Facilitating the introduction and registration of new crop protection products for intensive horticulture

Ian Macleod
Peracto Pty Ltd

Project Number: VG04024

VG04024

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FINAL REPORT

Facilitating the Introduction and Registration of new Crop Protection Products for Intensive Horticulture

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Media Summary

The availability of crop protection products for Australian vegetable growers is an on going issue. It is a massive undertaking by any company to register a new active ingredient in Australia which is based on economic and risk management decisions.

Effective programs have been implemented to deal with maintaining registrations of existing products and application for permits to extend use of existing products. However, the introduction of new products for Australian vegetable growers is still an issue. New products are often more target specific, have improved environmental profiles and are more compatible with integrated crop management practices. This project was initiated to look at potential new crop protection products and to help facilitate their introduction.

Team members from this project are represented on Australia's Minor Use Task Force and HAL's Vegetable Chemical Access Group and are involved with related projects such as the minor use program and research projects for numerous government and corporate clients. This is a valuable way of helping facilitate linkages between companies and industry.

A review of available information was conducted by making contacts with over 30 different companies including those whose mission is to source, develop and distribute crop protection products, and specialist consulting companies. The details of this review are contained in the report along with priorities for products to be progressed for possible registration in Australia.

The collection of lists of priority products was important to the project but ensuring a usable outcome was of high priority to the project team. Of the products listed the herbicide Frontier-P (dimethenamid-P) stood out as an example of a product sought by industry that was not commercially available due to breakdowns in the development and registration process. Frontier-P fitted a number of issues in the gap analysis and was also a product for which an outcome could be completed and submitted to the APVMA within the timeframes and budget of this project. Four field trials were required to complete the registration package for submission of registration of this herbicide in Australia. This project facilitated the continued development of this herbicide and generated the necessary data to allow submission for registration to the APVMA. If registration is approved by the APVMA Frontier-P will be the first herbicide registered specifically for vegetable crops in Australia in the past 20 years. Frontier-P will significantly improve weed management for Australian vegetable growers.

This project also highlights the need for more investment in weed management research for the Australian vegetable industry, despite the significant cost of weed management to the industry there is very little work currently being done in this area.

Technical Summary

The availability of crop protection products for Australian vegetable growers is an on going issue. It is a massive undertaking by any company to register a new active ingredient in Australia which is based on economic and risk management decisions.

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The collection of lists of priority products was important to the project but ensuring a usable outcome was of high priority to the project team. Of the products listed the herbicide Frontier-P (dimethenamid-P) stood out as an example of a product sought by industry that was not commercially available due to breakdowns in the development and registration process. Frontier-P fitted a number of issues in the gap analysis and was also a product for which an outcome could be achieved within the timeframes and budget of this project. Four field trials were required to complete the registration package for submission of registration of this herbicide in Australia. This project facilitated the continued development of this herbicide and generated the necessary data to allow submission for registration to the APVMA. If registration is approved by the APVMA Frontier-P will be the first herbicide registered specifically for vegetable crops in Australia in the past 20 years. Frontier-P will significantly improve weed management for Australian vegetable growers.

The registration of Frontier-p will address a number of issues in the gap analysis including management of group A herbicide resistant ryegrass and weed management in beans, peas, potatoes and onions. It also provides a new option for weed management in vegetable crops, an area where there is currently very little research work being conducted in Australia.

Proposed crops for the initial registration of Frontier-P are Navy Beans, Green Beans, Processing Peas, Pumpkin, Kabocha and Sweet Corn. Proposed weeds for registration include Crowsfoot Grass (*Eleusine indica*), Barnyard Grass (*Echinochloa crus galli*), Potato Weed (*Galinsoga parviflora*), Summer Grass (*Digitaria ciliaris*), Amaranthus (*Amaranthus powellii*), Fumitory / Pinkweed (*Fumaria* spp) and Wild Hops (*Nicandra physaloides*).

This project also highlights the need for more investment in weed management research for the Australian vegetable industry, despite the significant cost of weed management to the industry there is very little work currently being done in this area.

Introduction

The global trend in crop protection is for larger companies to bring fewer products to market. The products are targeted towards specific markets of global significance, for example rice, cereals and corn. This trend is further compounded in Australia due to the dominance of broad acre agriculture in the crop protection market. As a consequence there has been limited development of new products for the vegetable industry.

New crop protection products developed in recent years are more target specific, have improved environmental profiles and are safer to the user. If they were available these products would offer a number of benefits to the Australian vegetable industry. In Australia there are currently systems in place to help maintain registrations of existing crop protection products and also to facilitate the application for permits for existing products to new crops. However, there is currently no program to facilitate access to new products for the smaller crops. Without a mechanism for facilitating access to a boarder range of new products for intensive crops, management options available to growers will diminish.

This project aims to

- Identify and prioritise new crop protection products for Australian vegetable growers
- Facilitate the development of these products in Australia.

Materials and Methods

Gap Analysis

The issues and priorities for the vegetable industry were obtained from the following sources.

- Reviewing chemical inputs for the Tasmanian vegetable industry (Facilitated by Stephen Welsh). A meeting was held in Devonport Tasmania on 18th July 2005
- Reviewing chemical inputs for the West Australian vegetable industry (Facilitated by David Ellement and Peter Dal Santo). Meetings were was held in Perth on 23rd and 24th July 2006
- Vegetable Chemical Access Meetings conducted in Sydney on July 5th 2005 and July 4th 2006 attended by representatives from HAL, Ausveg, APVMA and various consultants.
- Pest management strategies Audit report for Queensland's fruit and vegetable industries – Janine Clark, QFVG and HAL.

A review of available information was conducted by contacting over 30 different companies including those whose mission is to source, develop and distribute crop protection products, and specialist consulting companies (Table 10).

With information provided from various companies combined with priorities developed by industry input the list provided in Table 28 was compiled. To assign priorities for these products for progression towards possible registration a number of criteria were used including -:

- Need identified by industry
- Support of industry
- Availability of product
- Compatibility with other crop management tools used (Integrated Crop Management)
- Cooperation of supply company in allowing product to proceed through registration
- Availability of data to support use
- Cost of assembling required data package for registration
- Time required to complete registration

Frontier-P herbicide was identified as a product which was sought by industry, fitted a number of issues in the gap analysis and also was the only product for which the registration package could be completed with in the timeframes and budget of this project. Four field trials were required to complete the data package for submission of registration of this herbicide in Australia and these four trials were completed as part of this project.

Field Trials

Four field trials were conducted to generate data required to complete the Frontier-P submission. Trials were conducted as replicated small plot trials. The details of the trials are summarised below and complete trial reports with trial details, data analysis, discussions and interpretation of the results can be found in the individual trial reports listed in the reference section.

Table 1 - Summary of Field Trials Conducted With Frontier-P

Trial Number	Crop	State	Purpose
Field Trial 1	Processing Peas	Tasmania	Yield Data
Field Trial 2	Green Beans	Queensland	Formulation Bioequivalence
Field Trial 3	Green Beans	Queensland	Formulation Bioequivalence
Field Trial 4	Sweet Corn	Queensland	Formulation Bioequivalence

Materials and Methods

Field Trial 1 (HVG04024#1)

Title

Comparison of Frontier-p 720 EC with Stomp 330 EC and Sencor 480 SC for the control of fat hen (*Chenopodium album*) and blackberry nightshade (*Solanum nigrum*) in green peas cv. Resal. Forth, Tasmania, 2005-06.

Table 2 - Treatment List, Field Trial 1 (HVG04024#1)

No.	Product	Rate		Application Schedule
		Product (mL/ha)	Active Ingredient (g ai/ha)	
1	Untreated control	nil	nil	nil
2	Hand weeded control	nil	nil	
3	Frontier-p 720 EC	250	180	Applied post sowing, pre emergence
4	Frontier-p 720 EC	500	360	
5	Frontier-p 720EC	700	504	
6	Frontier-p 720 EC	1000	720	
7	Frontier-p 720 EC	2000	1440	
8	Stomp 330 EC	3000	990	
9	Sencor 480 SC	580	278.4	

Table 3 - Site Details, Field Trial 1 (HVG04024#1)

Grower	Forthside Vegetable Research Farm
Location	Forth, Tasmania
Soil Type	Ferrosol
Crop	Peas
Variety	Resal
Trial Design	Randomised Complete Block
Replications	4
Plot Size	1.6 m x 9 m
Sowing Rate	280 kg/ha
Sowing Date	29/11/05
Harvest Date	22/02/06

Materials and Methods

Field Trial 2 (HVG04024#4)

Title

Comparison of Frontier 900 EC and Frontier-P 720 EC with Dual Gold 960 EC for crop safety as pre-emergent herbicides in green beans cv. Symbah. Allora, Qld, 2005

Table 4 - Treatment List, Field Trial 2 (HVG04024#4)

No.	Product	Rate		Application Schedule
		Product (mL/ha)	Active Ingredient (g ai/ha)	
1	Untreated control	nil	nil	n/a
2	Hand weeded control	nil	nil	n/a
3	Frontier 900 EC	182	163.6	Single application immediately after sowing
4	Frontier 900 EC	364	327.3	
5	Frontier 900 EC	727	654.5	
6	Frontier 900 EC	1018	916.4	
7	Frontier 900 EC	1455	1309	
8	Frontier-p 720 EC	125	90 (55% of Trt. 3)	
9	Frontier-p 720 EC	250	180 (55% of Trt. 4)	
10	Frontier-p 720 EC	500	360 (55% of Trt. 5)	
11	Frontier-p 720 EC	700	504 (55% of Trt. 6)	
12	Frontier-p 720 EC	1000	720 (55% of Trt. 7)	
13	Frontier-p 720 EC	2000	1440	
14	Dual Gold 960 EC	1000	960	
15	Dual Gold 960 EC	2000	1920	

Materials and Methods

Field Trial 2 (HVG04024#4) (Cont.)

