The addition of celery to the Movento (spirotetramat) label for the control of aphids and thrips

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Bayer CropScience

Project Number: VG10077

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Project number: **VG10077 (30th August 2011)**

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Horticulture Australia Ltd Project VG10077 (30 August 2011)

The addition of celery to the Movento 240 SC (spirotetramat) label for the control of aphids and thrips.

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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 Movento 240 SC Insecticide in celery which will allow for a submission for registration to the APVMA for the control of aphids and thrips.

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

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Media Summary

The Australian celery industry currently grows around 1309 ha per year. Victoria is the largest producer growing around 850 ha of celery per year, approximately 65% of the Australian celery market. Overall, the celery industry is rather small compared to larger vegetable industries such as potatoes, lettuce and cucurbits. As a result, registrations for suitable pesticides, especially newer chemistry for this industry are infrequent. At the time this project was initiated in 2010 there were 14 current minor use permits (MUP) issued relevant to the celery industry, but only one product for the control of both aphids and thrips.

The only product registered for the control of aphids and thrips is the active ingredient dimethoate which has an uncertain long-term future in Australian agriculture. Endosulfan which was also used to control aphids and thrips is no longer registered. The only product registered for the control of western flower thrips in celery is Success^{TM}2.

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 Bayer's new IPM chemistry. 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 "Movento® – celery project" was identified based on industry requirements. Movento® 240 SC Insecticide (active ingredient spirotetramat) is an innovative insecticide for the control of sucking pests in a range of vegetable crops. The first Group 23 insecticide available in Australia, Movento is effective on many pest populations that may have developed resistance to existing insecticide groups. Movento has a unique '2-way systemicity'. The systemic nature of Movento provides a highly effect means of aphid control, vectors of Celery Mosaic Virus. By using Movento during early stages of crop development it will control aphids which are not directly contacted by non-systemic insecticides. The effectiveness of Movento on thrips would also be very useful in reducing feeding damage on stalks (sustained earlier in the crop), but also these vectors of Tomato Spotted Wilt Virus. Movento also has an excellent Integrated Pest Management (IPM) fit and is "soft" on most beneficial species compared to broad spectrum alternatives when used according to current label directions.

The data generated from this project (which includes 3 x efficacy and 2 x "Good Laboratory Practice" residue field trials) will allow for the submission to the APVMA of Movento 240 SC Insecticide in celery avoiding the need to rely on a short-term minor use permit. The subsequent registration (anticipated as early 2013) provides celery growers with a long-term tool to help manage both aphids and thrips, and will assist in the overall insecticide management of celery crops.

Technical Summary

The Australian celery industry currently grows around 1309 ha per year. Victoria is the largest producer growing around 850 ha of celery per year, approximately 65% of the Australian celery market. The main pests affecting celery are heliothis, loopers, aphids (inc. green peach aphid), thrips (inc. onion, plague and western flower thrips), nematodes, slugs and snails. This information has been confirmed by a Strategic Agrichemical Review Process undertaken with the celery industry in late 2008. Aphids, including green peach aphid (*Myzus persicae*) and cotton aphid (*Aphis gossypii*) and thrips including onion (*Thrips tabaci*), plague (*Thrips imaginis*) and western flower thrips (*Frankliniella occidentalis*) were all considered major pests in all celery growing regions of Australia.

The only product registered for the control of aphids and thrips is the active ingredient dimethoate which has an uncertain long-term future in Australian agriculture. The active ingredient, endosulfan, which was also used to control aphids and thrips, is no longer registered. The only product registered for the control of western flower thrips in celery is Success™2.

It is known from other vegetable industries that products such as dimethoate have limited activity on aphids and thrips. Dimethoate also belongs to the organophosphate group of chemistry, which are known to be disruptive to beneficial species when used in a spray program. This lack of new and softer chemistry, especially those with an Integrated Pest Management (IPM) fit has impacted on celery production and resulted in a reliance on minor use permit applications to gain access to alternative chemistry for a large number of insects e.g. Confidor® for aphid control and plague thrips suppression, as well as products to control diseases and weeds. Currently the industry has no IPM suitable products registered. The celery industry is desperately seeking an aphicide compatible in an Integrated Pest Management System.

