering cabbage (*Brassica rapa* L. var. *utilis* Tsen and Lee)
Shanghai pak choy (*Brassica rapa* L. var. *communis* Tsen and Lee)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: EFFECT OF SEEDING DATE AND RANMAN APPLICATION ON CLUBROOT OF ASIAN VEGETABLES, 2009

MATERIAL: RANMAN 400SC (cyazofamid 34.5%, ISK Biosciences Corp.)

METHODS: The trial was conducted at the Muck Crops Research Station, Holland Marsh, Ontario, in organic soil (pH ≈ 6.7, organic matter ≈ 69%) naturally infested with *Plasmodiophora brassicae* pathotype 6. Shanghai pak choy and Chinese flowering cabbage were direct seeded (34 seeds/m) on 13 May, 11 June, 8 July, 5 August and 2 September using a Stan Hay precision seeder. There were two treatments; an untreated control and RANMAN as a soil drench (114 mL product/100L of water, 300 mL/meter) in a 15-cm band over the seed row at the day after seeding. About 7mm of irrigation was applied within 24 hr after the RANMAN treatment. Treatments were replicated four times and arranged in a randomized complete-block design. Each replicate consisted of two rows, each 6 m in length, for both crops. Plants were harvested at weekly intervals from 2 or 3 weeks to 6 or 7 weeks after seeding. Following harvest, roots were thoroughly washed and assessed for clubroot incidence and severity. Disease severity was rated using a 0–3 scale, where: 0 = no clubbing, 1 < 1/3 of root clubbing, 2 = 1/3 to 2/3 of root clubbing, and 3 > 2/3 of root clubbing. A disease severity index (DSI) was calculated using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

All 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 with $P = 0.05$ level of significance.

WEATHER: The air temperatures in the 2009 growing season were below the long term (10 year) average for June (16.5˚C), July (17.9˚C) and October (7.3˚C), and average for May (12.6˚C), August (19.4oC) and September (14.9˚C). The long term (10 year) average temperatures were: May 12.1˚C, June 18.2˚C, July 19.9˚C, August 19.3˚C, September 15.5˚C and October 8.9˚C. Monthly rainfall was below the long term (10 year) average for June (49 mm) and September (51 mm), and above average for May (117 mm), July (135 mm), August (89 mm) and October (62 mm). The long term (10 year) rainfall averages were: May 86 mm, June 74 mm, July 76 mm, August 57 mm, September 72 mm and October 59 mm.

RESULTS: As presented in Tables 1 and 2

CONCLUSIONS: Clubroot incidence and severity were higher in June and July plantings in both Shanghai pak choy and Chinese flowering cabbage compared to other seeding dates (Table 1 & 2) because mean air temperatures were higher during growing period for these crops planted in June and July. Clubroot incidence and severity were lower in seedlings treated with RANMAN as a soil drench in comparison to the nontreated control (Table 1 & 2).Clubroot severity was consistently lower for both crops with Ranman treatment. However, there were no significant differences in incidence between the two treatments in the June and July seedings of Shanghai pak choy when incidence reached up to 100% in the nontreated control. RANMAN did not eliminate clubroot but has potential in reducing disease severity in crops grown in organic soil. Thus this fungicide should be included as a component of Integrated Pest Management systems to manage clubroot on Brassica vegetables.

ACKNOWLEDGEMENTS: Funding for this project was provided by the Pest Management Centre of Agriculture and Agri-Food Canada, and the Sustainable Production Systems Program of the Ontario Ministry of Agriculture, Food and Rural Affairs and the University of Guelph.

Table 1: Effect of seeding date and RANMAN application on clubroot incidence and severity in Shanghai pak choy grown at the Muck Crops Research Station, 2009.

Days after seeding	Seeding Date									
	13 May		11 June		08 July		05 August		02 September	
	C1	R2	C	R	C	R	C	R	C	R
Clubroot Incidence (%)										
13	---	---	---	---	0 a	0 a	0 a	0 a	---	---
20	0 a3	0 a	8 a	0 a	2 a	0 a	16 a	5 a	0 a	0 a
27	0 a	0 a	20 b	0 a	96 b	70 a	19 b	3 a	0 a	0 a
34	22 b	4 a	99 b	84 a	100 a	94 a	46 b	12 a	0 a	0 a
41	36 b	6 a	99 a	99 a	100 a	94 a	87 b	34 a	0 a	0 a
48	95 b	69 a	---	---	---	---	---	---	---	---
Disease Severity Index										
13	---	---	---	---	0 a	0 a	0 a	0 a	---	---
20	0 a	0 a	3 a	0 a	1 a	0 a	5 a	2 a	0 a	0 a
27	0 a	0 a	10 b	0 a	40 b	24 a	8 a	1 a	0 a	0 a
34	13 b	2 a	70 b	34 a	74 b	53 a	18 b	5 a	0 a	0 a
41	24 b	4 a	81 b	62 a	88 b	69 a	38 b	13 a	0 a	0 a
48	53 b	26 a	---	---	---	---	---	---	---	---

1Nontreated Control
2Treated with Ranman 400 SC fungicide
3The control and Ranman treatments within the same date and day of assessment are not significantly different at P = 0.05, Fisher's Protected LSD test if they are followed by the same letter.

