The addition of root and hydroponic vegetables to the Belt (flubendiamide) label for control of Lepidoptera sp.

Robert Vitelli
Bayer CropScience

Project Number: VG10078

VG10078

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the vegetables industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of the vegetables industry.

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ISBN 0 7341 2753 7

Published and distributed by:
Horticulture Australia Ltd
Level 7
179 Elizabeth Street
Sydney NSW 2000
Telephone: (02) 8295 2300
Fax: (02) 8295 2399

Horticulture Australia

FINAL REPORT

Project number: **VG10078 (1st November 2011)**

Project Title: **The addition of root and hydroponic vegetables to the Belt (flubendiamide) label for the control of lepidopteran species.**

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Bayer Project No.: MU-I-1009

Horticulture Australia Ltd Project VG10078 (1 November 2011)

The addition of root and hydroponic vegetables to the Belt (flubendiamide) label for the control of lepidopteran species.

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The purpose of this report is to present data generated from field efficacy and “Good Laboratory Practice” (GLP) residue trials with Belt 480 SC Insecticide in protected cropping (including hydroponics) Asian greens of leafy brassicas, protected cropping (including hydroponics) lettuce, protected cropping (including hydroponics) and field grown herbs, and root and tuber vegetables which will allow for a submission for registration to the APVMA for the control of various lepidopteran pests.

This project has been funded by HAL using the vegetable industry levy, voluntary contributions from industry and matched funds from the Australian Government.

Table of Contents

Media Summary

The Australian root and tuber vegetable crop group includes crops such as carrot, beetroot and the smaller root and tuber industries of swede and radish. Of the 56 minor use permits (MUP) current for the root and tuber vegetable crop group in early 2010, six MUP (involving four molecules), had been issued for a variety of lepidopteran pests, indicating a lack of registered insecticide options.

The lettuce (head and leafy) industry currently grows around 320 ha per year in protected situations. The exact area of protected cropping leafy brassicas and herbs (dominated by parsley and coriander) grown in Australia is not known, but is estimated to be approximately 40 ha and 22 ha respectively. At the time this project commenced in early 2010 there were 18 minor use permits issued to protected cropping industries, also highlighting a low number of registered products.

Bayer CropScience has shown a commitment in addressing minor use crops or major crops with minor uses with a new initiative called MUSCLE – **M**inor **U**se, **S**creening **P**roducts, **C**o-funding opportunities and **L**abel **E**xtensions. As part of this initiative Bayer CropScience resources have been allocated towards working more closely with the horticultural industry to help facilitate minor use claims. The main aim of this initiative is to avoid minor use permits and where possible, with support of industry funding, achieve registrations and label extensions.

In November 2009, Bayer CropScience held a meeting with HAL, AusVeg and Mr. Peter Dal Santo (AgAware Consulting and The Pesticide Minor Use Coordinator – Project MT07029). The purpose of this meeting was to identify the prioritised vegetable industry requirements (for minor use) and match these with new Integrated Pest Management (IPM) chemistry from Bayer.

As a result of this meeting the "Belt® – protected cropping, and root and tuber project" was identified based on industry requirements. Belt® 480 SC Insecticide (active ingredient flubendiamide) is an innovative insecticide for the control of lepidopteran pests in a range of vegetable crops. Belt belongs to a new chemical group (Group 28) and is effective on many pest populations that may have developed resistance to existing insecticide groups. Belt is very active, rainfast quickly after spraying and very stable to UV radiation. It shows translaminar activity and has very long residual effect. Belt has excellent compatibility with IPM with little to no effect on most beneficial species compared to broad spectrum alternatives when used according to current label directions.

A significant issue for protected cropping grown crops, including hydroponic growing situations, are the limited number of chemical insecticide registrations. Products such as Avatar® (active ingredient indoxacarb) and Coragen® (active chlorantraniliprole, also Group 28), are not registered for use in hydroponic growing situations. Belt would be the only Group 28 insecticide registered for use in hydroponic production. Without Belt, the ability of lettuce, leafy brassicas and herb growers to rotate lepidopteran chemistry and adopt new IPM compatible products into their growing systems will be limited.

The data generated from this project (which includes 22 "Good Laboratory Practice" residue field sites) will allow for the submission to the Australian Pesticides and Veterinary Medicines Authority (APVMA) of Belt® 480 SC Insecticide in protected cropping Asian greens of leafy brasscias, protected cropping (lettuce), protected cropping and field grown herbs and, root and tuber vegetables, thus, avoiding the need to rely on a short-term minor use permit. The subsequent registration (anticipated as late 2012) provides vegetable growers with a long-term tool to help manage many lepidopteran pests, and will assist in the overall insecticide management of their respective crops.