Table 5 - Site Details, Field Trial 2 (HVG04024#4)

Grower	Rugby Farms (Paul Foley – contract grower)
Location	Nicholls Rd, Allora, Qld
Soil Details	Texture - Light clay (35-40% clay) pH (1:5 Water) – 6.9, pH (1:5 $CaCl_2$) – 6.2 Organic Carbon – 1.3% Cation Exchange Capacity – 50.4 Meq/100 g
Crop	Green beans
Variety	Symbah
Trial Design	Randomised complete block
Replications	4
Plot Size	10 m x 3 m (4 rows)
Plant Spacing	4 cm
Row Spacing	2 rows 60 cm apart + inter-row spacing 90 cm
Bed Centres	150 cm
Sowing Date	01/12/05
Harvest Date	06/02/06

Materials and Methods

Field Trial 3 (HVG04024#5)

Title

Comparison of Frontier 900 EC and Frontier-p 720 EC with Dual Gold 960 EC for the pre-emergent control of giant pigweed (*Trianthema portulacastrum*) in sweet corn cv. H5. Laidley, Qld, 2005-06.

Table 6 - Treatment List, Field Trial 3 (HVG04024#5)

No.	Product	Rate		Application Schedule
		Product (mL/ha)	Active Ingredient (g ai/ha)	
1	Untreated control	nil	nil	nil
2	Hand weeded control	nil	nil	
3	Frontier 900 EC	182	163.6	Single application immediately after sowing
4	Frontier 900 EC	364	327.3	
5	Frontier 900 EC	727	654.5	
6	Frontier 900 EC	1018	916.4	
7	Frontier 900 EC	1455	1309	
8	Frontier-p 720 EC	125	90 (55% of Trt. 3)	
9	Frontier-p 720 EC	250	180 (55% of Trt. 4)	
10	Frontier-p 720 EC	500	360 (55% of Trt. 5)	
11	Frontier-p 720 EC	700	504 (55% of Trt. 6)	
12	Frontier-p 720 EC	1000	720 (55% of Trt. 7)	
13	Frontier-p 720 EC	2000	1440	
14	Dual Gold 960 EC	1000	960	
15	Dual Gold 960 EC	2000	1920	

Materials and Methods

Field Trial 3 (HVG04024#5) (Cont.)

Table 7 - Site Details, Field Trial 3 (HVG04024#5)

Grower	Mulgowie Farming Company (David Jackwitz – contract grower)
Location	Gatton - Laidley Rd, Laidley. Qld
Soil Details	Texture - Light clay (35-40% clay) pH (1:5 Water) - 7.9, pH (1:5 $CaCl_2$) – 7.3 Organic Carbon – 1.5% Cation Exchange Capacity – 52.6 meq/100 g
Crop	Sweet corn
Variety	H5
Trial Design	Randomised complete block
Replications	4
Plot Size	12.0 m x 3.24 m
Plant Spacing	0.2 m
Row Spacing	0.81 m
Sowing Date	18/11/05
Harvest Date	08/02/06

Materials and Methods

Field Trial 4 (HVG04024#6)

Title

Comparison of Frontier 900 EC and Frontier-p 720 EC with Dual Gold 960 EC for the pre-emergent control of fat hen (*Chenopodium album*) and green amaranth (*Amaranthus viridis*) in green beans cv. Symbah. Lowood, Qld, 2006.

Table 8 - Treatment List, Field Trial 4 (HVG04024#6)

No.	Product	Rate		Application Schedule
		Product (mL/ha)	Active Ingredient (g ai/ha)	
1	Untreated control	nil	nil	nil
2	Hand weeded control	nil	nil	nil
3	Frontier 900 EC	182	163.6	Single application immediately after sowing
4	Frontier 900 EC	364	327.3	
5	Frontier 900 EC	727	654.5	
6	Frontier 900 EC	1018	916.4	
7	Frontier 900 EC	1455	1309	
8	Frontier-p 720 EC	125	90	
9	Frontier-p 720 EC	250	180	
10	Frontier-p 720 EC	500	360	
11	Frontier-p 720 EC	700	504	
12	Frontier-p 720 EC	1000	720	
13	Frontier-p 720 EC	2000	1440	
14	Dual Gold 960 EC	1000	960	
15	Dual Gold 960 EC	2000	1920	

Materials and Methods

Field Trial 4 (HVG04024#6) (Cont.)

Table 9 - Site Details, Field Trial 4 (HVG04024#6)

Grower	Pat Keller (Rugby Farms contract grower)
Location	O' Reilly's Weir Rd, Lowood, Qld
Soil Type	Texture - Medium clay (45-55% clay) pH (1:5 Water) – 6.7, pH (1:5 $CaCl_2$) – 6.0 Organic Carbon – 1.2% Cation Exchange Capacity – 32.2 meq/100 g
Crop	Green beans
Variety	Symbah
Trial Design	Randomised complete block
Replications	4
Plot Size	75 cm x 10 m
Plant Spacing	4 cm
Row Spacing	2 rows x 60 cm
Inter Row Spacing	90 cm
Bed centres	1.5 m
Sowing Date	14/03/06
Harvest Date	15/05/06

Results

Table 10 - Organisations communicated with by Project Team members.

Company	Communication	Location	Products of Interest
AgNova Technologies	Meeting	Australia	Baron
AgraQuest	Meeting	USA	Serenade, Sonata, Rhapsody
Amtrade	Meeting	Australia	
Anadiag	Meeting	France	
Arvesta	Meeting	Australia	
Bayer CropScience	Meeting	Australia	Various including Raft
Belchim	Meeting	Belgium	Cyazofamid – oomycete fungicide
Crompton	Meeting	Australia	
DAKRU	Phone / email	Sweden	Plant Defence Boosters
Dow AgroSciences	Meeting	Australia	Various
DuPont	Meeting	Australia	Various
Eden	Meeting	United Kingdom	Terpenes / Plant Defence
EE Muir and Sons	Meeting	Australia	
Elliott Technologies	Meeting	New Zealand	DuWett and Designer
Eureka! Ag Research	Meeting	Australia	
FMC	Meeting	Australia	Authority
Helena Chemicals	Meeting	USA	
Nufarm	Meeting	Australia	Various
Primaxa	Meeting	New Zealand	
Serve-Ag	Meeting	Australia	
Staphyt	Meeting	France	
Sumitomo Chemical Australia	Meeting	Australia	Various
Syngenta Crop Protection	Meeting	Australia	Various
Syntech Research	Meeting	USA	
Tomen	Meeting	Australia	
Wobelea	Meeting	Australia	

Additional Communications (Email / Phone) with –

AgAware Consulting Pty Ltd
AKC Consulting Pty Ltd
State Agriculture departments
Growers

Meetings and publications providing guidance to the project

- Reviewing chemical inputs for the Tasmanian vegetable industry (Facilitated by Stephen Welsh). A meeting was held in Devonport Tasmania on 18th July 2005
- Reviewing chemical inputs for the West Australian vegetable industry (Facilitated by David Ellement and Peter Dal Santo). Meetings were was held in Perth on 23rd and 24th July 2006
- Vegetable Chemical Access Meetings conducted in Sydney on July 5th 2005 and July 4th 2006 attended by representatives from HAL, Ausveg, APVMA and various consultants.
- Pest management strategies Audit report for Queensland's fruit and vegetable industries – Janine Clark, QFVG and HAL.
- Asian Conference on Plant Pathology - Singapore

Results

Table 11 - HAL Funded Vegetable Projects (taken from HAL website)

General Crop Protection Projects

Project No	Title	First Name	Last Name	Organisation
VG04024	Facilitating the introduction and registration of new crop protection products for intensive horticulture	Ian	Macleod	Serve-Ag Research Pty Ltd
VG05019	Residue risk analyses and management option development for export vegetable crops	Kevin	Bodnaruk	AKC Consulting Pty Ltd

Minor Use Projects

Project No	Title	First Name	Last Name	Organisation
AH04009	Coordination of minor use permits for horticulture	Peter	Dal Santo	AgAware Consulting Pty Ltd
AH04035	Minor Use coordination HAL management costs	Brad	Wells	Horticulture Australia Limited
VG04071	Generation of pesticide residue data in vegetables to support minor-use permits - Region 1	Martin	Collett	Agrisearch Services Pty Ltd
VG04072	Generation of pesticide residue data in vegetables to support minor-use permits - Region 2	Ian	Macleod	Serve-Ag Research Pty Ltd
VG04084	Preparing desktop minor use applications for vegetables	Peter	Dal Santo	AgAware Consulting Pty Ltd
VG05096	Generation of Pesticide Residue Data for Vegetable Minor-Use Permit Applications-Agronico	Dale	Griffin	Agronico Research Pty Ltd
VG05097	Generation of Pesticide Residue Data for Vegetable Minor-Use Permit Applications-Serve-Ag Research	Ian	Macleod	Serve-Ag Research Pty Ltd
VG05098	Generation of Pesticide Residue Data for Vegetable Minor-Use Permit Applications-Agrisearch	Martin	Collett	Agrisearch Services Pty Ltd
VG05099	Desktop Preparation of Pesticide Minor-Use Vegetable Permit Applications	Kevin	Bodnaruk	AKC Consulting Pty Ltd

Disease Projects

Project No	Title	First Name	Last Name	Organisation
VG03002	Managing bean root and stem diseases	Andrew	Watson	NSW Department of Primary Industries
VG03029	Development of guidelines for sustainable management of powdery mildew in capsicums	Chrys	Akem	QLD Department of Primary Industries and Fisheries
VG04012	Effective management of root diseases in hydroponic lettuce	Len	Tesoriero	NSW Department of Primary Industries
VG04013	Management strategies for white blister (rust) in Brassica vegetables	Elizabeth	Minchinton	VIC Department of Primary Industries
VG04021	Evaluation of new seed dressing technologies for improved disease and insect control in vegetable crops	Hoong	Pung	Serve-Ag Research Pty Ltd
VG04026	Effect of herbicides and wetter on foliar diseases of vegetables	Dean	Metcalf	Biocontrol Australia Pty Ltd
VG05005	Scoping study to determine the soil borne diseases affecting Brassica crops	Trevor	Wicks	SA Research & Development Institute
VG05029	Fusarium wilt of snow peas	Andrew	Watson	NSW Department of Primary Industries
VG05034	Managing mildews: prevention using systemic acquired resistance (SAR) in greenhouse and field grown cucurbits	Jenny	Jobling	Applied Horticultural Research Pty Ltd
VG05054	Management of powdery mildew in field and greenhouse cucurbits	Chrys	Akem	QLD Department of Primary Industries & Fisheries
VG05084	Integrated management of greenhouse vegetable diseases: Development of microbial biocontrols, biorational chemical and cultural strategies.	Len	Tesoriero	NSW Department of Primary Industries
VG05090	New fungicides and strategies for sustainable management of Sclerotinia and Rhizoctonia diseases on vegetable crops in Australia	Hoong	Pung	Serve-Ag Research Pty Ltd
VG05094	Sustainable integrated control of foliar diseases in Greenhouse Vegetables	Barbara	Hall	SA Research & Development Institute
VG06009	Management of vegetable diseases with Silicon	Frank	Hay	Tasmanian Institute of Agricultural Research