Table 2: Effect of seeding date and RANMAN application on clubroot incidence and severity in Chinese flowering cabbage grown at the Muck Crops Research Station, 2009.

Days after seeding	Seeding Date									
	13 May		11 June		08 July		05 August		02 September	
	C1	R2	C	R	C	R	C	R	C	R
Clubroot Incidence (%)										
13	---	---	---	---	0 a	0 a	0 a	0 a	---	---
20	0 a3	0 a	2 a	4 a	1 a	0 a	0 a	0 a	0 a	0 a
27	0 a	0 a	8 a	0 a	48 b	6 a	0 a	0 a	0 a	0 a
34	11 a	0 a	60 a	46 a	58 b	39 a	0 a	0 a	0 a	0 a
41	18 b	0 a	68 b	48 a	60 b	44 a	17 b	7 a	0 a	0 a
48	76 b	44 a	---	---	---	---	---	---	---	---
Disease Severity Index										
13	---	---	---	---	0 a	0 a	0 a	0 a	---	---
20	0 a	0 a	1 a	1 a	0.4 a	0 a	0 a	0 a	0 a	0 a
27	0 a	0 a	3 a	0 a	16 b	2 a	0 a	0 a	0 a	0 a
34	5 a	0 a	29 b	17 a	26 b	15 a	0 a	0 a	0 a	0 a
41	10 a	0 a	43 b	27 a	36 b	20 a	6 b	2 a	0 a	0 a
48	45 b	17 a	---	---	---	---	---	---	---	---

2Treated with Ranman fungicide

3The control and Ranman treatments within the same date and day of assessment are not significantly different at P = 0.05, Fisher's Protected LSD test if they are followed by the same letter.

2009 PMR REPORT # 35 **SECTION L: VEGETABLES and SPECIAL CROPS - Diseases**

CROP: Shanghai pak choy (*Brassica rapa* L. var. *communis* Tsen and Lee)
PEST: Clubroot (*Plasmodiophora brassicae* Woronin)

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TITLE: EFFICACY OF BIOFUNGICIDES AND FUNGICIDES ON CLUBROOT IN SHANGHAI PAK CHOY GROWN IN CONTROLLED ENVIRONMENT, 2009

MATERIALS: MYCOSTOP® WP (30% *Streptomyces griseoviridis*, strain K61), PRESTOP® WP (32% *Gliocladium catenulatum* strain J1446), ROOTSHIELD® Drench ™ WP (1.15% *Trichoderma harzianum* Rifai strain KRL-AG2), SERENADE® ASO™ (1.34% *Bacillus subtilis* QST 713), ACTINOVATE® SP (0.371% *Streptomyces lydicus* strain WYEC 108), ALLEGRO®500F (40% fluazinam) and RANMAN® 400 SC (34.5% cyazofamid)

METHODS: The trials were conducted at the University of Guelph in controlled environment growth cabinets. Shanghai pak choy was grown in soil less mix (Sunshine mix #4, Sun Gro Horticulture Canada Ltd, Alberta, Canada) using individual tall plastic conetainers (164 mL , Stuewe & Sons, Inc.) with one seedling maintained in each conetainer. The plants were maintained at 23º/18 ºC (day/night) with a 14 hr photoperiod and 65% of relative humidity. A combination of fluorescent and incandescent lights was used in growth cabinets with an intensity of 200 – 250 µmol.m^{-2}.s^{-1}. Trial 1 was seeded on 15 December, 2008, trial 2 on 3 March and trial 3 on 20 July, 2009. There were nine treatments (Table 1): five biofungicides, two fungicides, one noninoculated treatment (negative control) and an inoculated but nontreated treatment (positive control) arranged in a completely randomized design with 10 conetainers per treatment. Biofungicides were applied at five times the label rates 5 days after seeding and 3 days prior to pathogen inoculation to allow sufficient time for biocontrol agents to colonize the roots (Table 1). In this study, biofungicides were used higher the label rate for initial evaluation because there was no prior data for these microbial fungicides against *P. brassicae*. Fungicides were applied at label rates 1 hr after pathogen inoculation (Table 1). Both biofungicides and fungicides were applied as a soil drench at the rate of 50 mL/ seedling or conetainer. Each seedling was inoculated with 5 mL spore suspension (1x 10^5 or 1x10^6/mL) 8 days after seeding. Resting spores were extracted from clubroot stored at -20 ºC that was harvested from cabbage grown in organic soil having a history of clubroot pathogen. At the time of spore extraction, 3 gm clubroot was macerated with 100 mL distilled water in a commercial waring blender at a high speed for 2 minutes. The resulting suspension was filtered through eight layers of cheese cloth.