Technical Summary

Apart from potatoes, the Australian root and tuber vegetables industry is dominated by the carrot industry which grows around 6,900 ha nationally. Also included in this vegetable crop group is the beetroot industry (approximately 800 ha nationally). The state of Queensland is the largest producer of beetroot making up around 90% of the industry or 710 ha. The smaller root and tuber industries of swede and radish also belong to this vegetable group, however, their growing area is not known. Of the 56 minor use permits (MUP) current for the root and tuber vegetable crop group in early 2010, six MUP (involving four molecules), had been issued for a variety of lepidopteran pests, indicating a lack of registered insecticide options.

The lettuce (head and leafy) industry currently grows around 320 ha per year in protected cropping situations. New South Wales, Queensland and Victoria are the largest producers growing around 60-70 ha of lettuce each per year. The herb industry is dominated by two major herbs; parsley (200 ha) and coriander (71 ha) while the remaining herbs make up 186 ha. The exact area of protected cropping leafy brassicas and herbs grown in Australia is not known, but is estimated to be approximately 40 ha and 22 ha respectively. At the time this proposal was prepared in early 2010 there were 18 current minor use permits issued to protected cropping industries, highlighting a low number of registered products.

In terms of protected cropping including hydroponic growing situations, the numbers of chemical insecticide registrations are even fewer. Products such as Avatar® (active ingredient indoxacarb) and Coragen® (active chlorantraniliprole, also Group 28), are not registered for use in hydroponic growing conditions. Belt® 480 SC Insecticide (active ingredient flubendiamide) would be the only group 28 insecticide registered for use in hydroponic production. Belt® would give producers the option of using new, softer, Integrated Pest Management (IPM) compatible chemistry to control lepidopteran pests. Without Belt the ability of lettuce, leafy brassicas and herb growers to rotate lepidopteran chemistry and adopt new IPM compatible products into their growing systems will be limited.

In November 2009, Bayer CropScience held a meeting with HAL, AusVeg and Mr. Peter Dal Santo (AgAware Consulting and The Pesticide Minor Use Coordinator – Project MT07029). The purpose of this meeting was to identify the prioritised vegetable industry requirements (for minor use) and match these with new IPM chemistry from Bayer. This “proactive and cooperative approach” was aimed to better understand industry requirements and to develop a partnership with industry for achieving label extensions through registrations of minor use crops rather than reliance on a minor use permit based system.

As a result of this meeting the “Belt® – protected cropping, and root and tuber project” was identified based on industry requirements. Belt® 480 SC Insecticide is an innovative insecticide for the control of lepidopteran pests in a range of vegetable crops.

The data generated from this project (which includes 22 “Good Laboratory Practice” residue field sites) will allow for the submission to the Australian Pesticides and Veterinary Medicines Authority (APVMA) of Belt® 480 SC Insecticide for the label extension into protected cropping Asian greens of leafy brasscias, protected cropping (lettuce), protected cropping herbs and root and tuber vegetables, thus, avoiding the need to rely on a short-term minor use permits. The subsequent registration (anticipated as late 2012) provides vegetable growers with a long-term tool to help manage many lepidopteran pests, and will assist in the overall insecticide management of their respective crops.

Introduction

Apart from potatoes, the Australian root and tuber vegetables is dominated by the carrot industry which grows around 6,900 ha nationally. Also included in this vegetables is the beetroot industry (approximately 800 ha nationally). The state of Queensland is the largest producer of beetroot making up around 90% of the industry or 710 ha[1]. The smaller root and tuber industries of swede and radish also belong to this vegetable group, however, their growing area is not known.

The lettuce (head and leafy) industry currently grows around 320 ha per year in protected cropping situations. New South Wales, Queensland and Victoria are the largest producers growing around 60-70 ha of lettuce each per year.

The herb industry is dominated by two major herbs; parsley (200 ha) and coriander (71 ha) while the remaining herbs make up 186 ha[2] [3]. The major herb production areas tend to be located in the vicinity of major cities; however pockets of production occur in more remote areas e.g. Central Queensland, The Atherton Tablelands, Eastern/Western Victoria and Mt Gambier. The production systems are within three main types; protected, hydroponic or field grown.

The Australian Herb and Spice Industry Association Limited (AHSIA), the Australian herb and spice peak industry body, combined with the Rural Industries Research and Development Corporation (RIRDC) conducted a project (UCQ – 19J) during 2004 via a series of workshops involving growers and other industry representatives, throughout all states and territories to identify the key problematic pest and diseases facing the Australian herb and spice industry. The list below provides a summarised outline of the key lepidopteran pests identified by the RIRDC project.

Compendium of lepidopteran insects identified as pests causing some economic constraint to herbs and spices in Australia.

Common Name	Scientific name
Diamondback moth	*Plutella xylostella*
Cabbage white butterfly	*Pieris rapae*
Cutworms	*Agrotis* spp.
Heliothis	*Helicoverpa* spp
Armyworm	*Spodoptera* spp.
Centre grub	*Hellula* spp.
Cabbage cluster caterpillar	*Crocidolomia pavonana*
Loopers	*Chrysodeixis* spp.