Weed Projects

Project No	Title	First Name	Last Name	Organisation
VG02013	Evaluation of techniques to minimise weeds in conventional and organic vegetable production	A	Campbell	NSW Department of Primary Industries

Results

Table 11 (Cont.) - HAL Funded Vegetable Projects (taken from HAL website)

Insect and IPM projects

Project No	Title	First Name	Last Name	Organisation
VG06092	IPM Gap Analysis for Vegetable Pathology	Ian	Porter	VIC Department of Primary Industries
HG02023	Development of viral insecticides for use in horticultural crops	Anthony	Hawes	Australian Produced Biologicals Pty Ltd
HG03003	Evaluation of insecticides for western flower thrips resistance	Grant	Herron	NSW Department of Primary Industries
VG02037	Integrated management strategies for aphids control in vegetables	Siva	Subramaniam	QLD Department of Primary Industries and Fisheries
VG02038	Development of a new biopesticide against sucking pests for vegetables	Bronwyn	Walsh	QLD Department of Primary Industries and Fisheries
VG04004	National diamondback moth project: integrating biological, chemical and area-wide management of brassica pests	Greg	Baker	SA Research & Development Institute
VG04068	Generation of efficacy and residue data for imidacloprid (Confidor) in lettuce to control lettuce aphid	Phillip	Frost	Serve-Ag Research Pty Ltd
VG05008	Development of cultural control methods for pests of leafy vegetables	Paul	Horne	IPM Technologies Pty Ltd
VG05037	Improving the management of sweet potato soil insect pests	Eric	Coleman	QLD Department of Primary Industries & Fisheries
VG05044	Further developing integrated pest management for lettuce	Sandra	McDougall	NSW Department of Primary Industries
VG05050	Development and Promotion of IPM Strategies for Silverleaf whitefly in Vegetables	Siva	Subramaniam	QLD Department of Primary Industries & Fisheries
VG05052	Refining integrated pest management of eggfruit caterpillar	Iain	Kay	QLD Department of Primary Industries & Fisheries
VG05086	Development of Hippodamia and Micromus biocontrol agents for use in Brassica and other vegetable crops	Stephen	Goodwin	NSW Department of Primary Industries
VG06010	The sustainable use of pesticides (especially spinosad) against WFT in vegetables	Grant	Herron	NSW Department of Primary Industries
VG06087	Pesticide Effects on Beneficial Insects and Mites in Vegetables	Paul	Horne	IPM Technologies Pty Ltd
VG02030	Integrated pest management in the green bean industry	John	Duff	QLD Department of Primary Industries and Fisheries
VG03109	Extension to Greenhouse IPM Program	Stephen	Goodwin	NSW Department of Primary Industries
VG04032	Integrated management strategies for pests and diseases of Asian vegetables	Len	Tesoriero	NSW Department of Primary Industries
VG05007	Demonstrating integrated pest management of IPM in brassica crops	Paul	Horne	IPM Technologies Pty Ltd
VG05035	Improved IPM Systems in the Australian Sweet Corn Industry	Peter	Deuter	QLD Department of Primary Industries & Fisheries
VG05043	Benchmarking vegetable integrated pest management systems against other agricultural industries	Sandra	McDougall	NSW Department of Primary Industries
VG05056	Facilitating National IPM Stocktake and Sustainable IPM Servicing of Industry Needs at Virginia	Tony	Burfield	SA Research & Development Institute
VG05093	IPM for greenhouse vegetables - research to industry	Stephen	Goodwin	NSW Department of Primary Industries
VG06037	Increasing adoption of IPM by WA vegetable growers and development of an ongoing technical support service	Sonya	Broughton	Department of Agriculture Western Australia
VG06086	Scoping Study on IPM Potential and Requirements	Jessica	Page	IPM Technologies Pty Ltd

Results

Field Trial 1 (HVG04024#1)

Table 12 - Crop biomass at 8DAA (09/12/05) and 22DAA (23/12/05)

No.	Treatment	Product Rate (mL/ha)	Crop biomass (mean est. % of hand weeded control)	
			8DAA/10DAS	22DAA/24DAS
1	Untreated control	nil	-	-
2	Hand weeded control	nil	100 a	100 a
3	Frontier-P 720 EC	250	100 a	100 a
4	Frontier-P 720 EC	500	100 a	100 a
5	Frontier-P 720EC	700	99 a	99 a
6	Frontier-P 720 EC	1000	99 a	100 a
7	Frontier-P 720 EC	2000	79 b	85 b
8	Stomp 330 EC	2900	100 a	100 a
9	Sencor 480 SC	580	100 a	100 a
p-value			0.00	0.00
LSD (5% level)			2.80	2.70

DAA = Days after application
DAS = Days after sowing
Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Table 13 - Crop emergence at 11DAA/13DAS (12/12/05)

No.	Treatment	Product Rate (mL/ha)	Crop emergence (Mean no. plants/m of row)
1	Untreated control	nil	25.5
2	Hand weeded control	nil	28.0
3	Frontier-P 720 EC	250	24.8
4	Frontier-P 720 EC	500	25.0
5	Frontier-P 720EC	700	24.9
6	Frontier-P 720 EC	1000	24.2
7	Frontier-P 720 EC	2000	24.1
8	Stomp 330 EC	2900	25.6
9	Sencor 480 SC	580	22.3
p-value			0.9466
LSD (5% level)			N/A

DAA = Days after application
DAS = Days after sowing
Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Results

Field Trial 1 (HVG04024#1)

Table 14 - Efficacy on fat hen (CHEAL) and blackberry nightshade (SOLNI) at 22DAA (23/12/05)

No.	Treatment	Product Rate (mL/ha)	CHEAL (mean no./0.15 m^2)	SOLNI (mean no./0.15 m^2)
1	Untreated control	nil	3.6 a	4.4 ab
2	Hand weeded control	nil	-	-
3	Frontier-P 720 EC	250	2.8 ab	7.1 a
4	Frontier-P 720 EC	500	2.0 abc	0.3 c
5	Frontier-P 720EC	700	0.8 cd	1.1 bc
6	Frontier-P 720 EC	1000	1.5 bcd	0.3 c
7	Frontier-P 720 EC	2000	0.1 d	0.0 c
8	Stomp 330 EC	2900	0.3 d	0.9 c
9	Sencor 480 SC	580	0.0 d	7.5 a
p-value			0.0025	0.00
LSD (5% level)			N/A*	N/A**

DAA = Days after application
* Transformed using y =sqrt (x+0.5) to reflect a normal distribution.
**Transformed using y = log (x+1) to reflect a normal distribution.

Table 15 - Yield data - weight of plants (foliage + pods) and peas at harvest, 83DAA (22/02/06)

No.	Treatment	Product Rate (mL/ha)	Mean whole plant weight (g/3.2 m^2)	Mean pea seed weight (g/3.2 m^2)
1	Untreated control	nil	7653	2125
2	Hand weeded control	nil	6713	1952
3	Frontier-P 720 EC	250	7107	1974
4	Frontier-P 720 EC	500	8067	2205
5	Frontier-P 720EC	700	7760	2140
6	Frontier-P 720 EC	1000	7693	2203
7	Frontier-P 720 EC	2000	8010	2523
8	Stomp 330 EC	2900	7700	2186
9	Sencor 480 SC	580	7675	2316
p-value			0.7036	0.2700
LSD (5% level)			N/A	N/A*

*Transformed using y = log(x+1) to reflect a normal distribution, DAA = Days after application.
Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Results

Field Trial 1 (HVG04024#1)

Table 16 - Yield data - maturity indexes and 100 pea weights at harvest, 83DAA (22/02/06)

No.	Treatment	Product Rate (mL/ha)	Mean pea maturity index (MI)	Mean 100 pea weight (g/100 seeds)
1	Untreated control	nil	424	45.4
2	Hand weeded control	nil	431	45.2
3	Frontier-P 720 EC	250	401	44.9
4	Frontier-P 720 EC	500	419	44.3
5	Frontier-P 720EC	700	408	43.7
6	Frontier-P 720 EC	1000	405	43.4
7	Frontier-P 720 EC	2000	428	45.6
8	Stomp 330 EC	2900	363	44.5
9	Sencor 480 SC	580	424	44.6
p-value			0.3664	0.9472
LSD (5% level)			N/A	N/A

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Results

Field Trial 2 (HVG04024#4)

Table 17 – Effect of herbicide treatment on bean plant emergence 15 days after application (15DAA)

No.	Treatment	Rate (g ai/ha)	Bean Plant Emergence (Mean no./m row)
1	Untreated control	nil	16.1
2	Hand weeded control	nil	16.3
3	Frontier 900 EC	163.6	15.9
4	Frontier 900 EC	327.3	16.5
5	Frontier 900 EC	654.5	16.0
6	Frontier 900 EC	916.4	16.0
7	Frontier 900 EC	1309	16.1
8	Frontier-P 720 EC	90	16.9
9	Frontier-P 720 EC	180	16.3
10	Frontier-P 720 EC	360	16.1
11	Frontier-P 720 EC	504	18.0
12	Frontier-P 720 EC	720	16.0
13	Frontier-P 720 EC	1440	15.8
14	Dual Gold 960 EC	960	17.1
15	Dual Gold 960 EC	1920	17.6
p value			0.9158
LSD (5% level)			n/a

n/a = not applicable since *p* value >5%.