Resting spores in the filtered solution were counted by using a haemocytometer and adjusted to a desired concentration using distilled water for inoculation. Plants were inoculated with $1x10^6$/mL solution in trial 1, $1x\ 10^5$/mL in trial 2 and both concentrations were evaluated in trial 3. Inoculated plants were watered with acidified water (pH 6.3) for 2 weeks after inoculation and a high level of soil moisture was maintained by maintaining 2 cm of water in a bottom tray for 1 week after inoculation. After 2 weeks, plants were watered with tap water (pH 7.3). Plants were grown for 7 weeks and destructively harvested for disease assessment. At harvest, roots were thoroughly washed and assessed for disease incidence and severity using a 0–3 scale, where 0 = no clubbing, 1 < 1/3 of root clubbing, 2 = 1/3 to 2/3 of root clubbing, and 3 > 2/3 of root clubbing. A disease severity index (DSI) was calculated using the following equation:

$$DSI = \frac{\sum [(\text{class no.})(\text{no. of plants in each class})]}{(\text{total no. plants per sample})(\text{no. classes } -1)} \times 100$$

All data were analyzed using the General Analysis of Variance function of the Linear Models section of Statistix V.7. Means separation was conducted using Fisher's Protected LSD test at $P = 0.05$.

RESULTS: As presented in Table 2

CONCLUSIONS: Differences in disease severity were found among trials conducted at different time periods and with different inoculum concentrations. Fungicides ALLEGRO 500F and RANMAN 400 SC, were highly effective and reduced clubroot severity to 100% for all trials (Table 2). The biofungicide MYCOSTOP consistently reduced clubroot severity by 46 to 60% at both moderate and high disease pressure in trials 2 and 3 relative to the inoculated control. ACTINOVATE was also effective in all trials in comparison to inoculated control. SERENADE and PRESTOP were not significantly effective in suppressing clubroot development in all trials. Significant differences on disease severity index between the inoculated control and plants treated with ROOTSHIELD were found only in the second trial inoculated with a spore concentration of 10^5/mL resting spores (Table 2).

ACKNOWLEDGEMENTS: Funding for this project was provided by the Pest Management Centre of Agriculture and Agri-Food Canada, the Sustainable Production Systems Program of the Ontario Ministry of Agriculture, Food and Rural Affairs and the University of Guelph

Table 1. Evaluation of efficacy of biofungicides and fungicides treatments to control clubroot on Shanghai pak choy in growth cabinet trials at the University of Guelph, Guelph, ON, 2009.

Treatment	Company	Label rate	Application rate
Biofungicides			
MYCOSTOP®	Verdera OY	0.5 gm/L water	2.5 gm/L water
PRESTOP®	Verdear OY	1.5 gm/L water	7.5 gm/L water
ROOTSHIELD®	Bioworks Inc.	2.4 gm/L water	12 gm/L water
SERENADE® ASO	Agraquest Inc.	1% v/v	5% v/v
ACTINOVATE®	Natural Industries Inc.	0.4 m/L water	2 gm/L water
Fungicides			
ALLEGRO® 500F	ISK Bioscience Corp	0.5 gm/L water	0.5 gm/L water
RANMAN® 400SC	ISK Bioscience Corp	0.54 gm/L water	0.54 gm/L water

Table 2. Evaluation of efficacy of fungicides and biofungicides to control clubroot on Shanghai pak choy grown in growth cabinets at University of Guelph, ON, 2009.

Treatment	Disease Severity Index			
	Trial I	Trial II	Trial III	
	10^6 spores/mL[1]	10^5 spores/mL	10^6 spores/mL	10^5 spores/mL
Noninoculated control	nd	0 a	0 a	0 a
Fungicides				
- RANMAN 400 SC	0 a[2]	0 a	0 a	0 a
- ALLEGRO 500F	0 a	0 a	0 a	0 a
Biofungicides				
- MYCOSTOP	88 b	38 bc	36 b	16 b
- ACTINOVATE	92 bc	24 b	38 bc	19 b
- ROOTSHIELD	95 cd	43 c	48 b-d	21 bc
- SERENADE ASO	92 bc	69 d	48 b-d	30 cd
- PRESTOP	98 d	68 d	51 cd	25 bc
Pathogen control	100 d	66 d	60 d	35 d

[1] Resting spores per mL of distilled water.
[2] Means in a column followed by the same letter do not differ at $P<0.05$, Fisher's protected LSD test). nd = not done.

2009 PMR REPORT # 36 **SECTION L: VEGETABLE and SPECIAL CROPS - Diseases**

CROP: Tomato (*Lycopersicon esculentum*), cv. Celebrity
PEST: Bacterial Spot, *Xanthomonas gardneri* strain "Xg DC00T7A"
Late Blight, *Phytophthora infestans*

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TITLE: EVALUATION OF PRODUCTS FOR CONTROL OF BACTERIAL AND FUNGAL DISEASES IN TOMATO, 2009

MATERIALS: KOCIDE 2000 (copper hydroxide 53.8%), RANMAN 400SC (cyazofamid 34.5%), TANOS 50DF (famoxadone 25%, cymoxanil 25%), ACTIGARD 50WG (acibenzolar-S-methyl 50%) and KASUMIN (kasugamycin hydrochloride hydrate 2.3%)