Further examination of the Australian Pesticides and Veterinary Medicines Authority (APVMA) permit website confirms three of the major lepidopteran pests affecting the herb industry have current minor use permits issued. There is a current minor use permit (Permit number PER10305) issued to the AHSIA for the active ingredient *Bacillus thuringiensis Berliner* var. *kurstaki* for the control of diamondback moth, cabbage white butterfly and heliothis[4]. Also issued to the AHSIA is a minor use permit (PER12606) for the active ingredient methomyl for the control of heliothis.

The exact area of protected cropping leafy brassicas and herbs grown in Australia is not known, but is estimated to be approximately 40 ha and 22 ha respectively. Victoria is the largest producer of protected cropping leafy brassicas and herbs. At the time the project was prepared in early 2010 there were 18 current permits issued to protected cropping industries[3].

[1] (AUSVEG website) http://ausveg.businesscatalyst.com/resources/statistics/domestic-industry/detailed-data.htm
[2] The Australian Herb & Spice Industry Association website) http://web.ahsia.org.au/
[3] Midmore, D.J. et. al. (2005). "CropProtection – an issue for the Asian vegetables and herbs & spices industries". RIRDC Project No. UCQ-19J. Rural Industries Research and Development Corporation. The Australian Government.
[4] (APVMA website) http://www.apvma.gov.au/permits/search.php

The key lepidopteran pests affecting protected cropping and/or root and tuber vegetables include heliothis, loopers, cluster caterpillar, diamondback moth, potato moth and cabbage white butterfly. This information has been confirmed by the Strategic Agrichemical Review Process undertaken with the protected cropping (lettuce), beetroot, carrot and radish industries in 2007 and 2008 where they ranked lepidopteran pests at a medium to high priority in all situations.

The root and tuber vegetables group is limited predominantly to only one registered product for the control of lepidopteran pests with Success™2 (active ingredient spinosad). With only one registered chemical option, product rotation for resistance management is not possible for the control of lepidopteran pests and the industry instead must rely on additional chemistry via minor use permits. Of the 56 minor use permits issued to the root and tuber vegetables group in early 2010[5], six permits (four molecules) have been issued for a variety of lepidopteran pests. Three of the four molecules issued under permit are recognised to be disruptive to beneficial insects and all have an uncertain long-term future in Australian agriculture, including alpha-cypermethrin, lambda-cyhalothrin and methomyl.

In terms of protected cropping grown crops, including hydroponic growing situations, the numbers of chemical insecticide registrations are few. Products such as DuPont™ Avatar® Insecticide[6] (active ingredient indoxacarb, Group 22A) and DuPont™ Coragen® Insecticide[7] (active chlorantraniliprole, Group 28), are not registered for use in hydroponic growing situations.

Bayer CropScience has shown a commitment in addressing minor use crops or major crops with minor uses with a new initiative called MUSCLE – **M**inor **U**se, **S**creening **P**roducts, **C**o-funding opportunities and **L**abel **E**xtensions. As part of this initiative Bayer CropScience allocated resources towards working more closely with the horticultural industry to help address minor use. The main aim of this initiative is to avoid minor use permits and where possible with support of industry funding achieve eventual registrations and label extensions.

In November 2009, Bayer CropScience held a meeting with HAL, AusVeg and Mr. Peter Dal Santo (AgAware Consulting and The Pesticide Minor Use Coordinator – Project MT07029). The purpose of this meeting was to identify the prioritised vegetable industry requirements (for minor use) coupled with new Integrated Pest Management (IPM) compatible chemistry from Bayer to better ascertain future vegetable industry requirements. This allowed participants to identify a fit of the new Bayer products and predict those crops where permits will likely originate i.e. for those crops (groups) where Bayer CropScience will not pursue registrations based on financial returns. This “proactive and cooperative approach” was aimed to better understand industry requirements and to develop a partnership with industry for achieving label extensions through registrations of minor use crops rather than adopt a permit based system.

As a result of this meeting the Belt – protected cropping and root and tuber vegetables project was identified based on industry requirements. Belt® (active ingredient flubendiamide) is an innovative insecticide for the control of key lepidopteran pests in a range of vegetable crops. Belt belongs to a new chemical group (Group 28) and is effective on many pest populations that may have developed resistance to existing insecticide groups. Belt® is very active, rainfast quickly after spraying and very stable to UV radiation. It shows translaminar activity and has very long residual effect. Belt® has an excellent IPM fit and is “soft” on most beneficial species compared to broad spectrum alternatives when used according to current label directions.

This project had two aims.
1. To achieve the registration of Belt® 480 SC Insecticide in protected cropping grown lettuce, leafy brassicas and herbs (including parsley and coriander).
2. To achieve the registration of Belt® 480 SC Insecticide in root and tuber vegetables which includes crops such as radish, swede, beetroot and carrots.