Results

Field Trial 2 (HVG04024#4)

Table 18 – Effect of herbicide treatment on bean crop vigour 40 days after application (40DAA)

No.	Treatment	Rate (g ai/ha)	Bean Plant Vigour (Mean % vigour)
1	Untreated control	nil	100.00 d
2	Hand weeded control	nil	100.00 d
3	Frontier 900 EC	163.6	100.00 d
4	Frontier 900 EC	327.3	98.75 cd
5	Frontier 900 EC	654.5	96.25 c
6	Frontier 900 EC	916.4	92.50 b
7	Frontier 900 EC	1309	91.25 b
8	Frontier-P 720 EC	90	98.75 cd
9	Frontier-P 720 EC	180	100.00 d
10	Frontier-P 720 EC	360	98.75 cd
11	Frontier-P 720 EC	504	97.50 cd
12	Frontier-P 720 EC	720	90.00 b
13	Frontier-P 720 EC	1440	77.50 a
14	Dual Gold 960 EC	960	96.25 c
15	Dual Gold 960 EC	1920	90.00 b
p value			0.000
LSD (5% level)			3.499

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Results

Field Trial 2 (HVG04024#4)

Table 19 – Effect of herbicide treatment on bean yield, plant density, pod number and pod weight 67DAA

No.	Treatment	Rate (g ai/ha)	Mean plant fresh weight (incl. pods) (kg/2 m row)	Mean plant number (no./2 m row)	Mean pod weight (g/pod)	Bean pod number (no./plant)
2	Hand weeded control	nil	10.02	28.75	9.97	13.51
10	Frontier-P 720 EC	360	9.70	31.25	9.27	13.64
11	Frontier-P 720 EC	504	8.64	30.00	8.50	13.09
12	Frontier-P 720 EC	720	9.51	30.00	9.02	13.10
13	Frontier-P 720 EC	1440	9.12	24.75	9.56	14.77
15	Dual Gold 960 EC	1920	9.69	28.75	9.38	14.26
p value			0.6718	0.1576	0.6921	0.8584
LSD (5% level)			n/a	n/a	n/a	n/a

n/a = not applicable since *p* value >5%.

Results

Field Trial 3 (HVG04024#5)

Table 20 – Effect of herbicide treatment on giant pigweed (*Trianthema portulacastrum*) control in sweet corn

No.	Treatment	Rate (g ai/ha)	Mean % control	
			14DAA	28DAA
1	Untreated control (= actual number)	nil	0.0 a (*34.28 m^2*)	0.0 a (*36.78 m^2*)
2	Hand weeded control	nil	100.0 d	100.0 e
3	Frontier 900 EC	163.6	73.8 bc	67.1 bc
4	Frontier 900 EC	327.3	90.8 cd	88.6 de
5	Frontier 900 EC	654.5	92.4 cd	88.0 de
6	Frontier 900 EC	916.4	98.3 d	94.1 e
7	Frontier 900 EC	1309	100.0 d	99.2 e
8	Frontier-P 720 EC	90	65.5 b	59.9 b
9	Frontier-P 720 EC	180	81.1 bcd	70.2 bcd
10	Frontier-P 720 EC	360	92.4 cd	86.6 cde
11	Frontier-P 720 EC	504	98.3 d	95.3 e
12	Frontier-P 720 EC	720	99.7 d	98.0 e
13	Frontier-P 720 EC	1440	100.0 d	99.7 e
14	Dual Gold 960 EC	960	100.0 d	96.7 e
15	Dual Gold 960 EC	1920	100.0 d	99.4 e
p value			0.000	0.000
LSD (5% level)			20.2	20.1

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.
DAA = Days after application

Results

Field Trial 3 (HVG04024#5)

Table 21 – Effect of herbicide treatment on sweet corn emergence 18DAA

No.	Treatment	Rate (g ai/ha)	Mean plant emergence (no. per m of row)
1	Untreated control	nil	5.19 f
2	Hand weeded control	nil	4.69 bcdef
3	Frontier 900 EC	163.6	4.75 bcdef
4	Frontier 900 EC	327.3	4.75 bcdef
5	Frontier 900 EC	654.5	4.88 cdef
6	Frontier 900 EC	916.4	4.69 bcdef
7	Frontier 900 EC	1309	4.81 cdef
8	Frontier-P 720 EC	90	4.38 abcd
9	Frontier-P 720 EC	180	5.00 def
10	Frontier-P 720 EC	360	4.31 abc
11	Frontier-P 720 EC	504	5.06 ef
12	Frontier-P 720 EC	720	4.13 ab
13	Frontier-P 720 EC	1440	4.44 abcde
14	Dual Gold 960 EC	960	3.88 a
15	Dual Gold 960 EC	1920	4.81 cdef
p value			0.0085
LSD (5% level)			2.551

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.
DAA = Days after application

Results

Field Trial 3 (HVG04024#5)

Table 22 – Effect of herbicide treatment on sweet corn plant vigour 28DAA

No.	Treatment	Rate (g ai/ha)	Mean % plant vigour*
1	Untreated control	nil	91.3
2	Hand weeded control	nil	100.0
3	Frontier 900 EC	163.6	97.5
4	Frontier 900 EC	327.3	95.0
5	Frontier 900 EC	654.5	97.5
6	Frontier 900 EC	916.4	95.0
7	Frontier 900 EC	1309	93.8
8	Frontier-P 720 EC	90	95.0
9	Frontier-P 720 EC	180	91.3
10	Frontier-P 720 EC	360	90.0
11	Frontier-P 720 EC	504	98.8
12	Frontier-P 720 EC	720	95.0
13	Frontier-P 720 EC	1440	96.3
14	Dual Gold 960 EC	960	92.5
15	Dual Gold 960 EC	1920	95.0
p value			0.1306
LSD (5% level)			n/a

DAA = Days after application
*Assessed as plant vigour compared to the hand weeded control in each block of treatments
n/a = not applicable since p value is 13.1%

Results

Field Trial 3 (HVG04024#5)

Table 23 – Effect of herbicide treatment on sweet corn yield, plant density and cob number 82DAA

No.	Treatment	Rate (g ai/ha)	Mean cob yield (kg/8 m row)	Mean cob weight (kg/cob)	Mean plant density (no./8 m)	Mean cob number (no./plant)
1	Untreated control	nil	5.00 a	0.240 a	32.75	0.63 a
2	Hand weeded control	nil	8.98 b	0.313 b	32.00	0.88 b
10	Frontier-P 720 EC	360	7.10 ab	0.278 ab	29.25	0.88 b
11	Frontier-P 720 EC	504	8.25 b	0.301 b	31.50	0.88 b
12	Frontier-P 720 EC	720	8.29 b	0.302 b	28.50	0.96 b
13	Frontier-P 720 EC	1440	8.90 b	0.283 b	31.00	1.01 b
15	Dual Gold 960 EC	1920	8.29 b	0.279 b	31.00	0.97 b
p value			0.0116	0.0202	0.6061	0.0069
LSD (5% level)			2.081	0.0513	n/a	0.184

DAA = Days after application
Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.
n/a = not applicable since p value is 13.1%

Results

Field Trial 4 (HVG04024#6)

Table 24 - Effect of herbicide treatment on green bean plant emergence 15 days after application (15DAA) and 28DAA

No.	Treatment	Rate (g ai/ha)	Plant Emergence (mean no. emerged plants/m)	
			15DAA	28DAA
1	Untreated control	nil	17.0	17.3
2	Untreated control	nil	16.9	18.4
3	Frontier 900 EC	163.6	17.1	17.9
4	Frontier 900 EC	327.3	16.6	17.8
5	Frontier 900 EC	654.5	16.4	18.4
6	Frontier 900 EC	916.4	16.6	18.1
7	Frontier 900 EC	1309	16.6	18.8
8	Frontier-P 720 EC	90	17.7	17.4
9	Frontier-P 720 EC	180	17.9	18.4
10	Frontier-P 720 EC	360	17.3	18.1
11	Frontier-P 720 EC	504	15.6	16.8
12	Frontier-P 720 EC	720	16.1	19.1
13	Frontier-P 720 EC	1440	15.2	17.8
14	Dual Gold 960 EC	960	17.9	17.8
15	Dual Gold 960 EC	1920	17.1	18.9
p value			0.155	0.597
LSD (5% level)			n/a	n/a

Results

Field Trial 4 (HVG04024#6)

Table 25 - Effect of herbicide treatment on green bean crop vigour 28DAA

No.	Treatment	Rate (g ai/ha)	Plant Vigour (mean % vigour)
1	Untreated control	nil	100
2	Untreated control	nil	100
3	Frontier 900 EC	163.6	100
4	Frontier 900 EC	327.3	100
5	Frontier 900 EC	654.5	98.8
6	Frontier 900 EC	916.4	96.3
7	Frontier 900 EC	1309	98.8
8	Frontier-P 720 EC	90	100
9	Frontier-P 720 EC	180	100
10	Frontier-P 720 EC	360	98.8
11	Frontier-P 720 EC	504	96.3
12	Frontier-P 720 EC	720	98.8
13	Frontier-P 720 EC	1440	96.7
14	Dual Gold 960 EC	960	100
15	Dual Gold 960 EC	1920	100
p value			0.294
LSD (5% level)			n/a

Results

Field Trial 4 (HVG04024#6)

Table 26 - Effect of herbicide treatment on fat hen (*Chenopodium album*) control in green beans 28DAA

No.	Treatment	Rate (g ai/ha)	Fat hen Control (mean % control)
1	Untreated control (actual number)	nil	*3.39 m^2* a
2	Untreated control (actual number)	nil	*3.70 m^2* a
3	Frontier 900 EC	163.6	56.3 cd
4	Frontier 900 EC	327.3	41.9 bc
5	Frontier 900 EC	654.5	73.1 cde
6	Frontier 900 EC	916.4	99.4 e
7	Frontier 900 EC	1309	99.4 e
8	Frontier-P 720 EC	90	9.0 ab
9	Frontier-P 720 EC	180	69.0 cde
10	Frontier-P 720 EC	360	99.4 e
11	Frontier-P 720 EC	504	80.0 cde
12	Frontier-P 720 EC	720	84.1 de
13	Frontier-P 720 EC	1440	100.0 e
14	Dual Gold 960 EC	960	72.5 cde
15	Dual Gold 960 EC	1920	92.6 de
p value			0.0000
LSD (5% level)			38.9

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Results

Field Trial 4 (HVG04024#6)

Table 27 - Effect of herbicide treatment on green amaranth (*Amaranthus viridis*) control in green beans 28DAA

No.	Treatment	Rate (g ai/ha)	Green Amaranth Control (mean % control)
1	Untreated control	nil	*2.71 m^2* a
2	Untreated control	nil	*2.71 m^2* a
3	Frontier 900 EC	163.6	82.5 cde
4	Frontier 900 EC	327.3	80.0 bcde
5	Frontier 900 EC	654.5	58.3 bc
6	Frontier 900 EC	916.4	100.0 e
7	Frontier 900 EC	1309	100.0 e
8	Frontier-P 720 EC	90	42.9 b
9	Frontier-P 720 EC	180	62.5 bcd
10	Frontier-P 720 EC	360	99.3 de
11	Frontier-P 720 EC	504	75.0 bcde
12	Frontier-P 720 EC	720	90.0 cde
13	Frontier-P 720 EC	1440	100.0 e
14	Dual Gold 960 EC	960	75.8 bcde
15	Dual Gold 960 EC	1920	89.3 cde
p value			0.0001
LSD (5% level)			37.5

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.