METHODS: A field trial was conducted in 2009 at the Simcoe Research Station, University of Guelph. Tomatoes were seeded on 15 May into 128 cell plastic plug trays filled with a commercial soil-less mix and transplanted on 26 June using a mechanical transplanter. Fertilizers were applied according to Ontario recommendations. Plots were 6 m long and 3.0 m wide with 3 rows per plot. Rows were spaced 1.0 m apart and plants were spaced 0.50 m apart in the row. Soil type was a Berrien sandy loam (pH = 6.5). Weeds were controlled using a pre-plant application of napropamide at 1.12 kg/ha. Plants were inoculated in the field with bacterial spot (*Xanthomonas gardneri* strain DC00T7) on 16 July. The inoculum was prepared by culturing *X. gardneri* DC00T7A (provided by Dr. Cuppels, Agriculture and Agri-food Canada, London) on NBY agar plates incubated at ~25EC for 48 h. Two day old bacterial cells were transferred to flasks containing 500 mL sterile Luria-Bertani (LB) broth and flasks were incubated at 25EC overnight on a shaker (150 rpm). Bacterial cells were pelleted by centrifugation and re-suspended in sterile distilled water to 5 $x10^8$ CFU/ml, soon before field inoculations. Inoculum concentration was checked by serial diluting and plating the inoculum on NBY agar plates. Bacterial inoculum (5 $x10^8$ CFU/mL) was misted to the foliage using hand spray bottles (750 mL) until leaves were visibly wet. *Phytophthora infestans* occurred naturally in the field with symptoms first observed on 4 August. Treatments were: KOCIDE (3.2 kg/ha), RANMAN (200 mL/ha), TANOS (840g/ha), ACTIGARD (52.5 g/ha) and KASUMIN (1.167 L/ha) plus an untreated non-inoculated check and an untreated inoculated check. Treatments were arranged in a randomized complete block design with four replications. Products were applied using a CO_2 backpack sprayer equipped with three TeeJet XR8002 nozzles spaced 50 cm apart and calibrated to deliver 200 L/ha water at 220 kPa on 6, 13, 20, 27 August. Plots were assessed for disease incidence and severity on 28 July, 5, 12, 19, 27 August, 2 and 10 September. A 4 m section of the center row of each plot was harvested on 11 September. Numbers and weights of marketable and unmarketable fruit and disease incidence and severity were recorded. Average air temperatures (^oC) were below normal in July (18.6), close to normal in June (17.9) and slightly above normal in August (20.6) and September (16.6). The 30-year normal mean temperatures (^oC) were: June 18.1, July 20.5, August 19.5 and September 15.5. Monthly rainfall (mm) was below normal in September (18), above normal in August (95) and close to normal in June (80) and July (78). The 30-year normal rainfalls were (mm): June 82, July 77, August 80 and September 89. Data were analyzed using the General Linear Model procedure of SAS ver. 9.1.

RESULTS: As outlined in Tables 1, 2.

CONCLUSIONS: Bacterial spot symptoms occurred eight days after inoculation however our ability to measure the progress of bacterial spot was hindered by a severe infection of late blight (*Phytophthora infestans*). Total and marketable yields were significantly higher for RANMAN, TANOS and KOCIDE (Table 1) but the incidence and severity of bacterial spot and the percent of fruit with bacterial spot lesions were high in these treatments. Incidence of bacterial spot on the foliage at harvest was reduced by KASUMIN and ACTIGARD. Yield differences among the treatments were related to their efficacy in controlling late blight. Late blight incidence, severity and the percent of fruit with the disease were significantly reduced by RANMAN and TANOS, followed by KOCIDE (Table 2).The severe late blight infection masked the symptoms of bacterial spot to such an extent that in the plots with severe late blight the incidence of bacterial spot was lower because bacterial spot symptoms were difficult to see.

Table 1. Effects of fungicides and bactericides on the severity of *Xanthomonas gardneri* bacterial spot as determined by yield, disease incidence and severity at harvest for Celebrity tomatoes.

Treatment	Rate/ha	Yield (t/ha)		Disease Incidence (%)[2]	FDSI[3]	Bacterial Infected Fruit (%)
		Total	Marketable			
CONTROL – non-inoculated	--	1.0 d[1]	0.0 c	28.9 b	5.8 ns	0 b
CONTROL – inoculated	--	0.5 d	0.0 c	13.4 b	4.1	6.3b
KOCIDE	3.2 kg	6.5 c	1.1 c	30.8 ab	12.0	5.8 b
RANMAN	200 mL	33.6 a	15.8 a	32.0 ab	8.2	21.4 a
TANOS	840 g	17.0 b	6.2 b	51.0 a	12.3	23.8 a
ACTIGARD	52.5 g	1.2 d	0.0 c	22.7 b	4.5	0 b
KASUMIN	1.167 L	0.9 d	0.0 c	18.9 b	6.8	0 b

[1] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test; ns = not significant

[2] Incidence of bacterial spot symptoms on foliage in the field at harvest, measured 10 September.