Bayer CropScience has developed a new systemic product Movento® 240 SC Insecticide. Movento (active ingredient spirotetramat) is an innovative insecticide for the control of sucking pests in a range of vegetable crops. The first Group 23 insecticide available in Australia, Movento is effective on many pest populations that may have developed resistance to existing insecticide groups. Movento has a unique '2-way systemicity'. After penetrating into plant tissue it is highly mobile in sap flows both up and down through the phloem and xylem in the plant, so hidden pests can be controlled. The systemic nature of Movento may provide a highly effect means of aphid control, vectors of Celery Mosaic Virus. By using Movento during early stages of crop development it will control aphids which are not directly contacted by non-systemic insecticides. The effectiveness of Movento on thrips would also be very useful in reducing feeding damage on stalks (sustained earlier in the crop), but also these vectors of Tomato Spotted Wilt Virus. Movento also has an excellent IPM fit and is "soft" on most beneficial species compared to broad spectrum alternatives when used according to current label directions.

For Movento to be registered for celery, additional data was requested by the APVMA for Australian growing conditions. This project was established to generate the efficacy, crop safety and residue data to support the future registration of Movento as a foliar spray for the control of aphids and thrips.

A total of 3 efficacy trials and 2 residue trials were conducted in the field, over one season in celery production regions of Australia. Two efficacy trials were conducted on commercial properties in Carabooda, Western Australia and Toowoomba, Queensland. One efficacy trial was conducted on a research farm in Bowen, Queensland. All the data from this project will be used by Bayer CropScience to submit for registration to the APVMA for Movento as a foliar spray for the control of aphids and thrips in field grown celery.

The application of Movento as a foliar spray allows effective control of aphids and thrips with minimal effects on non-target species. As more management options for the control of aphids and thrips are developed, integrated crop management strategies and insecticide resistance strategies in celery production will need to be modified to ensure the sustainable management of these pests in the future.

Introduction

Western flower thrips **(*Frankliniella occidentalis*)**, tomato thrips **(*Frankliniella schultzei*),** onion thrips **(*Thrips tabaci*)** and plague thrips **(*Thrips imaginis*)** are important pests of a range of commercial celery crops where they infest plants and cause economic damage. Western flower thrips are particularly devastating as this species is exceptionally aggressive and capable of feeding on a wide range of plants. Both western flower thrips and tomato thrips are known vectors for tomato spotted wilt virus (TSWV), a particularly devastating virus of several vegetable crops including celery[1].

The life cycle of thrips is dependent on temperature and food quality. Direct feeding by these species can also cause scarring and deformations on leaves and stems, with seedlings and soft tissue particularly prone to feeding damage. Celery is particularly susceptible to fruit scarring.

Cotton aphid **(*Aphis gossypii*),** Green peach aphid **(*Myzus persicae*)** and Brown sowthistle **(*Uroleucon sonchii*)** are common pests in vegetables with a very wide host range. Typically, infestation commences with the arrival of winged adults which then give birth to wingless nymphs if a suitable host is found. Females do not need to mate before producing nymphs. Multiplication can continue until the colony becomes overcrowded or until young plant growth is no longer available when the winged forms are again produced.

Aphids in high numbers can produce large deposits of honeydew and as a secondary affect, can result in the development of sooty moulds. The development of sooty moulds results in an unsightly appearance on produce and thus affects the crops marketability. Large aphid numbers may also result in plant stunting particularly on younger plants. However, virus transmission, particularly of celery mosaic virus is a major issue with these aphids. This virus causes a dark green mosaic pattern on affected leaves as well as lumpy and distorted stems.

The project was set up with the following aims;

- To evaluate existing registered thrips rates of Movento at 300 and 400 mL/ha for control of thrips in celery.
- To evaluate Movento plus Hasten® 704 SL or Agridex® 810 XL for their crop safety to celery.
- To conduct residue trials with Movento to establish an industry Maximum Residue Limit (MRL) using “Good Laboratory Practice” (GLP).
- To generate data that can be used to support the submission and ultimately registration of Movento 240 SC Insecticide as a foliar spray for the control of several aphids and thrips species.