Discussion

Field Trial 1 (HVG04024#1)

Title

Comparison of Frontier-p 720 EC with Stomp 330 EC and Sencor 480 SC for the control of fat hen (*Chenopodium album*) and blackberry nightshade (*Solanum nigrum*) in green peas cv. Resal. Forth, Tasmania, 2005-06.

Summary

A trial was conducted at Forth in North-West Tasmania, on a ferrosol soil, to compare rates of Frontier-p 720 EC for crop safety and efficacy on fat hen (*Chenopodium album*) and blackberry nightshade (*Solanum nigrum)*. Frontier-p was applied post sowing pre-crop emergence at 250, 500, 700, 1000 and 2000 mL/ha to the soil surface. These treatments were compared to Stomp 330 EC at 2900 mL/ha and Sencor 480 SC at 580 mL/ha applied in the same manner. The crop was sown 2 days prior to the application of the treatments and emerged approximately 5 days after the herbicide application. The trial was irrigated with 15 mm within 24 hours of treatment application and received irrigation throughout the trial period when required.

The trial was assessed at 8, 11 and 22 days after application (DAA) for crop safety that included crop biomass and crop emergence. A weed efficacy assessment was conducted at 22DAA. Yield assessments on weight of plants (foliage and pods), pea weight after vining, seed maturity index and 100 pea weights were conduced at commercial harvest, 83DAA.

The most superior treatments for crop safety, and efficacy on fat hen and blackberry nightshade, were Frontier-p at 700 and 1000 mL/ha. These two rates had not affected crop vigour at either 8 or 22DAA.

Frontier-p at 2000 mL/ha caused a significant reduction in crop vigour at 8 and 22DAA, although these adverse affects were not evident in plants weights, seed yield, weight of seed or maturity index of seed at harvest.

Sencor 480 SC at 580 mL/ha controlled all fat hen but was not significantly different to Stomp 330 EC at 2900 and Frontier-p at rates of at least 700 mL/ha. Sencor at 580 mL/ha was ineffective in controlling blackberry nightshade.

Stomp was not significantly different to Frontier-p at rates of 500 mL/ha and greater for controlling blackberry nightshade and fat hen.

No treatment significantly affected plant (foliage and pods) weight, pea yield, 100-pea weight or the maturity index at harvest (83DAA).

No treatment significantly affected crop emergence.

Discussion

Field Trial 2 (HVG04024#4)

Title

Comparison of Frontier 900 EC and Frontier-p 720 EC with Dual Gold 960 EC for crop safety as pre-emergent herbicides in green beans cv. Symbah. Allora, Qld, 2005

Summary

At Allora on the Darling Downs, Queensland, in 2005, pre-emergent applications of Frontier-p 720 EC at 90, 180, 360, 504, 720 and 1440 g ai/ha and Frontier 900 EC at 163.6, 327.3, 654.5, 916.4 and 1309 g ai/ha were compared with Dual Gold 960 EC at 960 and 1920 g ai/ha, an untreated control and a hand weeded control for control of weeds and crop safety in green beans cv. Symbah. All chemical treatments were applied to weed free soil immediately after sowing with flat fan nozzles operated at 170 kPa resulting in a spray volume of 208 L/ha. The trial site was irrigated with overhead sprinklers within 2 days of spraying. The soil type was light clay (clay content 35 - 40%) with a cation exchange capacity of 50.4 meq/100 g, organic carbon content of 1.3% and pH (1:5 water) of 6.9, and was typical of the soils used for growing horticultural crops on the Darling Downs.

Plant emergence was assessed 15 days after application (15DAA) by counting the number of emerged plants in a 4 m x 0.6 m section of each plot. Crop vigour was assessed at 40DAA by visually comparing the vigour of each plot to the hand weeded control in each block. At 67DAA, plant yield was determined by assessing plant number, plant fresh weight, bean pod weight and pod number from 2 x 1.0 m sections in both rows of each plot.

The intended aim of determining pre-emergent weed control of dwarf amaranthus (Amaranthus mitchellii) and bladder ketmia (Hibiscus trionum) in green beans was not possible due to low weed emergence at the trial site.

At 15DAA there was no significant treatment effect on bean plant emergence for all rates of Frontier 900 EC, Frontier-p 720 EC and Dual Gold 960 EC.

At 40DAA, there was no significant reduction in bean plant vigour by Frontier 900 EC at 163.6 and 327.3 g ai/ha compared to the hand weeded control. Frontier 900 EC at 916.4 and 1309 g ai/ha significantly reduced bean plant vigour compared to the hand weeded control at 40DAA. Dual Gold 960 EC at 960 and 1920 g ai/ha significantly reduced plant vigour compared to the hand weeded control. There was no reduction of plant vigour in the untreated control plots due to the absence of weed competition. Frontier 900 EC at 916.4 g ai/ha and 1309 g ai/ha significantly reduced plant vigour compared to Dual Gold 960 EC at 960 g ai/ha. Dual Gold 960 EC at 1920 g ai/ha significantly reduced plant vigour compared to Frontier 900 EC at 163.6, 327.3 and 654.5 g ai/ha.

At 40DAA, there was no significant reduction in bean plant vigour by Frontier-p 720 EC at 90, 180, 360 and 504 g ai/ha compared to the hand weeded control. Frontier-p 720 EC at 720 and 1440 g ai/ha significantly reduced bean plant vigour compared to the hand weeded control at 40DAA. Frontier-p 720 EC at 720 and 1440 g ai/ha significantly reduced plant vigour compared to Dual Gold 960 EC at 960 g ai/ha. Dual Gold 960 EC at 1920 g ai/ha significantly reduced plant vigour compared to Frontier-p 720 EC at 90, 180, 360 and 504 g ai/ha. Frontier-p 720 EC at 1440 g ai/ha significantly reduced plant vigour compared to Dual Gold 960 EC at 960 and 1920 g ai/ha and all other rates of Frontier-p 720 EC.

At 40DAA, Frontier 900 EC at 654.5 g ai/ha, Frontier-p 720 EC at 360 g ai/ha and Dual Gold 960 EC at 960 g ai/ha gave equivalent reduction in bean plant vigour. Frontier 900 EC at 916.4 and 1309 g ai/ha, Frontier-p 720 EC at 720 g ai/ha and Dual Gold 960 EC at 1920 g ai/ha gave equivalent reduction in bean plant vigour. Frontier-p 720 EC at 1440 g ai/ha gave the greatest reduction in bean plant vigour for all chemical treatments.

At 67DAA, which was the day of commercial harvest, Frontier-p 720 EC at 360, 504, 720 and 1440 g ai/ha did not significantly reduce plant fresh weight, plant number, pod weight and pod number in green beans compared to Dual Gold 960 EC at 1920 g ai/ha and the hand weeded control. These treatments were the only treatments that were assessed at this time.

There were no visual symptoms of leaf or pod damage to green bean plants due to any chemical treatment during the trial.

Discussion

Field Trial 3 (HVG04024#5)

Title

Comparison of Frontier 900 EC and Frontier-p 720 EC with Dual Gold 960 EC for the pre-emergent control of giant pigweed (*Trianthema portulacastrum*) in sweet corn cv. H5. Laidley, Qld, 2005-06.

Summary

At Laidley in the Lockyer Valley, Queensland, in 2005-06, Frontier-p 720 EC was compared with Frontier 900 EC and Dual Gold 960 EC for pre-emergent control of weeds in sweet corn cv. H5. Treatments applied were Frontier 900 EC at 163.6, 327.3, 654.5, 916.4 and 1309 g ai/ha, Frontier-p 720 EC at 90, 180, 360, 504, 720 and 1440 g ai/ha, Dual Gold 960 EC at 960 and 1920 g ai/ha and an untreated control and hand weeded control. All chemical treatments were applied to weed free soil immediately after sowing with flat fan nozzles operated at 190 kPa resulting in a spray volume of 240 L/ha. The trial site was irrigated with overhead sprinklers within 3 days of sowing and spraying. The soil type was light clay (clay content 35 - 40%) with a cation exchange capacity of 52.6 meq/100 g, organic carbon content of 1.5% and pH (1:5 water) of 7.9, and was typical of the soils used for growing horticultural crops in the Lockyer Valley.

Weed efficacy assessment for giant pigweed (*Trianthema portulacastrum*) was performed by counting the number of weeds present in each plot 14 days after application (14DAA) and 28DAA. Plant emergence was assessed at 18DAA by counting the number of emerged plants in a 4 m section of each plot. Crop vigour was assessed at 28DAA by comparing the vigour of each plot to the hand weeded control in each block. Plant yield was assessed by counting and weighing the mature cobs and the number of plants from an 8 m section in each plot.