[3] Fruit Disease Severity Index

$$\text{FDSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \times 100$$

Table 2. Effects of fungicides and bactericides on the severity of *Phytophthora infestans* late blight as determined by disease incidence and disease severity at harvest for Celebrity tomatoes initially inoculated with *Xanthomonas gardneri* .

Treatment	Rate/ha	Disease Incidence (%)[2]	FDSI[3]	Late Blight Infected Fruit (%)
CONTROL – non-inoculated	--	100.0 a[1]	94.3 a	91.7 a
CONTROL – inoculated	--	96.4 ab	94.3 a	93.8 a
RANMAN	200 mL	34.5 c	23.7 c	22.9 c
TANOS	840 g	44.5 c	29.9 c	36.5 c
KOCIDE	3.2 kg	80.2 b	69.2 b	69.3 b
ACTIGARD	52.5 g	89.8 ab	85.1 ab	100.0 a
KASUMIN	1.167 L	95.0 ab	93.1 a	100.0 a

[1] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test; ns = not significant

[2] Incidence of late blight symptoms on foliage in the field at harvest, measured 10 September.

[3] Fruit Disease Severity Index (FDSI) =

$$\text{FDSI} = \frac{\sum[(\text{class no.})(\text{no. of leaves in each class})]}{(\text{total no. leaves per sample})(\text{no. classes} - 1)} \times 100$$

2009 PMR Report # 37 **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 20, 2008 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. Five lines (32-36) 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 19.5%. Line #35 from Ridgetown Campus, University of Guelph (RCUOGTr34) had the lowest FHB index (Table 1).

Table 1: Fusarium head blight reaction of winter wheat breeding lines (NUWWSN test) in inoculated and misted plots at Ridgetown, Ontario. 2008-2009.

No.	Winter wheat lines	Incidence (%)	Severity (%)	FHB Index (%)
1	ERNIE	73.3	21.0	15.4
2	TRUMAN	30.0	16.3	5.1
3	FREEDOM	35.0	11.7	4.8
4	PIONEER 2545	88.3	38.7	34.3
5	P.03615A1-4-4	86.7	29.0	25.0
6	P.04704A1-2-1-1	90.0	49.7	45.5
7	P.053A1-6-7	83.3	29.0	24.3
8	P.0537A1-7-12	76.7	16.3	12.4
9	P.0128A1-22-22	68.3	14.0	9.6
10	MOCHA	86.7	55.3	48.1
11	SHAVER	80.0	29.0	23.6
12	RUBIN	76.7	30.7	22.9
13	ARENA	80.0	33.0	26.4
14	CANON	76.7	25.0	19.3
15	NE06469	83.3	25.0	21.1
16	NI04420	85.0	29.0	24.9
17	NI04427	76.7	18.7	14.2
18	NE05459	53.3	18.7	10.5
19	NE06471	80.0	25.0	20.4
20	NY03179FHB-10	60.0	18.7	11.4
21	NY03180FHB-10	63.3	25.0	16.1
22	NY03179FHB-12	80.0	21.0	16.8
23	NYW103-21-9183	60.0	33.0	19.8
24	NYW103-102-9103	60.0	50.0	30.0
25	IL02-18228	56.7	14.0	7.9
26	IL04-7874	90.0	29.0	26.1
27	IL04-7942	81.7	26.7	22.5
28	IL04-10721	83.3	21.0	17.5
29	IL04-10741	76.7	16.3	12.6
30	MD02W81-08-2	60.0	33.0	19.8
31	MD02W81-08-4	53.3	18.7	10.3
32	ACF213003B	83.3	25.0	21.1
33	ACF126103	73.3	18.7	13.3
34	ACF12004	86.7	34.7	30.1
35	RCUOGTr34	21.7	11.7	3.9
36	RCUOGTr35	60.0	21.0	12.6
37	M05-1531	76.7	22.7	18.1
38	B0390207	86.7	38.7	33.7
39	03M1539#031	60.0	18.7	10.7
40	03M1599#0007	80.0	45.7	37.5
41	MO 050101	53.3	18.7	10.0
42	MO 050921	60.0	33.0	19.8
43	MO 041020	65.0	21.0	13.7
44	MO 050219	60.0	18.7	11.4
45	MO 050144	76.7	21.0	16.1
46	KY00C-2059-19	90.0	33.0	29.7
47	KY00C-2515-02	60.0	21.0	12.6

48	KY00C-2059-24	86.7	29.0	25.0
49	KY00C-2567-01	63.3	18.7	12.1
50	KY00C-2143-08	86.7	34.7	30.5
51	MSU Line E6003	50.0	21.0	10.5
52	MSU Line E7035R	80.0	29.0	23.2
53	OH04-264-58	66.7	25.0	16.4
54	OH04-268-39	70.0	33.0	23.1
55	OH05-248-38	80.0	33.0	26.4
56	VA07W-580	70.0	16.3	11.4
57	VA07W-600	60.0	16.3	9.6
58	VA07W-672	70.0	30.7	20.5
59	VA06W-558	90.0	26.7	24.0
60	VA06W-615	76.7	29.0	22.1
	AVERAGE	71.3	26.1	19.5
	MINUMUM	21.7	11.7	3.9
	MAXIMUM	90	55.3	48.1
	LSD (0.05)	20.5	13	11.4

2009 PMR Report # 38 **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 20, 2008 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. The plots were fertilized and maintained using provincial recommendations. 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: The range for FHB index was between 5.8% (KY02C-3007-45) to 34.3% (IL05-15079).