[5] (APVMA website) http://www.apvma.gov.au/permits/search.php
[6] (DuPont website) http://www2.dupont.com/Crop_Protection/en_AU/assets/images/labels/dupont_avatar_label.pdf
[7] (DuPont website) http://www2.dupont.com/Crop_Protection/en_AU/assets/images/labels/Coragen%20insecticide_61519_52194.pdf

The data generated from this project (which includes 22 “Good Laboratory Practice” residue field sites) will allow for the submission to the APVMA of Belt® 480 SC Insecticide in protected cropping Asian greens of leafy brasscias, protected cropping (lettuce), protected cropping herbs and root and tuber vegetables, thus, avoiding the need to rely on a short-term minor use permits. The subsequent registration of Belt® 480 SC (anticipated as late 2012) will provide Australian growers with a long-term new insecticide with an alternate mode of action to any other insecticide currently registered. The introduction of an insecticide with a new mode of action will be a valuable tool for resistance management, particularly for the control of lepidopteran pests where multiple applications of insecticides can be required to protect crops from damage.

Materials and Methods - Residues

(i) Study number BCS-0337: Protected cropping (Lettuce)

The aim of the residue trial was:

- **Determination of residues of NNI-00001 (flubendiamide) in protected hydroponic lettuce (leafy and head) following three applications of Belt 480 SC at 48 and 96 g ai/ha at weekly intervals.**

Four field trials were conducted under Good Laboratory Practice (GLP) to generate residue data to set Maximum Residue Limits (MRLs).

The field investigation phase of the GLP study (four sites) were conducted using Peracto Pty Ltd's Standard Operating Procedures, which comply with the OECD Principles of Good Laboratory Practice Number 1 (revised 1997), Paris 1998 and Number 13, June 2002. All samples were analysed by Bayer CropScience Analytical laboratories in Brisbane. The results from the GLP study (four sites) will be used in the registration submission for the control of lepidopteran pests (Tables 1 to 3).

Table 1: Residue study site summary for BCS-0337

Test site	Location	Crop	Cultivar	Environment	Spray Volume (L/ha)	Interval
C571	Wanneroo, WA	Leafy lettuce	Flame	Hydroponic	A = 585 B = 586 C = 581	14 DBFH 7 DBFH 0 DBFH
C572	Wanneroo, WA	Leafy lettuce	Frizzmo	Hydroponic	A = 585 B = 586 C = 581	14 DBFH 7 DBFH 0 DBFH
C573	Stanthorpe, Qld	Leafy lettuce	Symphony	Hydroponic	A = 442 B = 435 C = 442	14 DBFH 7 DBFH 0 DBFH
C574	Stanthorpe, Qld	Head lettuce	Forhman	Hydroponic	A = 442 B = 435 C = 442	14 DBFH 7 DBFH 0 DBFH

DBFH – Days before the First Harvest

Table 2: Treatment list for residue study

Treatment Number	Formulated Test Substance	Active Ingredient	Rates of Test Substance (mL/ha)	Rates of Active Ingredient (g ai/ha)	Application Timing Codes
1	Untreated	N/A	Nil	Nil	N/A
2	Belt® 480 SC	NNI-0001 (flubendiamide)	100*	48	A, B and C
3	Belt® 480 SC	NNI-0001 (flubendiamide)	200*	96	A, B and C

*Agral 600 SL Spray Adjuvant was added to treatments T2 and T3 at a rate of 10 mL/100 L.
Applications A, B and C were made at targeted timings of 14, 7 and 0 days before harvest.

Table 3: Sampling information for residue study

Test Sites	C571 Leafy lettuce	C572 Leafy lettuce	C573 Leafy lettuce	C574 Head lettuce
Quantity of Test Sample Collected	Leaves from six plants	Leaves from six plants	Leaves from six plants	Three heads
Sample Timing	7 DAAB	7 DAAB	7 DAAB	7 DAAB
	0 DAAC	0 DAAC	0 DAAC	0 DAAC
	1 DAAC	1 DAAC	1 DAAC	1 DAAC
	3 DAAC	3 DAAC	3 DAAC	3 DAAC
	5 DAAC	5 DAAC	5 DAAC	5 DAAC
	7 DAAC	7 DAAC	7 DAAC	7 DAAC

DAAB = Days after application B of applications A and B.
DAAC = Days after application C of applications A, B and C.

(ii) Study number BCS-0338: Protected cropping (herbs)

The aim of the residue trial was:

- **Determination of residues of NNI-00001 (flubendiamide) in protected herb crops, parsley, coriander and basil, following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.**

Four field trials were conducted under Good Laboratory Practice (GLP) to generate residue data to set Maximum Residue Limits (MRLs).

The field investigation phase of the GLP study (five sites) were conducted using Peracto Pty Ltd's Standard Operating Procedures, which comply with the OECD Principles of Good Laboratory Practice Number 1 (revised 1997), Paris 1998 and Number 13, June 2002. All samples were analysed by Bayer CropScience Analytical laboratories in Brisbane. The results from the GLP study (four sites) will be used in the registration submission for the control of lepidopteran pests (Tables 4 to 6).