Frontier 900 EC at 163.6, 327.3, 654.5, 916.4 and 1309 g ai/ha controlled giant pigweed in sweet corn 14DAA and 28DAA. At 14DAA, Frontier 900 EC at 163.6 g ai/ha gave significantly less control of giant pigweed than Frontier 900 EC at 916.4 g ai/ha and 1309 g ai/ha. At 14DAA, Frontier 900 EC at 163.6 g ai/ha gave significantly less control of giant pigweed than Dual Gold 960 EC at 960 and 1920 g ai/ha. At 14DAA, Frontier 900 EC at 327.3, 654.5, 916.4 and 1309 g ai/ha and Dual Gold 960 EC at 960 and 1920 g ai/ha gave equivalent control of giant pigweed in sweet corn. At 28DAA, Frontier 900 EC at 163.6 g ai/ha gave significantly less control of giant pigweed than Frontier 900 EC at 327.3, 654.5, 916.4 and 1309 g ai/ha. At 28DAA, Frontier 900 EC at 163.6 g ai/ha gave significantly less control of giant pigweed than Dual Gold 960 EC at 960 and 1920 g ai/ha. At 28DAA, Frontier 900 EC at 327.3, 654.5, 916.4 and 1309 g ai/ha and Dual Gold 960 EC at 960 and 1920 g ai/ha gave equivalent control of giant pigweed.

Frontier-p 720 EC at 90, 180, 360, 504, 720 and 1440 g ai/ha controlled giant pigweed in sweet corn 14DAA and 28DAA. At 14DAA, Frontier-p 720 EC at 90 g ai/ha gave significantly less control of giant pigweed than Frontier-p at 360, 504, 720 and 1440 g ai/ha. At 14DAA, Frontier-p 720 EC at 90 g ai/ha gave significantly less control of giant pigweed than Dual Gold 960 EC at 960 and 1920 g ai/ha. At 14DAA, Frontier-p 720 EC at 180, 360, 504, 720 and 1440 g ai/ha and Dual Gold 960 EC at 960 and 1920 g ai/ha gave equivalent control of giant pigweed in sweet corn. At 28DAA, Frontier-p 720 EC at 90 and 180 g ai/ha gave significantly less control of giant pigweed than Frontier-p 720 EC at 504, 720, and 1440 g ai/ha. At 28DAA, Frontier-p 720 EC at 90 and 180 g ai/ha gave significantly less control of giant pigweed than Dual Gold 960 EC at 960 and 1920 g ai/ha. At 28DAA, Frontier-p 720 EC at 504, 720 and 1440 g ai/ha and Dual Gold 960 EC at 960 and 1920 g ai/ha gave equivalent control of giant pigweed in sweet corn.

Frontier-p 720 EC at 360, 504, 720 and 1440 g ai/ha gave no significant reduction in sweet corn cob yield, mean cob weight, final plant density or cob number per plant compared to Dual Gold 960 EC at 1920 g ai/ha or the hand weeded control. The untreated control however had reduced yield, cob weight and cob number per plant due to weed competition.

There was no significant reduction in plant vigour of sweet corn for any chemical treatment compared to the hand weeded control. There were no visual symptoms of plant phytotoxicity to sweet corn during the trial.

Discussion

Field Trial 4 (HVG04024#6)

Title

Comparison of Frontier 900 EC and Frontier-p 720 EC with Dual Gold 960 EC for the pre-emergent control of fat hen (*Chenopodium album*) and green amaranth (*Amaranthus viridis*) in green beans cv. Symbah. Lowood, Qld, 2006.

Summary

At Lowood, Queensland, in 2006, pre-emergent applications of Frontier-p 720 EC at 90, 180, 360, 504, 720 and 1440 g ai/ha and Frontier 900 EC at 163.6, 327.3, 654.5, 916.4 and 1309 g ai/ha were compared with Dual Gold 960 EC at 960 and 1920 g ai/ha and two untreated controls for the control of weeds and crop safety in green beans cv. Symbah. All chemical treatments were applied to weed free soil immediately after sowing with flat fan nozzles operated at 170 kPa resulting in a spray volume of 260 L/ha. The trial site was irrigated with overhead sprinklers immediately after spraying. The soil type was medium clay (clay content 45 - 55%) with a cation exchange capacity of 32.2 meq/100 g, organic carbon content of 1.2% and pH (1:5 water) of 6.7, and was typical of the soils used for growing horticultural crops in the Lockyer Valley.

Plant emergence was assessed 15 days after application (15DAA) and 28DAA by counting the number of emerged plants in 4 m of row within each plot. Crop vigour was assessed at 28DAA by visually comparing the vigour of each plot to the untreated control in each block. Weed efficacy assessment for fat hen (*Chenopodium album*) and green amaranth (*Amaranthus viridis*) was assessed by counting weeds in an 8 m x 0.6 m section of each plot at 28DAA.

At 28DAA, Frontier 900 EC at 163.6, 327.3, 654.5, 916.4 and 1309 g ai/ha controlled fat hen and green amaranth in beans. Frontier 900 EC at 163.6 and 327.3 g ai/ha gave significantly less control of fat hen than Frontier 900 EC at 916.4 and 1309 g ai/ha. Frontier 900 EC at 654.5 g ai/ha gave significantly less control of green amaranth than Frontier 900 EC at 163.6, 327.3, 916.4 and 1309 g ai/ha.

At 28DAA, Frontier-p 720 EC at 180, 360, 504, 720 and 1440 g ai/ha controlled fat hen in beans. Frontier-p 720 EC at 90 g ai/ha gave significantly less control of fat hen than Frontier-p 720 EC at 180, 360, 504, 720 and 1440 g ai/ha. Frontier-p 720 EC at 90, 180, 360, 504, 720 and 1440 g ai/ha controlled green amaranth in beans. Frontier-p 720 EC at 90 g ai/ha gave significantly less control of green amaranth than Frontier-p 720 EC at 360, 720 and 1440 g ai/ha. Frontier-p 720 EC at 180 g ai/ha gave significantly less control of green amaranth than Frontier-p 720 EC at 1440 g ai/ha.

At 28DAA, the 163.6, 654.5, 916.4 and 1309 g ai/ha rates of Frontier 900 EC and the 960 and 1920 g ai/ha rates of Dual Gold 960 EC gave equivalent control of fat hen in green beans. Frontier-p 720 EC at 180, 360, 504, 720 and 1440 g ai/ha and Dual Gold 960 EC at 960 and 1920 g ai/ha gave equivalent control of fat hen in green beans.

At 28DAA, Frontier at 327.3 g ai/ha compared with Frontier-p at 180 g ai/ha, Frontier at 654.5 g ai/ha compared with Frontier-p at 360 g ai/ha, Frontier at 916.4 g ai/ha compared with Frontier-p at 504 g ai/ha and Frontier at 1309 g ai/ha compared with Frontier-p at 720 g ai/ha gave equivalent control of fat hen in beans. At 28DAA, Frontier at 327.3 g ai/ha compared with Frontier-p at 180 g ai/ha, Frontier at 916.4 g ai/ha compared with Frontier-p at 504 g ai/ha and Frontier at 1309 g ai/ha compared with Frontier-p at 720 g ai/ha gave equivalent control of green amaranth in beans. Comparison of Frontier 900 EC with 55% bio-equivalent rates of Frontier-p 720 EC showed equal control of fat hen and green amaranth in beans.

Frontier-p 720 EC did not affect bean plant emergence at 15DAA and 28DAA. Frontier-p 720 EC did not affect bean plant vigour at 28DAA and there was no significant reduction in plant vigour of beans for the chemical treatments. There were no visual symptoms of plant phytotoxicity to green beans during the trial.

Discussion

Vegetable Industry Needs

The introduction and registration of new crop protection products for intensive horticulture is something that occurs a lot less frequently than growers would like. It is a massive undertaking by any registrant and is based on economic and risk management decision making. Sales need to be large enough to repay the massive investment undertaken, and risks must be minimal to ensure that claims for lack of efficacy or crop damage are unlikely. For these reasons most products are only registered for larger markets which means that horticultural crops are sometimes not considered. Products that are registered in these crops are frequently also registered in major crops.

A review of available information was conducted by contacting over 30 different companies including those whose mission is to source, develop and distribute crop protection products, and specialist consulting companies (Table 10).

With information provided from various companies combined with priorities developed by industry input the list provided in Table 28 was compiled. To assign priorities for these products for progression towards possible registration a number of criteria were used including -:

- Need identified by industry
- Support of industry
- Availability of product
- Compatibility with other crop management tools used (Integrated Crop Management)
- Cooperation of supply company in allowing product to proceed through registration
- Availability of data to support use
- Cost of assembling required data package for registration
- Time required to complete registration

It is critical to consider the requirements to get a new product onto the Australian market. The permit system allowing products to be used for minor use is only available for products with an existing registration. To gain an initial registration a vast amount of data must be submitted to cover issues such as environment, occupational health and safety and toxicology, along with data to support usage in terms of efficacy (does the product work), crop safety (does it damage the crop) and residues (does it result in unacceptable residues in produce).

This process just cannot be done under the current registration system in Australia without massive support from a registrant. The process thus must be considered on commercial terms. Registrants must carefully consider market size for the product, costs of registration, and liability that may occur due the products usage. Unless there is a suitable financial return to the registrant the process simply will not occur.

In some circles it is thought that industry contribution towards gathering data to support a registration is providing the registrant with a huge windfall from massive sales revenue and profit. This is rarely the case. Industry contributions are a welcome part of the process but generally just tilt the balance towards viability of taking the product through registration. Without these contributions it is unlikely some of these registrations will ever occur.

The ease of registration of mirror image products has made it increasingly difficult for research based companies to recover their investment in new registrations. Once a product is off patent, as most products used in Australia are, then the introduction of generic products to complete with the original product is common. This is a disincentive for registrants to undertake the initial investment to gain first registrations. The good news is that in recent times some changes in legislation have resulted in increased data protection for those submitting for registration.

Discussion

International communications

Although not funded under this project, team members and colleagues did travel to USA, Europe and South East Asia on other business and provided additional contacts and information of value to this project.

Overseas travel to the USA was considered important due to the number of products originating from there and also the success of the IR-4 program. On separate occasions Rodney Burn (Peracto Study Director) and Ian Macleod both travelled to the USA on other business during the period the project was running, these visits were not funded by the project and limited business relating to this project was undertaken. Rodney met with IR4 staff in California and Ian met with a number of people from private and public sector organisation while attending a conference in Arizona. These contacts allowed an increased understanding of global issues and paved the way for stronger international relations for future exchanges of information regarding the facilitation of new product development on a local level.