Table 1: Fusarium head blight reaction of winter wheat breeding lines (PNUWWSN test) in inoculated and misted plots at Ridgetown, Ontario. 2008-2009.

No.	Winter wheat lines	Incidence (%)	Severity (%)	FHB Index (%)
1	ERNIE	85.0	25.0	21.5
2	TRUMAN	40.0	22.7	8.8
3	FREEDOM	50.0	21.0	10.5
4	PIONEER 2545	83.3	29.0	23.9
5	P.0513A1-2-3	80.0	29.0	23.6
6	P.0527A1-9-15	80.0	34.7	26.8
7	P.0558A1-5-5	85.0	30.7	27.0
8	P.0570A1-7-6	93.3	33.0	30.8
9	P.05218A1-6-31	80.0	33.0	26.4
10	OH02-12686	70.0	22.7	15.5
11	SILAS	53.3	25.0	12.8
12	LINUS	76.7	34.7	27.0
13	OKIE	73.3	25.0	18.2
14	PENZO	76.7	29.0	22.5
15	AJAX	86.7	29.0	25.4
16	IL04-11003	73.3	16.3	12.1
17	IL04-17762	70.0	25.0	17.9
18	IL05-15079	88.3	38.7	34.3
19	IL05-27333	83.3	18.7	15.4
20	IL05-27522	86.7	21.0	18.2
21	MH06-2370	70.0	29.0	21.5
22	MH06-2410	50.0	16.3	8.2
23	ML07*7571	66.7	16.3	11.0
24	ML07-7758	83.3	21.0	17.5
25	MO 050771	43.3	20.3	11.8
26	MO 041687	86.7	29.0	25.0
27	MO 071411	83.3	21.0	17.5
28	MO 071722	83.3	38.7	31.5
29	MO 071522	36.7	18.7	6.5
30	KY02C-3007-41	43.3	14.0	6.1
31	KY02C-3005-25	43.3	20.3	11.8
32	KY03C-2170-24	70.0	33.0	23.1
33	KY03C-2170-06	83.3	29.0	24.3
34	KY02C-3007-45	36.7	16.3	5.8
35	MSU Line E5024	60.0	18.7	11.9
36	VA07W-643	76.7	21.0	16.1
37	VA06W-580	60.0	16.3	10.3
38	VA07W-591	80.0	34.7	27.2
39	VA06W-578	83.3	22.7	18.8
40	VA04W-90	63.3	16.3	11.0
41	OH05-101-1	73.3	25.0	18.6
42	OH05-72-6	60.0	25.0	16.2
43	OH05-249-32	81.7	25.0	20.8
44	OH05-152-68	36.7	22.7	9.2
45	OH05-164-76	70.0	22.7	16.7
46	OH05-200-74	63.3	25.0	15.7

AVERAGE	69.6	24.8	18.1
MINUMUM	36.7	14.0	5.8
MAXIMUM	93.3	38.7	34.3
LSD(0.05)	24.6	12.4	11.8

2009 PMR REPORT # 39 **SECTION P: GREENHOUSE CROPS, ORNAMENTALS and TURF - Weeds**

CROP: Golf Course Greens
PEST: Silvery Thread Moss (*Byrum argenteum* Hedw.)

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TITLE: EVALUATION OF KOCIDE 2000 FOR THE CONTROL OF SILVERY THREAD MOSS ON GOLF COURSE GREENS

MATERIALS: KOCIDE 2000® (copper hydroxide 53.8%; metallic copper equivalent 35%)