Materials and Methods - Efficacy

The aims of the efficacy trials were:

- **To evaluate Movento 240 SC at 72 and 96 g ai/ha (300 and 400 mL/ha) plus Hasten 704 SL at 500 mL/ha for the control of thrips in celery.**
- **To compare the spray adjuvant Hasten at 500 mL/ha and 1 L/ha tank mixed with Movento at 96 g ai/ha for the control of thrips in celery.**
- **To compare the spray adjuvant Agridex 810 EC and Hasten both applied at 500 mL/ha tank mixed with Movento at 72 g ai/ha.**
- **To compare Movento plus Hasten or Agridex with the industry standard insecticides Dimethoate 400 EC and Success2 240 SC for the control of thrips in celery.**
- **To evaluate Movento plus Hasten or Agridex for their crop safety to celery.**

All efficacy trials were conducted as replicated complete block trials with 4 replicates of each treatment. Two trials, QB19 and QB21 were conducted on commercial celery properties while QB20 was planted on a research farm in Bowen to simulate commercial celery production in a historical thrips location. A summary of the efficacy trials conducted are listed in Table 1.

Table 1: Summary of efficacy trial site details

Site	ID10AUSHM1 QB19	ID10AUSHM1 QB20	ID10AUSHM1 QB21
Grower	Westview Gardens	Peracto Research Farm	Luch Monte
Location	Wyreema, Queensland	Bowen, Queensland	Carabooda, Western Australia
Pest	Western flower thrips Plague thrips	Tomato thrips	Western flower thrips Tomato thrips Onion thrips
Soil Type	Black clay loam	Sandy loam	Sand
Crop	Celery	Celery	Celery
Variety	Westham	Sierra	Tango
Trial Design	Randomised Complete Block	Randomised Complete Block	Randomised Complete Block
Replicate	4	4	4
Plot Size	1 bed (4 rows) x 10 m	1 bed (2 rows) x 7 m	1 bed x 12 m
Equipment	Hand-held air pressure mini-boom	Motorised knapsack sprayer fitted with hand held boom	Hand held compressed air boom sprayer
Nozzles	3 x Conejet TXVK-10 (Black)	Turbo Teejet	11002VA Yellow flat fan
Application Dates	1. 07/04/11 2. 19/04/11	1. 04/05/11 2. 16/05/11 3. 27/05/11	1. 20/11/10 2. 01/12/10
Crop stage	1. 5th fully expanded leaf 2. 7-8 leaf stage	1. 10 leaf stage 2. 16 leaf stage 3. 26 leaf stage	1. 5 stems - 10 cm high 2. 7 stems - 11 cm high
Assessment Dates	Pre-spray: 07/04/11 1. 19/04/11 2. 03/05/11	Pre-spray: 03/05/11 1. 16/05/11 2. 27/05/11 3. 07/06/11	Pre-spray: 18/11/10 1. 30/11/10 2. 10/12/10 3. 22/12/10

Figure 1: QB19 - Movento trial site, Toowoomba, Qld

Table 2: Efficacy product list

Product name	Active ingredient (ai)	Concentration of active ingredient	Formulation
Movento 240 SC	spirotetramat	240 g/L	Suspension concentrate
Hasten 704 SL	esterified canola oil	704 g/L	Soluble concentrate
Agridex 810 XL	petroleum oil	810 g/L	Soluble concentrate
Dimethoate 400 EC	dimethoate	400 g/L	Emulsifiable concentrate
Success2 240 SC	spinosad	240 g/L	Suspension concentrate

Table 3: Efficacy treatment list

No.	Treatment	Rate	
		Product (mL/ha)	Active ingredient (g ai/ha)
1	Untreated control	nil	nil
2	Movento 240 SC Hasten 704 SL	300 500	72
3	Movento 240 SC Agridex 810	300 500	72
4	Movento 240 SC Hasten 704 SL	400 500	96
5	Movento 240 SC Hasten 704 SL	400 1000	96
6	Dimethoate 400 EC	750	300
7	Success2 240 SC	400	96

Treatment application

Movento was applied as either two or three broadcast foliar applications in a spray volume ranging from 344 to 622 L/ha on an 11 or 12 day spray interval to an establishing or established population of thrips (Table 1 and Table 4). Motorised or compressed air spray equipment fitted with a hand boom was used across all efficacy trials. Booms were fitted with either flat fan or hollow cone nozzles. In all trials the density of thrips was assessed pre-spray and at 2-3 assessment timings post-spray. The numbers of adult and juvenile thrips were counted on randomly sampled young mature stalks (QB20) or entire plants (QB19 and QB21).