Linkages created by Kevin Bodnaruk (AKC Consulting) and Peter Dal Santo (Agaware Consulting) with IR4 in the USA are being used to work towards greater sharing of data and collaborations between countries. This is of great importance for the minor use program and is expected to reduce the cost of obtaining more minor use permits and will also assist in the extension of labels for more product uses in Australia.

Interaction with other projects

Team members from this project are closely involved with the minor use program and participate on HAL's Vegetable Chemical Access Group and the National Minor Use Taskforce. This has ensured that there is continuing communication between different groups to provide updated information on issues relating to crop protection products in vegetables.

Team members also participate in many privately funded projects in a range of crops (not just horticulture) for a large range of corporate clients. This provides an excellent insight into new products that are being developed around the world. This is a valuable way of helping facilitate linkages between companies and industry with the interests of both being considered.

Plant Disease Research

Disease work is being well covered by plant pathology projects run by organisations such as the various state departments (Primary Industry / Agriculture), Applied Horticultural Research Pty Ltd and Peracto Pty Ltd (Table 11). In particular the project team is well aware of progress in VG05090 (New fungicides and strategies for sustainable management of Sclerotinia and Rhizoctonia diseases on vegetable crops in Australia) led by Dr Hoong Pung. There is good synergy in the approach being undertaken in this project and in Dr. Pung's project.

Insect Pest Research

From the list of projects (Table 11) there is a considerable amount of work currently being conducted on insect management and in IPM, which are often overlapping areas. There is generally good support from registrants to proceed with development and registration of insecticides as products are often able to be used across a number of crops and market size is large enough for economic justification for registration. For smaller crops the minor use permits provide a back up to support such uses. Projects to extend label claims into additional crops are also a far easier process than initial registrations.

Weed Research

Currently there is only one project (VG02013, Evaluation of techniques to minimise weeds in conventional and organic vegetable production) looking at weed management in vegetables in Australia (Table 11). Although the cost of weed control in Agriculture is huge globally there is little research underway in Australia to improve management options. It has been estimated that the global value of herbicides used in 1996 was US$16,500MIL compared to US$9,500MIL for insecticides and US$6,700MIL for fungicides (Hopkins 1997). Based on these figures it would seem that the investment made on improving weed management systems in Australia, in comparison with other crop protection areas, should be considerably higher. Generally vegetable growers spend far more managing weeds than on managing diseases or insects. Certain weeds on farms act as refuges for insect pests and disease inoculum, thus demonstrating an increased value in managing weeds.

Discussion

Table 28 – Product Priorities

Name	Active	Mode of Action Group	Target	Type	Priority
Frontier-P	dimethenamid-P	K	broadleaf and grass weeds	Herbicide	High
Authority	sulfentrazone	G	broadleaf and grass weeds	Herbicide	Medium
Raft	oxadiargyl	G	broadleaf and grass weeds	Herbicide	High
Baron WP and WG	oxyfluorfen	G	broadleaf and grass weeds	Herbicide	High
Lasso	alachlor	K	broadleaf and grass weeds	Herbicide	Medium
Goltix	metamitron	C	broadleaf and grass weeds	Herbicide	Medium
Propanil	propanil	C	broadleaf and grass weeds	Herbicide	Low
BioCover	mineral oil	-	mites, aphids, powdery mildew	Fungicide and Insecticide	High
Bion	acibenzolar-S-methyl	-	Fungi, bacteria and virus	Fungicide	Medium
Serenade	*Bacillus subtilus*	-	fungi and bacteria	Fungicide	Medium
Rhapsody	*Bacillus subtilus*	-	fungi and bacteria	Fungicide	Low
Sonata	*Bacillus pumilus*	-	fungi and bacteria	Fungicide	Low
Aero	Metiram + pyraclostrobin	K + Y	Phytophthora and Alternaria	Fungicide	Medium
Various eg Curzate	cymoxanil	-	Phytophthora, Plasmopara and Peronospora	Fungicide	Medium
Plictran	cyhexatin	12B	mites	Miticide	Medium
Peropal	azocyclotin	12A	mites	Miticide	Medium
Admiral	pyriproxyfen	7C	various	Insecticide	High

Discussion

Focus on Frontier-P

The collection of lists of priority products was important to the project but ensuring a useable outcome was a high priority to the project team. Of the products listed Frontier-P (dimethenamid-P) stood out as an example of a product much in demand that was not available due to breakdowns in the development and registration process. Frontier-P was also a new product for which the registration package could be completed and submitted to the APVMA in the limited timeframes and budget of this project.

The registration of Frontier-p will address a number of issues in the gap analysis (Appendix i) including management of group A herbicide resistant ryegrass and weed management in beans, peas, potatoes and onions. It also provides a new option for weed management in vegetable crops, an area where there is currently very little research work being conducted in Australia (Table 11).

This project aimed to demonstrate that it is possible to finish off the requirements for registration for products that have been identified in previous research.

The collection of data to satisfy all APVMA requirements for registration in Australia is a long and detailed process taking a number of years. It is clear that many projects are able to identify potential product uses but it is rare for a project to complete the process.

The herbicide dimethenamid was identified as having potential for use in a range of crops following preliminary trial work in the early 1990's. However, to complete the process and also to gain support from a registrant has taken a further 10 years. This has been due to many factors including the product ownership shifting between different companies as a result of a number of corporate mergers and acquisitions. Originally a Sandoz product Frontier-p has also been managed in Australia by each of AgrEvo, BASF and Nufarm.

It appears that the product may finally be registered in 2007 but it has taken many years of work and much pushing from industry and researchers to arrive at this point. It has become clear that a traditional three year project is not able to achieve this result. It requires great persistence, good grower support, a willing registrant and continuity of staff to be able to achieve such results.

In the past 20 years no herbicide has been registered primarily for vegetable crops. If Frontier-P is in fact registered following the latest APVMA review it will be a major achievement for all involved. It has taken a number of HRDC / HAL projects (Table 29) and major negotiations with the procession of companies that have had responsibility for the product. Without this project to complete the process the product would not have progressed in this country.

This project completed the collection of data required by APVMA and enabled the registration to be submitted, which occurred in August 2006. The four field trials conducted as part of this project completed the registration package to support the proposed label (Appendix ii).

Table 29 – HRDC/HAL Projects related to the development of Frontier-P

Project No	Title
VG95027	Control of amaranthus and other weeds in beans
VG97060	Weed management in peas
VG97062	Weed management in sweetcorn
VG97063	Weed management in pumpkins and other cucurbit crops

Discussion

Proposed crops for registration of dimethenamid-p are Navy Beans, Green Beans, Processing Peas, Pumpkin, Kabocha and Sweet Corn. Proposed weeds for registration include Crowsfoot Grass (*Eleusine indica*), Barnyard Grass (*Echinochloa crus galli*), Potato Weed (*Galinsoga parviflora*), Summer Grass (*Digitaria ciliaris*), Amaranthus (*Amaranthus powellii*), Fumitory / Pinkweed (*Fumaria* spp) and Wild Hops (*Nicandra physaloides*).

The detailed soil matrix on the label will allow growers to accurately select rates for any given soil type, this will ensure no crop damage or yield reduction when using the product on different soil types; as generally variations in crop safety on varying soil types is a problem with pre emergent herbicides.

Due to the mode of action and proposed use pattern of Frontier-p the development of resistance to this herbicide in previously susceptible weed populations is unlikely but still possible if the product is not used as part of an integrated weed management program.

Commercial scale trials conducted throughout Australia under permit (PER8499) have shown positive results for growers throughout Australia. Frontier-P has significantly reduced hand weeding costs in pumpkins and provided improved control of Amaranthus in Tasmanian green been crops. It also provides an alternative herbicide in crops which only have very limited number of effective registered herbicides.

Details of the Frontier-p draft label are in Appendix ii.

Other products on priority list

Members of this project team have assisted in the registration of both Baron and Biocover. No field trials were conducted with products other than Frontier-p as part of this project.

Baron 400 WP (oxyfluorfen)

Baron 400 WP herbicide was first registered in Australia in February 2006 in broccoli, cabbage, cauliflower and onions. This product contains the active ingredient oxyfluorfen in a wettable powder formulation. Data is currently being generated to test bio-equivalence between a wettable powder and water dispersible granule formulation of Baron.

Due to the formulation of the product it can be safely applied post transplant to brassica crops and also post emergence to onions. The product provides residual control of a range of problem weeds including wild radish (*Raphanus raphanistrum*) in brassicas.

Baron has a number of benefits for brassica growers including ease of application (post transplant where as other formulations of oxyflourfen are applied pre transplant), control of a broad range of weed species and high crop safety.

Baron has a key role in integrated crop management programs in both onion and brassica crops as its crop safety compared to other common herbicides may reduce damage to crop leaves hence allowing crops to better resist the development of foliar diseases. It can also reduce reliance on inter row cultivation hence reducing crop damage and soil structural damage.

BioCover (Petroleum Oil)

Biocover is a horticultural oil which is effective for the control of various diseases, including powdery mildew, and insect pests in a number of horticultural crops. As an oil, the product has a 1 day withholding period. The product became registered in Australia in July 2005.

Raft (oxadiargyl)

Raft is a pre emergent herbicide which is effective for the control of a range of weeds in crops such as potatoes, capsicums and brassicas. For crops such as capsicums, there is currently no broadleaf herbicides registered. Control of black nightshade (*Solanum nigrum*) control in potatoes in Australia is

also a major issue.

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Technology Transfer

This is a pilot study and does not generate much information suitable for general technology transfer. Although team members have been active in many forums and made presentations at such events as Tasmanian ARAC presentation day, much of the transfer of information has been via informal meetings. The major outcome from this project that will be directly usable by levy payers will be the registration of Frontier-p which is expected to occur around March 2007. Commercial operations will ensure that all potential users of this product will be advised through various local crop advisors and reseller organisations.

Recommendations

- Funding of weed research in Horticulture needs to be reviewed.
- Plans for the registration of Frontier-P have been finalised, other products need to be prioritised and developed.