Table 4: Residue study site summary for BCS-0338

Test site	Location	Crop	Cultivar	Environment	Spray Volume (L/ha)	Interval
C575	Wanneroo, WA	Parsley	Afro	Shade house hydroponics	A = 572 B = 591 C = 583	14 DBFH 7 DBFH 0 DBFH
C576	Wanneroo, WA	Coriander	Garden Fresh	Shade house hydroponics	A = 572 B = 591 C = 583	14 DBFH 7 DBFH 0 DBFH
C577	Stanthorpe, Qld	Parsley	Frizz	Covered hydroponics	A = 267 B = 267 C = 267	14 DBFH 6 DBFH 0 DBFH
C578	Stanthorpe, Qld	Basil	Aroma	Covered hydroponics	A = 267 B = 267 C = 267	14 DBFH 6 DBFH 0 DBFH

DBFH – Days before the First Harvest

Table 5: Treatment list for residue study

Treatment Number	Formulated Test Substance	Active Ingredient	Rates of Test Substance (mL/ha)	Rates of Active Ingredient (g ai/ha)	Application Timing Codes
1	Untreated	N/A	Nil	Nil	N/A
2	Belt® 480 SC	NNI-0001 (flubendiamide)	100*	48	A, B and C
3	Belt® 480 SC	NNI-0001 (flubendiamide)	150*	72	A, B and C
4	Belt® 480 SC	NNI-0001 (flubendiamide)	300*	144	A, B and C

*Agral 600 SL Spray Adjuvant was added to treatments T2 and T4 at a rate of 10 mL/100 L.
Applications A, B and C were made at targeted timings of 14, 7 and 0 days before harvest.

Table 6: Sampling information for residue study

Test Sites	C575 Parsley	C576 Coriander	C577 Parsley	C578 Basil
Quantity of Test Sample Collected	Approx 500 g			
Sample Timing	7 DAAB	7 DAAB	6 DAAB	6 DAAB
	0 DAAC	0 DAAC	0 DAAC	0 DAAC
	1 DAAC	1 DAAC	1 DAAC	1 DAAC
	3 DAAC	3 DAAC	3 DAAC	3 DAAC
	5 DAAC	5 DAAC	4 DAAC	4 DAAC
	7 DAAC	7 DAAC	6 DAAC	6 DAAC

DAAB = Days after application B of applications A and B.
DAAC = Days after application C of applications A, B and C.

(iii) Study number BCS-0339: Root vegetables

The aim of the residue trial was:

- **Determination of residues of NNI-00001 (flubendiamide) in root vegetables (carrots, beetroot and radish) following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.**

Five field trials were conducted under Good Laboratory Practice (GLP) to generate residue data to set Maximum Residue Limits (MRLs).

The field investigation phase of the GLP study (five sites) were conducted using Peracto Pty Ltd's Standard Operating Procedures, which comply with the OECD Principles of Good Laboratory Practice Number 1 (revised 1997), Paris 1998 and Number 13, June 2002. All samples were analysed by Bayer CropScience Analytical laboratories in Brisbane. The results from the GLP study (five sites) will be used in the registration submission for the control of lepidopteran pests (Tables 7 to 9).

Table 7: Residue study site summary for BCS-0339

Test site	Location	Crop	Cultivar	Environment	Spray Volume (L/ha)	Interval
C579	Wanneroo, WA	Carrots	Flame	Field	A = 585 B = 594 C = 578	14 DBFH 7 DBFH 0 DBFH
C580	Wanneroo, WA	Beetroot	Frizzmo	Field	A = 585 B = 594 C = 578	14 DBFH 7 DBFH 0 DBFH
C649	Lillico, Tas	Carrots	Symphony	Field	A = 488 B = 382 C = 389	15 DBFH 8 DBFH 0 DBFH
C582	The Summit, Qld	Beetroot	Forhman	Field	A = 678 B = 656 C = 661	14 DBFH 8 DBFH 0 DBFH
C583	Stanthorpe, Qld	Radish	Fireball	Hydroponic	A = 442 B = 433 C = 433	14 DBFH 7 DBFH 0 DBFH

DBFH – Days before the First Harvest

Table 8: Treatment list for residue study

Treatment Number	Formulated Test Substance	Active Ingredient	Rates of Test Substance (mL/ha)	Rates of Active Ingredient (g ai/ha)	Application Timing Codes
1	Untreated	N/A	Nil	Nil	N/A
2	Belt® 480 SC	NNI-0001 (flubendiamide)	100*	48	A, B and C
3	Belt® 480 SC	NNI-0001 (flubendiamide)	150*	72	A, B and C
4	Belt® 480 SC	NNI-0001 (flubendiamide)	300*	144	A, B and C

*Agral 600 SL Spray Adjuvant was added to treatments T2 and T4 at a rate of 10 mL/100 L.
Applications A, B and C were made at targeted timings of 14, 7 and 0 days before harvest.