Table 4: Application summary

Trial No.	Application No. and interval	Application Volume
ID10AUSHM1 QB19	2 x 12 days	600 and 622 L/ha
ID10AUSHM1 QB20	3 x 11-12 days	400 L/ha
ID10AUSHM1 QB21	2 x 11 days	344 L/ha

Thrips assessment

In QB19, plants were cut at ground level and placed into alcohol filled containers and shaken. The solution was passed through a course sieve to remove large debris, then a 250 µm sieve to separate thrips from the solution.

In QB20, the youngest mature stalk (leaf blade + petiole) from each of 20 randomly-selected plants per plot was cut from the plant and placed into a container of methylated spirits. The container was shaken, allowed to settle and the contents were strained through gauze to separate plant material from thrips.

In QB21, plants were cut off at ground level and collected into 70% methanol in water. Samples were sieved to remove plants and thrips.

In all trials sampled thrips were returned to the laboratory and were washed into small petri dishes with the thrips adults identified and the number of adult and juvenile thrips counted using a stereo microscope.

Statistical Analysis

In QB19, Analysis of Variance (ANOVA) was conducted on untransformed data and if the *p* value was significant at the 5% and 11% level, treatment means separated using the Least Significant Difference (LSD) test.

In QB20, ANOVA conducted on untransformed or square-root transformed data and if the *p* value was significant at the 5% level, means were separated using the LSD test.

In QB21, ANOVA was conducted on untransformed data and if the *p* value was significant at the 5% or 10% level, means were separated using the LSD test.

Materials and Methods - Residues

The aim of the residue trial was:

- **Determination of residues of BYI-08330 (spirotetramat) in celery following two applications of Movento 240 SC at 400 and 600 mL/ha at 7 day intervals.**

Two 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 two studies 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 two trials will be used in the registration submission for the control of aphids and thrips.

Table 5: Residue trial summary

Study Plan No.	Test site	Location	Cultivar	Spray Volume (L/ha)	Interval
BCS-0334	C619	Carabooda, WA	Sierra	A = 571 B = 580	7 days
	C594	Stanthorpe, Qld	American Stringless	A = 500 B = 525	9 days

Table 6: Treatment list for residue trials

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	Movento 240 SC	BYI-08330 (spirotetramat)	400*	96	A and B
3	Movento 240 SC	BYI-08330 (spirotetramat)	600*	144	A and B

*Hasten Spray Adjuvant was added to treatments T2 and T3 at a rate of 1 L/ha.

Table 7: Sampling information for residue trials

Treatment Number	Test Item	Rates of Test Substance (mL/ha)	Sample Timing	Specimen Quantity
1	Untreated	Nil	C619 – 7 DAAA	Celery bunches – whole commodity after removal of obviously decomposed or withered leaves
			C594 – 9 DAAA	
2	Movento 240 SC	400*	C619 – 0,2,7,9,14,21 DAAB	
			C594 – 0,3,7,10,14,20 DAAB	
3	Movento 240 SC	600*	C619 – 0,2,7,9,14,21 DAAB	
			C594 – 0,3,7,10,14,20 DAAB	

DAAA = Days after application A; DAAB = Days after application B

Results

Individual reports have been written for each of the efficacy and residue trials. The following efficacy results are taken from the individual trial reports. Not all assessment data is presented, only the relevant assessments, particularly with statistical differences have been presented.

Efficacy – Adult thrips

In **QB19**, the trial was dominated by a population of **plague thrips *(Thrips imaginis*)**, with an average of 1.05 adults per plant and only 0.05 western flower thrips adults (*Frankliniella occidentalis*) (WFT) recorded pre-spray (Table 8). Treatments were only statistically significant at a probability of 11%. All Movento treatments were equally effective for the control of adult plague thrips as recorded at 12 days after application 1 (DAA1). All Movento treatments trended to higher levels of adult control compared to the standard Dimethoate 400 EC but were equivalent to the standard Success2 240 SC.

Table 8: Mean adult plague thrips per plant (ID10AUSHM1QB19).