METHODS: KOCIDE 2000 was evaluated for the control of silvery thread moss (*Byrum argenteum*) on golf course greens (creeping bentgrass, *Agrostis stolonifera* L., annual bluegrass, *Poa annua* L., and velvet bentgrass, *Agrostis canina* L.) at a golf course located in Victoria, British Columbia. The trial was replicated simultaneously on four different golf sites (Green 4, Green 5, Chipping green and Putting green) within the same golf course. At each site, Kocide 2000 was applied as foliar-drench application at half label rate (105 g in 8L water/100 m^2), label rate (210 g in 8L water/100 m^2 and twice the label rate (420 g in 8L water/100 m^2), using a hand-pump backpack applicator. The first application was carried out on November 18, 2006, followed by four subsequent applications, each at approximately two-week interval, depending on the weather conditions. As a general golf maintenance practice, iron supplement at the rate of 57 g iron in 8L water/100 m^2 was applied to golf course greens 24 h after each treatment. Since copper is known to interfere with iron metabolism in plants iron was supplemented to compensate iron deficiency. Plots treated with no Kocide 2000 were served as controls. The trial sites were maintained according to standard golf course maintenance practices. Percentage silvery thread moss infestation was estimated prior to each treatment application and two weeks after the fifth application of the treatments and mean percentage of silvery thread moss infestations and percentage reduction in silvery thread moss infestations were calculated. The foliar colour intensity, as an indicator for phytotoxicity, was recorded twice, prior to the first application and two weeks after the fifth application of each treatment. In order to avoid variability in the estimation of percentage moss infestation within each treatment, both percentage silvery thread moss infestation and foliar colour intensity were estimated within four, 1 m^2 treatment areas, using a 1 m^2 wooden frame divided into 16 equal square grids. The percentage of silvery thread moss coverage was estimated using a scale of 0-100%, where 0% = no silvery thread moss infestation, 50% = half of the area infested with silvery thread moss, 100% = entire area infested with silvery thread moss. The colour intensity of golf course greens was estimated using a scale of 1 to 5, where 1 = entirely white/yellow or necrotic leaf blades or other symptoms resembling phytotoxicity, 5 = green and healthy leaf blades. Statistical analysis (SigmaStat ® 3.5, Systat Software, Inc. 2006) was performed separately on mean percentage silvery thread moss infestation data set collected from the four trial sites at the golf course. Percentage values were subjected to arcsine square-root transformation and, then, analysis of variance (ANOVA). All pair-wise multiple mean comparisons were determined with the Turkey's test.

RESULTS: KOCIDE 2000 applied at half, label and twice the label rates significantly reduced the percentage silvery thread moss infestation of golf course greens compared to those of the control plots that did not receive Kocide 2000 treatment (Table 1). Although a significant reduction in the percentage silvery thread moss infestation was apparent on all four trial sites after 3 or 4 applications of Kocide 2000 at the label and twice the label rates, a substantial control of silvery thread moss was achieved after 5 applications. Kocide 2000 applied to golf course greens at the label rate reduced silvery thread moss infestation by 49.15%, 32.61%, 18.43% and 38.33% at the trial site 1, 2, 3 and 4, respectively. Kocide 2000 applied to golf course greens at twice the label rate reduced silvery thread infestation by 65.98%, 83.20%, 43.95% and 43.33% at the trial site 1, 2, 3 and 4, respectively. Whereas, Kocide 2000 applied to golf course greens at half the label rate had no impact or reduced silvery thread moss infestation only by small percentages, 9.88%, 13.32%, 20.83% and 0.00% at the trial site 1, 2, 3 and 4, respectively. In comparison to the Kocide 2000 treatments, the percentage silvery thread moss infestation at the untreated control plots increased, substantially, from the initial infestation by 148.89%, 93.48%, 197.26% and 157.03% at the trial site 1, 2, 3 and 4, respectively. The phytotoxic effect of Kocide 2000 treatment on golf course greens is presented in Table 2. In general, Kocide 2000 did not cause any visible symptoms of phytotoxicity on golf course greens even after 5 applications. In contrast, the colour (green) intensity and vigour of the golf course green were noticeably improved over the period of Kocide 2000 application along with iron supplement. However, since the trial did not include a control treatment with iron supplement alone, the increase in colour intensity and vigour of golf course greens solely due to KOCIDE 2000 treatment cannot be confirmed.

CONCLUSIONS: Application of KOCIDE 2000 at the label rate as foliar-drench to golf course greens during fall and winter months in southern British Columbia significantly reduced the percentage infestation of silvery thread moss, *Byrum argenteum*. Evidently, a maximum of 5 applications of Kocide 2000 did not cause any visible symptoms of phytotoxicity on golf course greens.

Table 1: Effects of KOCIDE 2000 on the control of silvery thread moss (Byrum agrenteum) infestation on golf course greens at a golf course in the southern coastal region of British Columbia.