Table 9: Sampling information for residue study

Test Sites	C579 Carrots	C580 Beetroot	C649 Carrots	C582 Beetroot	C583 Radish
Quantity of Test Sample Collected	Approx 1 to 1.5 kg				
Sample Timing	7 DAAB	7 DAAB	8 DAAB	7 DAAB	7 DAAB
	0 DAAC	0 DAAC	0 DAAC	0 DAAC	0 DAAC
	1 DAAC	1 DAAC	1 DAAC	1 DAAC	1 DAAC
	3 DAAC	3 DAAC	3 DAAC	3 DAAC	3 DAAC
	5 DAAC	5 DAAC	5 DAAC	5 DAAC	5 DAAC
	7 DAAC	7 DAAC	7 DAAC	6 DAAC	7 DAAC

DAAB = Days after application B of applications A and B.
DAAC = Days after application C of applications A, B and C.

(iv) Study number BCS-0341: Root vegetables

The aim of the residue trial was:

- **Determination of residues of NNI-00001 (flubendiamide) in root vegetables (carrots, beetroot and radish) following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.**

Five field trials were conducted under Good Laboratory Practice (GLP) to generate residue data to set Maximum Residue Limits (MRLs).

The field investigation phase of the GLP study (five sites) were conducted using Peracto Pty Ltd's Standard Operating Procedures, which comply with the OECD Principles of Good Laboratory Practice Number 1 (revised 1997), Paris 1998 and Number 13, June 2002. All samples were analysed by Bayer CropScience Analytical laboratories in Brisbane. The results from the GLP study (five sites) will be used in the registration submission for the control of lepidopteran pests (Tables 10 to 12).

Table 10: Residue study site summary for BCS-0341

Test site	Location	Crop	Cultivar	Environment	Spray Volume (L/ha)	Interval
C588	Baldivis, WA	Carrots	Stephano	Field	A = 585 B = 596 C = 586	14 DBFH 7 DBFH 0 DBFH
C589	Ashby, WA	Beetroot	Orbit	Field	A = 585 B = 596 C = 586	14 DBFH 7 DBFH 0 DBFH
C650	Moriarty, Tas	Carrots	Ringo	Field	A = 392 B = 380 C = 357	14 DBFH 7 DBFH 0 DBFH
C591	The Summit, Qld	Beetroot	Detroit Supreme	Field	A = 678 B = 656 C = 661	14 DBFH 6 DBFH 0 DBFH
C592	Stanthorpe, Qld	Radish	Radio	Hydroponic	A = 442 B = 433 C = 433	14 DBFH 7 DBFH 0 DBFH

DBFH – Days before the First Harvest

Table 11: Treatment list for residue study

Treatment Number	Formulated Test Substance	Active Ingredient	Rates of Test Substance (mL/ha)	Rates of Active Ingredient (g ai/ha)	Application Timing Codes
1	Untreated	N/A	Nil	Nil	N/A
2	Belt® 480 SC	NNI-0001 (flubendiamide)	100*	48	A, B and C
3	Belt® 480 SC	NNI-0001 (flubendiamide)	150*	72	A, B and C
4	Belt® 480 SC	NNI-0001 (flubendiamide)	300*	144	A, B and C

*Agral 600 SL Spray Adjuvant was added to treatments T2 and T4 at a rate of 10 mL/100 L.
Applications A, B and C were made at targeted timings of 14, 7 and 0 days before harvest.

Table 12: Sampling information for residue study

Test Sites	C588 Carrots	C589 Beetroot	C650 Carrots	C591 Beetroot	C592 Radish
Quantity of Test Sample Collected	Approx 1 to 1.5 kg				
Sample Timing	7 DAAB	7 DAAB	7 DAAB	6 DAAB	7 DAAB
	0 DAAC	0 DAAC	0 DAAC	0 DAAC	0 DAAC
	1 DAAC	1 DAAC	1 DAAC	1 DAAC	1 DAAC
	3 DAAC	3 DAAC	3 DAAC	3 DAAC	3 DAAC
	4 DAAC	4 DAAC	5 DAAC	5 DAAC	5 DAAC
	7 DAAC	7 DAAC	7 DAAC	6 DAAC	7 DAAC

DAAB = Days after application B of applications A and B.
DAAC = Days after application C of applications A, B and C.

(v) Study number BCS-0340: Protected cropping (Asian greens of leafy brassicas)

The aim of the residue trial was:

- **Determination of residues of NNI-00001 (flubendiamide) in protected herb crops, parsley, coriander and basil, following three applications of Belt 480 SC at 48 and 96 g ai/ha at weekly intervals.**

Four field trials were conducted under Good Laboratory Practice (GLP) to generate residue data to set Maximum Residue Limits (MRLs).

The field investigation phase of the GLP study (four sites) were conducted using Peracto Pty Ltd's Standard Operating Procedures, which comply with the OECD Principles of Good Laboratory Practice Number 1 (revised 1997), Paris 1998 and Number 13, June 2002. All samples were analysed by Bayer CropScience Analytical laboratories in Brisbane. The results from the GLP study (four sites) will be used in the registration submission for the control of lepidopteran pests (Tables 13 to 15).