Rating Data Type			**Plague thrips per plant**	
Rating Date			**19/04/11**	**03/05/11**
Days after application number			**12 DAA1**	**14DAA2**
No.	**Treatment**	**Rate (g ai/ha)**	Pre-spray*: 1.05 adults /plant	
1	Untreated control	nil	7.8 a	2.4
2	Movento + Hasten	72 + 0.5 L/ha	4.4 b	2.6
3	Movento + Agridex	72 + 0.5 L/ha	3.6 b	3.3
4	Movento + Hasten	96 + 0.5 L/ha	4.1 b	2.9
5	Movento + Hasten	96 + 1 L/ha	4.8 b	4.2
6	Dimethoate	300	5.9 ab	3.1
7	Success2	96	5.3 b	4.2
LSD (P=0.05) or (P=0.11)*			**2.35***	**ns**
Treatment Prob(F)			**0.1090**	**0.1850**

Means within columns followed by the same letter are not significantly different at the 5% or 11% level according to least significant difference (LSD) test.
ns: no significant treatment effect.
*WFT pre-spray: 0.05 adults/plant

In **QB20**, the density of **tomato thrips (*Frankliniella schultzei*)** in untreated plots at trial initiation was 24 adults/20 stalks (Table 9). The density of adult thrips declined from the pre-spray peak to 12.3 adults/20 stalks at 11 DAA2 and then increased to 13.8 adults/20 stalks at 11 DAA3.

There was no significant treatment effect for adult tomato thrips at 12 DAA1. At 11 DAA2 and 11 DAA3, all insecticide treatments significantly reduced the density of adult tomato thrips (1.0 to 5.8 and 0.8 to 3.5 adults/20 stalks, respectively) compared with the untreated control (12.3 and 13.8 adults/20 stalks, respectively). Overall, all Movento treatments were equally effective for the control of adult tomato thrips at 11 DAA2 and 11 DAA3.

All Movento treatments provided equivalent control of adult tomato thrips compared with the standard Dimethoate but were less efficacious compared with the standard Success2 at the second post-spray assessment at 11 DAA2 (Tables 9 and 11).

Table 9: Mean adult tomato thrips per 20 stalks (ID10AUSHM1QB20).

Rating Data Type			Tomato thrips per 20 stalks		
Rating Date			**16/05/11**	**27/05/11**	**07/06/11**
Days after application number			**12 DAA1**	**11 DAA2**	**11 DAA3**
No.	**Treatment**	**Rate (g ai/ha)**	Pre-spray: 12.3 adults /20 stalks		
1	Untreated control	nil	12.5	12.3 a	13.8 a
2	Movento + Hasten	72 + 0.5 L/ha	9.0	4.0 b	3.5 b
3	Movento + Agridex	72 + 0.5 L/ha	8.5	5.5 b	2.0 b
4	Movento + Hasten	96 + 0.5 L/ha	8.5	5.8 b	2.3 b
5	Movento + Hasten	96 + 1 L/ha	8.5	4.8 b	1.3 b
6	Dimethoate	300	3.3	4.0 b	0.8 b
7	Success2	96	3.0	1.0 c	1.0 b
LSD (5% level)			**#**	**#**	**3.27**
***P*-value**			**0.2584**	**0.0013**	**0.0001**

Means within columns followed by the same letter are not significantly different at the 5% level according to least significant difference (LSD) test.
Analysis performed on log transformed data – presented mean separators are for transformed data.
not applicable since data transformed using square root (X+0.5) transformation

In **QB21**, a pre-spray sample of plants across the trial site recorded a total of 2.6 thrips adults per plant. Three thrips species were present: western flower thrips (*Frankliniella occidentalis*), tomato thrips (*F. schultzei*) and **onion thrips (*Thrips tabaci*)** in the ratio 61, 30 and 10%, respectively. At subsequent assessments the numbers of adult western flower and tomato thrips declined and the population was dominated predominantly by onion thrips.

Significant differences between treatments in the number of onion adult thrips were recorded at only one assessment timing made at 9 DAA2. Only the standards Dimethoate and Success2 significantly reduced adult onion thrips compared with the untreated control.

Table 10: Mean adult onion thrips per plant (ID10AUSHM1QB21).