Time of KOCIDE 2000 Application	Mean Percentage Silvery thread moss infestation (Persentage reduction in Silvery thread moss infestation)			
	Control	**KOCIDE (0.5x rate)**	**KOCIDE (1x rate)**	**KOCIDE (2x rate)**
Site 1 (Green #4)				
Nov. 18, 2005	7.0 ± 0.9a (0.00)	26.2 ± 1.8b (0.0)	9.2 ± 0.6c (0.0)	15.2 ± 1.8d (0.0)
Dec. 05, 2005	7.8 ± 1.3ab (-11.1)	25.3 ± 2.2ab (3.6)	8.2 ± 1.4bc (10.2)	12.2 ±1.4cd (19.2)
Jan. 17, 2006	10.9 ± 1.9abc (-55.6)	23.0 ± 2.6ab (12.5)	7.2 ± 0.8bc (22.0)	9.2 ± 1.4bc (39.2)
Jan. 31, 2006	13.4 ± 1.6cd (-91.1)	19.4 ± 3.5a (26.2)	5.9 ± 1.2ab (35.6)	8.0 ± 1.6b (47.4)
Feb. 22, 2006	17.5 ± 3.8d (-148.8)	20.8 ± 3.5ab (20.8)	4.7 ± 1.2a (49.2)	5.1 ± 0.9a (66.0)
Site 2 (Green #5)				
Nov. 18, 2005	14.4 ± 1.8a (0.0)	12.6 ± 2.4a (0.0)	14.4 ± 6.6c (0.0)	19.5 ± 3.1c (0.0)
Dec. 05, 2005	16.2 ± 1.8a (-13.0)	12.0 ± 3.2a (4.9)	13.8 ± 6.2bc (4.4)	17.3 ± 4.4c (11.2)
Jan. 17, 2006	20.6 ± 0.5b (-43.4)	14.7 ± 2.9a (-16.1)	12.2 ± 3.1bc (15.1)	14.0 ± 6.4bc (28.0)
Jan. 31, 2006	24.4 ± 2.1bc (-69.6)	13.2 ± 1.8a (-4.9)	11.2 ± 1.2ab (21.7)	10.6 ± 3.8b (45.6)
Feb. 22, 2006	27.8 ± 2.4c (-93.4)	12.6 ± 1.6a (0.0)	9.7 ± 2.2a (32.6)	3.2 ± 2.1a (83.2)
Site 3 (Chipping Green)				
Nov. 18, 2005	2.9 ± 2.6a (0.0)	8.6 ± 3.6a (0.0)	6.2 ± 4.3a (0.00)	12.6 ± 11.6b (0.0)
Dec. 05, 2005	4.6 ± 1.4ab (-57.8)	47.0 ± 2.6a (1.5)	5.8 ± 3.6a (5.6)	11.8 ± 11.0b (6.2)
Jan. 17, 2006	6.2 ± 1.2bc (-110.7)	8.4 ± 4.2a (1.5)	5.2 ± 2.7a (15.2)	10.3 ± 8.2b (18.5)
Jan. 31, 2006	9.4 ± 1.7c (-221.9)	8.0 ± 3.7a (6.6)	5.2 ± 2.7a (16.6)	9.0 ± 7.7ab (28.6)
Feb. 22, 2006	8.6 ± 0.8c (-196.2)	7.8 ± 2.56a (9.8)	5.0 ± 2.4a (18.4)	7.1 ± 5.6a (44.0)
Site 4 (Putting Green)				
Nov. 18, 2005	5.8 ± 1.8a (0.0)	6.4 ± 0.4a (0.0)	7.5 ± 5.2b (0.0)	13.6 ± 11.2b (0.0)
Dec. 05, 2005	9.3 ± 1.1b (-60.8)	5.4 ± 1.0a (15.2)	7.0 ± 5.2b (7.2)	13.1 ± 10.6b (3.4)
Jan. 17, 2006	8.4 ± 0.6b (-46.0)	5.2 ± 1.8a (18.2)	5.8 ± 4.6ab (22.9)	11.7 ± 9.6b (13.8)
Jan. 31, 2006	8.0 ± 0.6b (-39.2)	5.1 ± 2.2a (20.3)	4.7 ± 4.2ab (36.6)	8.8 ± 5.4a (34.7)
Feb. 22, 2006	14.8 ± 3.3c (-157.0)	5.6 ± 2.8a (13.3)	4.6 ± 4.0a (38.3)	7.7 ± 5.6a (43.3)

[1] The intervals between applications of each treatment varied from 2 weeks to 4 weeks, as determined by weather conditions (events of snow and rain falls) during the trial period. Assessments of silvery thread moss infestations, except for the final assessment, were carried out 24 hours prior to each application of

Kocide 2000 treatment. The final assessment of silvery thread moss infestation was estimated 2 weeks after the fifth application of each Kocide 2000 treatment.

[2] Means in each column followed by the same letter are not significantly different at $P \leq 0.05$ according to Turkey's Test.

[3] Mean percentage reduction in silvery thread moss infestation was calculated from the respective silvery thread moss infestation estimated prior to the first application of each treatment at the trial sites.

Table 2. Effect of Kocide 2000 on the colour intensity of golf course greens.

Time of KOCIDE 2000 Application	Mean foliar colour intensity of golf course greens			
	Control	**KOCIDE (0.5x rate)**	**KOCIDE (1x rate)**	**KOCIDE (2x rate)**
Site 1 (Green #4)				
Nov. 18, 2005	4.0	4.0	4.0	4.0
Feb. 22, 2006	3.0	4.5	5.0	3.5
Site 2 (Green #5)				
Nov. 18, 2005	3.5	3.5	3.5	3.5
Feb. 22, 2006	3.5	3.5	4.0	3.5
Site 3 (Chipping Green)				
Nov. 18, 2005	4.0	4.0	4.0	4.0
Feb. 22, 2006	4.0	5.0	4.5	4.5
Site 4 (Putting Green)				
Nov. 18, 2005	4.0	4.0	4.0	4.0
Feb. 22, 2006	4.0	5.0	5.0	5.0

[1] The colour intensity of golf course greens was estimated using a scale of 1 to 5, where 1 = entirely white/yellow or blighted leaf blades or other symptoms resembling phytotoxicity, 5 = green and healthy leaf blades. Assessments of the foliar colour intensity of golf course greens were carried out 24 hours prior to the first application and 2 weeks after the fifth application of Kocide 2000.