Table 13: Residue study site summary for BCS-0340

Test site	Location	Crop	Cultivar	Environment	Spray Volume (L/ha)	Interval
C584	Wanneroo, WA	Buk choy	Sumo	Hydroponic inside hot house	A = 585 B = 586 C = 581	14 DBFH 7 DBFH 0 DBFH
C585	Wanneroo, WA	Pak choy	White variety	Hydroponic inside hot house	A = 585 B = 586 C = 581	14 DBFH 7 DBFH 0 DBFH
C586	Stanthorpe, Qld	Mustard	Mizuna	Hydroponic under greenhouse plastic	A = 467 B = 456 C = 467	14 DBFH 7 DBFH 0 DBFH
C587	Stanthorpe, Qld	Rocket	Myway	Hydroponic under greenhouse plastic	A = 467 B = 456 C = 467	14 DBFH 7 DBFH 0 DBFH

DBFH – Days before the First Harvest

Table 14: Treatment list for residue study

Treatment Number	Formulated Test Substance	Active Ingredient	Rates of Test Substance (mL/ha)	Rates of Active Ingredient (g ai/ha)	Application Timing Codes
1	Untreated	N/A	Nil	Nil	N/A
2	Belt® 480 SC	NNI-0001 (flubendiamide)	100*	48	A, B and C
3	Belt® 480 SC	NNI-0001 (flubendiamide)	200*	96	A, B and C

*Agral 600 SL Spray Adjuvant was added to treatments T2 and T3 at a rate of 10 mL/100 L.
Applications A, B and C were made at targeted timings of 14, 7 and 0 days before harvest.

Table 15: Sampling information for residue study

Test Sites	C584 Buk choy	C585 Pak choy	C586 Mustard	C587 Rocket
Quantity of Test Sample Collected	Approx 500 g			
Sample Timing	7 DAAB	7 DAAB	7 DAAB	7 DAAB
	0 DAAC	0 DAAC	0 DAAC	0 DAAC
	1 DAAC	1 DAAC	1 DAAC	1 DAAC
	3 DAAC	3 DAAC	3 DAAC	3 DAAC
	5 DAAC	5 DAAC	5 DAAC	5 DAAC
	7 DAAC	7 DAAC	7 DAAC	7 DAAC

DAAB = Days after application B of applications A and B.
DAAC = Days after application C of applications A, B and C.

Results

No efficacy trials were proposed nor conducted as part of the HAL project VG10078. Final reports have been written for each of the GLP studies. See Appendices 1 to 5 for additional information. The following crop safety results outlined below are taken from the individual residue reports (Table 16).

Crop safety

(i) Protected cropping (Lettuce): Study number BCS-0337

No phytotoxicity to the crop was observed throughout the trial period.

(ii) Protected cropping (herbs): Study number BCS-0338

No phytotoxicity to the crop was observed throughout the trial period.

(iii) Root vegetables: Study number BCS-0339

No phytotoxicity to the crop was observed throughout the trial period.

(iv) Root vegetables: Study number BCS-0341

No phytotoxicity to the crop was observed throughout the trial period.

(v) Protected cropping (Asian greens of leafy brassicas): Study number BCS-0340

No phytotoxicity to the crop was observed throughout the trial period.

Table 16: Residue study summary

Study Number	Test site	Crop	Environment	Belt rates* (g ai/ha)
BCS-0337	C571	Leafy lettuce	Hydroponic	48 / 96
	C572	Leafy lettuce	Hydroponic	
	C573	Leafy lettuce	Hydroponic	
	C574	Head lettuce	Hydroponic	
BCS-0340	C584	Buk choy	Hydroponic inside hot house	
	C585	Pak choy	Hydroponic inside hot house	
	C586	Mustard	Hydroponic under greenhouse plastic	
	C587	Rocket	Hydroponic under greenhouse plastic	
BCS-0338	C575	Parsley	Shade house hydroponics	48 / 72 / 144
	C576	Coriander	Shade house hydroponics	
	C577	Parsley	Covered hydroponics	
	C578	Basil	Covered hydroponics	
BCS-0339	C579	Carrots	Field	
	C580	Beetroot	Field	
	C649	Carrots	Field	
	C582	Beetroot	Field	
	C583	Radish	Hydroponic	
BCS-0341	C588	Carrots	Field	
	C589	Beetroot	Field	
	C650	Carrots	Field	
	C591	Beetroot	Field	
	C592	Radish	Hydroponic	

*Belt tank mixed with Agral 600 SL Spray Adjuvant at 0.01% v/v.

Discussion

Crop safety

In all GLP studies there were no visual symptoms of phytotoxicity to the various crops sprayed following three applications of Belt® 480 SC at 48, 72 and 144 g ai/ha plus Agral 600 SL at 0.01% v/v (Study Plans BCS-0338, 0339 and 0341) and Belt at 48 and 96 g ai/ha plus Agral 0.01% v/v (Study Plans BCS-0337 and 0340).