Rating Data Type			Onion thrips per plant		
Rating Date			**30/11/10**	**10/12/10**	**22/12/10**
Days after application number			**10 DAA1**	**9 DAA2**	**21 DAA2**
No.	**Treatment**	**Rate (g ai/ha)**	Pre-spray: 2.6 thrips adults/plant		
1	Untreated control	nil	1.20	0.68 ab	0.67
2	Movento + Hasten	72 + 0.5 L/ha	1.30	0.78 ab	0.58
3	Movento + Agridex	72 + 0.5 L/ha	1.00	0.55 abc	0.87
4	Movento + Hasten	96 + 0.5 L/ha	1.17	0.45 bc	0.57
5	Movento + Hasten	96 + 1 L/ha	1.17	0.45 bc	0.51
6	Dimethoate	300	0.88	0.27 c	0.45
7	Success 2	96	0.92	0.38 c	0.53
LSD (*p*=0.05)			**ns**	**0.29**	**ns**
***P*-value**			**0.9097**	**0.0195**	**0.4246**

Means within columns followed by the same letter are not significantly different at the 5% level according to least significant difference (LSD) test.
ns: no significant treatment effect.

Table 11: Summary of performance of Movento against standards for adult thrips control when applied as a foliar spray in celery.

Trial No:		QB19		QB20		QB21	
Dominant thrips species		Plague		Tomato		Onion	
Rate (g ai/ha)	**Adjuvant (Rate L/ha)**	Dimethoate 400 EC	Success2 240 SC	Dimethoate 400 EC	Success2 240 SC	Dimethoate 400 EC	Success2 240 SC
72	Hasten 0.5	=	=	=	-*	-	-
72	Agridex 0.5	=	=	=	-*	=	=
96	Hasten 0.5	=	=	=	-*	=	=
96	Hasten 1.0	=	=	=	-*	=	=

* One assessment timing in trial after second application. All treatments equally effective when assessed after third foliar spray.

Key to efficacy rating

-	inferior to standard
=	equal to standard
+	superior to standard

Efficacy – Thrips nymphs

In **QB19**, the population of nymphs though dominated by plague thrips also contained WFT thrips nymphs. The pre-spray count averaged 12.3 thrips nymphs/plant (Table 12).

At 12 DAA1, the population of nymphs declined in untreated plots to 6.3 thrips nymphs/plant and there were no significant differences in larval abundance between any insecticide treatment and the untreated control. At 14 DAA2, all insecticide treatments significantly ($p < 0.11$) reduced the number of larvae (1.5 to 2.4 nymphs/plant) compared with the untreated control (5.2 nymphs/plant) with no statistical differences between the Movento treatments and the standard insecticide treatments.

Table 12: Mean thrips nymphs per plant (ID10AUSHM1QB19).

Rating Data Type			**Thrips nymphs per plant**	
Rating Date			**19/04/11**	**03/05/11**
Days after application number			**12 DAA1**	**14 DAA2**
No.	**Treatment**	**Rate (g ai/ha)**	Pre-spray: 12.3 nymphs /plant	
1	Untreated control	nil	6.3	5.2 a
2	Movento + Hasten	72 + 0.5 L/ha	5.0	2.4 b
3	Movento + Agridex	72 + 0.5 L/ha	3.6	2.0 b
4	Movento + Hasten	96 + 0.5 L/ha	3.5	2.1 b
5	Movento + Hasten	96 + 1 L/ha	4.4	2.1 b
6	Dimethoate	300	3.5	1.5 b
7	Success2	96	4.1	2.1 b
LSD (P=0.05) or (P=0.11)*			**ns**	**2.06***
Treatment Prob(F)			**0.3020**	**0.1120**

Means within columns followed by the same letter are not significantly different at the 5% or 11% level according to least significant difference (LSD) test.
ns: no significant treatment effect.

In **QB20**, the density of tomato thrips nymphs in untreated plots at trial initiation was 2.3 nymphs/20 celery stalks (Table 13). Nymphal thrips numbers peaked in untreated plots at 7.8 nymphs/20 stalks at 10 DAA2.

At 12 DAA1, there was no significant treatment effect for thrips nymphs. At 11 DAA2 and 11 DAA3, all insecticide treatments significantly reduced the density of tomato thrips nymphs compared to the untreated control. All Movento treatments were equally effective for the control of tomato thrips nymphs at 11 DAA2 and 11 DAA3.

All Movento treatments provided equivalent control of tomato thrips nymphs compared with the standard Dimethoate at 11 DAA2 and 11 DAA3. Movento at 72 g ai/ha plus Agridex at 0.5 L/ha or Hasten at 0.5 L/ha, and Movento at 96 g ai/ha plus Hasten at 1 L/ha were statistically ($p < 0.05$) less efficacious against tomato thrips nymphs compared with Success2 at one assessment timing (11 DAA2), however, all the Movento treatments provided equivalent control to Success2 at 11 DAA3 (Tables 13 and 15).