Residue Trials

Twenty-two GLP residue sites were conducted as outlined in Table 16 in a range of vegetable crops. The data from these trials, in conjunction with overseas studies, will be used for the APVMA submission for registration of Belt® 480 SC Insecticide for control of various lepidopteran pests as discussed and agreed with the APVMA.

Technology Transfer

The main extension activities associated with the project are listed below (Table 17).

Table 17: Extension activities

Date	Purpose	Attendees
November 2009	Meeting to discuss project	Bayer CropScience, AUSVEG, HAL, AgAware Consulting
May 2010	Project planning meeting to discuss project	Bayer CropScience
May 2011	Project planning meeting to discuss project	Bayer CropScience
August 2011	Teleconference to discuss progress of project	Bayer CropScience
1Q 2012	Contact relevant HAL and relevant vegetable industry representatives to notify of Bayer CropScience submission to APVMA	NA
4Q 2012	Post registration: Article published in Vegetables Australia and/or AUSVEG magazine to highlight collaboration for minor use	NA

There has also been continual communication during the project with the following industry sectors.

- HAL and AgAware Consulting relating to the progress of the project including Milestone reports.
- Peracto Pty Ltd staff regarding the requirements for the Belt efficacy and GLP residue trials.
- Various vegetable growers (relating to crops tested in the project) throughout Australia who are looking to implement management strategies for the control of key lepidopteran pests with Belt® 480 SC Insecticide with on farm visits and telecommunications by Bayer CropScience representatives.
- Internally within Bayer CropScience on the preparation of protocols and study plans as well as the progress of field trials, laboratory analysis and reports.

Recommendations

- Submission to the Australian Pesticides and Veterinary Medicines Authority (APVMA), no later than the 4th quarter 2011, for the registration of Belt® 480 SC Insecticide as a foliar spray for the control of key lepidopteran pests in protected cropping (includes hydroponics) Asian greens of leafy brassicas, protected cropping (includes hydroponics) lettuce, protected cropping (includes hydroponics) and field grown herbs, and root and tuber vegetables proceed.

- As more management tools for the control of lepidopteran pests are developed, integrated crop management strategies and insecticide resistance strategies in vegetable production will need to be modified to ensure the sustainable management of these pests and insecticides in the future.

References

[1] (AUSVEG website) http://ausveg.businesscatalyst.com/resources/statistics/domestic-industry/detailed-data.htm

[2] The Australian Herb & Spice Industry Association website) http://web.ahsia.org.au/

[3] Midmore, D.J. et. al. (2005). "CropProtection – an issue for the Asian vegetables and herbs & spices industries". RIRDC Project No. UCQ-19J. Rural Industries Research and Development Corporation. The Australian Government.

[4 5] (APVMA website) http://www.apvma.gov.au/permits/search.php

Acknowledgements

The input and assistance of the following is gratefully acknowledged.

- Don Nicoll, Bayer CropScience
- Sue Cross, Bayer CropScience
- Anthony De Monte, Bayer CropScience
- Geoff Robertson, Bayer CropScience
- Leon Radunz, Bayer CropScience
- Andrew Ellis, Bayer CropScience
- Andrew Lynch, Bayer CropScience
- David Gregor, Bayer CropScience
- Geoff Perkins, Bayer CropScience
- Denise Wallis, Bayer CropScience
- Kylie Connelly, Bayer CropScience
- Peter Dal Santo, AgAware Consulting
- Brad Wells, Horticulture Australia
- Ian Macleod, Peracto
- Mark Sumner, Peracto
- Tim Bywater, Peracto
- Stephen Tancred, Peracto
- Melissa Webster, Peracto
- Kate Allen, Peracto

Appendices

Appendix 1 - GLP residue report (Study number: BCS-0337)

Determination of residues of NNI-00001 (flubendiamide) in protected hydroponic lettuce (leafy and head) following three applications of Belt 480 SC at 48 and 96 g ai/ha at weekly intervals.

Appendix 2 - GLP residue report (Study number: BCS-0338)

Determination of residues of NNI-00001 (flubendiamide) in protected herb crops, parsley, coriander and basil, following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.

Appendix 3 - GLP residue report (Study number: BCS-0339)

Determination of residues of NNI-00001 (flubendiamide) in root vegetables (carrots, beetroot and radish) following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.

Appendix 4 - GLP residue report (Study number: BCS-0340)

Determination of residues of NNI-00001 (flubendiamide) in protected herb crops, parsley, coriander and basil, following three applications of Belt 480 SC at 48 and 96 g ai/ha at weekly intervals.

Appendix 5 - GLP residue report (Study number: BCS-0341)

Determination of residues of NNI-00001 (flubendiamide) in root vegetables (carrots, beetroot and radish) following three applications of Belt 480 SC at 48, 72 and 144 g ai/ha at weekly intervals.