Table 13: Mean thrips nymphs per 20 stalks (ID10AUSHM1QB20).

Rating Data Type			Thrips nymphs per 20 stalks		
Rating Date			16/05/11	27/05/11	07/06/11
Days after application number			12 DAA1	11 DAA2	11 DAA3
No.	Treatment	Rate (g ai/ha)			
1	Untreated control	nil	6.0	7.8 a	4.5 a
2	Movento + Hasten	72 + 0.5 L/ha	1.8	2.0 b	0.3 b
3	Movento + Agridex	72 + 0.5 L/ha	1.3	2.3 b	0.3 b
4	Movento + Hasten	96 + 0.5 L/ha	1.5	1.5 bc	0.3 b
5	Movento + Hasten	96 + 1 L/ha	2.5	2.0 b	0.0 b
6	Dimethoate	300	0.8	1.0 bc	0.0 b
7	Success2	96	0.8	0.0 c	0.0 b
LSD (5% level)			#	#	#
P-value			0.2993	0.0004	0.0001

Means within columns followed by the same letter are not significantly different at the 5% level according to least significant difference (LSD) test.
Analysis performed on log transformed data – presented mean separators are for transformed data.
not applicable since data transformed using square root (X+0.5) transformation

In **QB21**, the population of nymphs contained a mixed population of Western flower, tomato and onion thrips. At 10 DAA1, all insecticide treatments significantly ($p < 0.10$) reduced the number of larvae compared with the untreated control with no differences in effects between the insecticide treatments (Table 14). The level of thrips larval control averaged around 45%. At 9 and 21 DAA2, there were no significant differences in larval abundance between any insecticide treatment and the untreated control.

Table 14: Mean thrips nymphs per plant (ID10AUSHM1QB21).

Rating Data Type			Onion thrips per plant		
Rating Date			30/11/10	10/12/10	22/12/10
Days after application number			10 DAA1	9 DAA2	21 DAA2
No.	Treatment	Rate (g ai/ha)	Pre-spray: 0.0 nymphs /plant		
1	Untreated control	nil	0.87 a	1.58	1.56
2	Movento + Hasten	72 + 0.5 L/ha	0.42 b	1.20	2.43
3	Movento + Agridex	72 + 0.5 L/ha	0.37 b	1.05	2.18
4	Movento + Hasten	96 + 0.5 L/ha	0.33 b	1.02	2.44
5	Movento + Hasten	96 + 1 L/ha	0.22 b	0.55	1.60
6	Dimethoate	300	0.45 b	0.55	0.95
7	Success 2	96	0.23 b	0.43	1.93
LSD (*p*=0.10)			0.35	ns	ns
P-value			0.0791	0.5367	0.2853

Means within columns followed by the same letter are not significantly different at the 10% level according to least significant difference (LSD) test.
ns: no significant treatment effect.

Table 15: Summary of performance of Movento against standards for thrips nymphs control when applied as a foliar spray in celery.

Trial No:		QB19		QB20		QB21	
Dominant thrips species		Plague		Tomato		Onion	
Rate (g ai/ha)	**Adjuvant (Rate L/ha)**	Dimethoate 400 EC	Success2 240 SC	Dimethoate 400 EC	Success2 240 SC	Dimethoate 400 EC	Success2 240 SC
72	Hasten 0.5	=	=	=	-*	=	=
72	Agridex 0.5	=	=	=	-*	=	=
96	Hasten 0.5	=	=	=	=	=	=
96	Hasten 1.0	=	=	=	-*	=	=

* One assessment timing in trial after second application. All treatments equally effective when assessed after third foliar spray.

Key to efficacy rating

-	inferior to standard
=	equal to standard
+	superior to standard

Crop safety – Celery

- In QB19, no phytotoxicity to celery was observed from two applications of Movento with either Hasten or Agridex.
- In QB20, there were no visual symptoms of phytotoxicity on foliage and stalks of field-grown celery cv. Sierra following three foliar applications of Movento at 72 g ai/ha plus Agridex at 0.5 L/ha or Movento at up to 96 g ai/ha plus Hasten at up to 1 L/ha.
- In QB21, there were no signs of phytotoxicity or adverse plant effects by any treatment in this trial following two spray applications.

Discussion

In all trials foliar applications of Movento 240 SC were made to an existing population of thrips adults (QB21) and in two trials adults and nymphs (QB19 and QB20) in field grown celery. Pest pressure across the three trials was generally low to moderate.

Efficacy - Adults

In 2 of the 3 trials, Movento provided some reduction in numbers of adult plague (QB19) and tomato thrips (QB20) but no adult control was recorded against onion thrips (QB21). Overall, all Movento treatments provided equivalent levels of control compared to the standards except for one assessment timing in QB20 for tomato thrips where Movento was less efficacious (Table 11). In early development work, data generated against thrips in a range of vegetable crops has often shown Movento is active only on the juvenile stages rather than adults; however a decline in the total thrips population will occur over time as the juvenile stages are controlled. Similar trends on thrips adults were recorded in the celery trials presented in this report.

Efficacy - Nymphs

In all trials Movento provided significant control ($p < 0.05$ to <0.11) of western flower, tomato, plague and onion thrips nymphs. Overall, all Movento treatments provided equivalent levels of control compared to the standards except for one assessment timing in QB20 for tomato thrips where both Movento treatments at 72 g ai/ha were statistically less effective (Tables 13 and 15).

Efficacy conclusions

- Movento 240 SC provided commercially acceptable control of plague, tomato, onion and western flower thrips nymphs in field grown celery.
- Movento at 72 and 96 g ai/ha tank mixed with Hasten 704 SL at 0.5 L/ha provided equivalent control of thrips nymphs in celery.
- Movento at 96 g ai/ha when applied with Hasten at 0.5 or 1 L/ha was equally efficacious for the control of thrips nymphs in celery.
- The addition of Agridex 810 XL at 0.5 L/ha or Hasten at 0.5 L/ha to Movento at 72 g ai/ha resulted in equivalent control of thrips nymphs in celery.
- Movento at 72 g ai/ha plus Hasten or Agridex, and Movento at 96 g ai/ha plus Hasten provided equivalent control of thrips nymphs and adult plague and tomato thrips in celery to the standards Dimethoate 400 EC and Success 2 240 SC.
- Movento treatments were less efficacious against onion thrips adults and only the standards Dimethoate and Success2 significantly reduced adult onion thrips compared with the untreated control.

Crop safety

In all trials there were no visual symptoms of phytotoxicity on foliage and stalks of field-grown celery following two or three foliar applications of Movento at 72 g ai/ha plus Agridex at 0.5 L/ha and Movento at 96 g ai/ha plus Hasten at up to 1 L/ha.

Residue Trials

Two residue trials were conducted as outlined in Tables 5 to 7 in field grown celery crops. The data from these trials, in conjunction with overseas studies, will be used for the APVMA submission for registration of Movento 240 SC Insecticide in celery as discussed and agreed with the APVMA.

Technology Transfer

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 with Bayer's new IPM compatible chemistry. 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 reliance on a minor use permit based system.

At the meeting Bayer CropScience also presented its concept in addressing minor use crops or major crops with minor uses with its 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 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 eventual registrations and label extensions.

Table 16: 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
1-2Q 2012	Contact relevant HAL and celery industry representatives to notify of Bayer CropScience submission to APVMA	NA
2Q 2013	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 Movento efficacy and GLP residue trials.
- Celery growers throughout Australia who are looking to implement management strategies for the control of aphids and thrips with Movento 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 APVMA (no later than the 2nd quarter 2012) for the registration of Movento® 240 SC Insecticide as a foliar spray for the control of aphids and thrips in field grown celery should proceed at 300 and 400 mL/ha (72 and 96 g ai/ha) plus spray adjuvant.

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

- The celery test samples analysed in the laboratory contained a high percentage of stem material and was not representative of the whole plant. As a result it is proposed that Bayer CropScience repeat the GLP trial studies prior to submitting to the APVMA for registration in 2012.

References

[1]Cooke. T, Persley, D. & House. S. (2010). "Diseases of Vegetable Crops in Australia". The State of Queensland, Department of Employment, Economic Development and Innovation.

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- Brad Wells, Horticulture Australia
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- Mark Sumner, Peracto
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Appendices

Appendix 1 - GLP residue report

Study Number BCS-0334: Determination of residues of BYI 08330 (spirotetramat) in celery following two applications of Movento 240 SC at 96 and 144 g a.i./ha at seven day intervals just before harvest.