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- Belchim
- Crompton
- DAKRU
- Dow AgroSciences
- DuPont
- Eden
- EE Muir and Sons
- Elliott Technologies
- Eureka! Ag Research
- FMC
- Helena Chemicals
- Nufarm
- Primaxa
- Serve-Ag
- Staphyt
- Sumitomo Chemical Australia
- Syngenta Crop Protection
- Syntech Research
- Tomen
- Wobelea

Appendices

Appendix i - Gap Analysis Tasmania

Review of the main chemical inputs of major vegetable crops grown in Tasmania July 2005

Summary of issues affecting specific crops

Issue	Crop	Details
Late blight	Potatoes	Heavy reliance on protectant products, particularly mancozeb. Heavy reliance on metalaxyl as only curative. Need to develop an integrated management strategy.
Common scab	Potatoes	R&D continues on common scab, but other management options are needed. In-furrow use of Maxim / Amistar may be useful (reg. pending)
Powdery scab	Potatoes	No products available - management options needed. May be benefits from Maxim / Amistar in furrow (recommended to not pursue Ridomil for use as this will exacerbate current over-exposure to the product in potatoes)
Pink rot	Potatoes	Over reliance on Ridomil - need other options. Amistar found to be not sufficiently effective. Work done on Phosphorous acid, but with variable results - needs further investigation.
Downy mildew	Onions	Over reliance on protectant products, patricularly mancozeb. Need to develop an integrated management strategy.
White rot	Onions	Need more effective management options (currently being investigated by Horticulture Australia and Serve-Ag Research)
Black root rot	Beans	No suitable options. Seed treatment is being investigated.
Head rot	Brassicas	Poor understanding of this problem. Some recent work done, but more management options still needed.
Aphids	Carrots	Over reliance on older chemistries. Pursue permits for Pirimor and Chess?
Aphids	Brassicas	Over reliance on Pirimor.
Grasshoppers	Potatoes	Three products available, but two under APVMA review
Lucerne flea and Springtails	Onions	Over reliance on older chemistries. Need other options.
Wireworm	Potatoes	Only one product available - need other management options.
Onion maggot	Onions	Heavy reliance on older chemistries. Need other management options.

Stephen Welsh
Vegetable Industry Development Officer
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Appendix i (Cont.) - Gap Analysis Tasmania

Summary of issues affecting multiple crops

Issue	Crop	Details
Frequent use of Ridomil	Most crops	Ridomil is heavily relied upon in numerous crops in the rotation, potentially pre-disposing the product to resistance build-up.
Over reliance on older chemistries for insecticides	Most crops	The majority of insecticides used are older generation chemistries such as chlorpyrifos, dimethoate and diazinon. Many of these older products are under review by APVMA and may have restricions placed on future usage patterns.
Sclerotinia	Most crops	Problematic across most crops. Current rotations probably contributing to problem. A few management options, but an integrated management strategy is needed.
Rhizoctonia	Most crops	Problematic across most crops. Current rotations probably contributing to problem. A few management options, but an integrated management strategy is needed.
Botrytis	Most crops	Problematic across most crops. Current rotations probably contributing to problem. A few management options, but an integrated management strategy is needed.
Nematodes	Potatoes, carrots	Concerns over future availability of Nemacur. Metham sodium rarely used in Tas. Few other effective options for nematode management - need to develop an integrated management strategy.
White fringed weevil	Potatoes, carrots	WFW is increasing in numbers in several growing areas. Only one product is registered for its control. Integrated management options needed.
Cutworm	Onions, carrots, beans	Heavy reliance on just a few products. Need other management options.
Slugs and snails	Most crops	Widely problematic.Likely loss of metaldehyde in near future. Problems with staining of some pellets on produce such as cauliflower.
Onion thrips	Onions, potatoes	Resistance to commonly used insecticides. Current insecticides hard on beneficials.
Herbicide-resistant ryegrass	Most crops	Populations of resistant ryegrass common in many areas. Few suitable management options available.
Volunteer potatoes	Most crops	Long running problem with few effective options being used by growers.
Weeds generally	Carrots	Over reliance on linuron and Gesagard.
	Potatoes	Over reliance on post emergent products, particularly Group C
	Onions	Over reliance on Totril
	Peas	Over reliance on Group C herbicides
	Beans	Poor level of control offered by existing products. Heavy reliance upon post-emergent products.
Cleavers	Most crops	Distribution and incidence increasing, with few effective management options at present. Permit for Command may assist in many crops (Serve-Ag Research can assist with this)

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Detailed breakdown of chemical usage by crop (pests / diseases / weeds)

Crop	Pest	Comments	Products used	Reg	Per	Chem Group	APVMA Review	Needs Attention
Potatoes	White fringed weevil	Pest incidence and distribution increasing	Regent (fipronil)	R		2C	Y	Need other management options
Potatoes	Onion thrips	TSWV vector. Some resistance to SPs and diazinon.	Ambush (permethrin)			3A		
Potatoes			Dominex (alpha-cypermethrin)			3A		
Potatoes			Diazinon			1B	Y	
Potatoes			Confidor (imidacloprid)			4A		
Potatoes			Rogor (dimethoate)			1B	Y	
Potatoes			Endosulfan			2A	Y	Use to be retained as an outcome from APVMA review
Potatoes			Thimet (phorate)			1B		
Potatoes	Potato moth		Success (spinosad)			5A		
Potatoes			BAS 320					Product being considered for registration
Potatoes	Grasshoppers	Need other management options due to old chemistry / products under review	Chlorpyrifos			1B	Y	
Potatoes			Ambush (permethrin)			3A		
Potatoes			Fenitrothion			1B	Y	
Potatoes	Wireworm		Thimet (phorate)			1B		Need other management options
Potatoes	Nematodes		Nemacur (fenamiphos)				Y	Product may cease production
Potatoes			Metham sodium				Y	Very low usage in Tas
Potatoes	Aphids		Pirimor (pirimicarb)			1A		
Potatoes			Chess (pymetrozine)			9A		
Potatoes			Ambush (permethrin)			3A		
Potatoes			Rogor (dimethoate)			1B	Y	
Potatoes			Endosulfan			2A	Y	Pending
Potatoes			Confidor (imidacloprid)			4A		
Potatoes			Mospilan			4A		Under development for green peach

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Appendix i (Cont.) - Gap Analysis Tasmania

Potatoes	Loopers and		Ambush (permethrin)			3A		
Potatoes	Cutworm		Chlorpyrifos			1B	Y	
Potatoes			Supracide (methidathion)			1B	Y	
Potatoes			Success (spinosad)			5A		
Potatoes	Target spot		Mancozeb			Y		
Potatoes			Score (difenoconazole)			C		
Potatoes			Bravo (chlorothalonil)			Y		
Potatoes			Amistar (azoxystrobin)			K		
Potatoes			Rovral (iprodione)			B		
Potatoes			Sumisclex (procymidone)			B	Y	
Potatoes			Walabi (chlorothalonil, pyrimethanil)			Y, I		
Potatoes			Polyram (metiram)			Y		
Potatoes			BAS518					Registration pending
Potatoes			Filan (boscalid)			G		To be investigated in 2007
Potatoes	Late blight	A2 strain likely to be susceptible to same products, although	Mancozeb			Y		Protectants are the basis of control programs, with heavy reliance on mancozeb.
		concerns with	Ridomil (metalaxyl)			D		
Potatoes		metalaxyl efficacy.	Bravo (chlorothalonil)			Y		
Potatoes		Other chemistry in	Amistar (azoxystrobin)			K		
Potatoes		Europe and US may	Acrobat (dimethomorph)			X		
Potatoes		be worth investigating if A2	Polyram (metiram)			Y		
Potatoes		arrives in Australia	BAS518			Y		Under investigation
Potatoes	Rhizoctonia		Terraclor (quintozene)			Y		
Potatoes			Rizolex (tolclofos-methyl)			X		
Potatoes			Maxim (fludioxonil)			L		
Potatoes			Rovral (iprodione)			B		
Potatoes			Monceren (pencycuron)			X		
Potatoes			Moncut (flutolanil)			G		
Potatoes			Amistar (azoxystrobin)			K		In-furrow registration pending (may be only product addressing soil-borne Rhizoctonia)

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Potatoes	Common scab		Mancozeb			Y		R&D continues on common scab, but other management options are needed. In-furrow use of Maxim / Amistar may be useful (reg. pending)
Potatoes			Terraclor (quintozene)			Y		Very low usage in Tas
Potatoes	Powdery scab		cultural management - variable results					No products available - management options needed. May be benefits from Maxim / Amistar in furrow, or Ridomil granules?
Potatoes	Pink rot		Ridomil foliar, Ridomil granules (metalaxyl)			D		Over reliance on Ridomil - need other options. Amistar found to be not sufficiently effective. Work done on Phosphorous acid, but with variable results - needs further investigation.
Potatoes	Sclerotinia	Micro-formulated gypsum may be a useful spray additive for Sclerotinia management.	Sumisclex (procymidone)			B	Y	Subject to ongoing review of procymidone
Potatoes			Rovral (iprodione)			B		
Potatoes			Terraclor (quintozene)			Y		
Potatoes			Filan (boscalid)			G		Product under investigation for this use
Potatoes	Fusarium seed piece decay	Other species may be causing this problem in addition to Fusarium.	Fungaflor (imazalil)			C		
Potatoes			Tecto (thiabendazole)	R		A		Some resistance reported overseas
Potatoes			Mancozeb	R		Y		
Potatoes	Black dot (seed borne and soil borne)		Maxim (fludioxonil)			L		

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Vegetable Industry Development Officer
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Appendix i (Cont.) - Gap Analysis Tasmania

Potatoes	Weeds generally		Gesagard (prometryn)			C		Over reliance on post emergent products, particularly Group C
Potatoes			Command (clomazone)			F		
Potatoes			Bladex (cyanazine)			C		
Potatoes			Linuron			C		
Potatoes			Sprayseed (diquat, paraquat)			L		
Potatoes			Sencor (metribuzin)			C		
Potatoes	Grasses	Localised populations of ryegrass resistant to fops and dims	Fusilade (fluazifop-p)			A		
Potatoes			Sertin (sethoxydim)			A		
Potatoes			Select (clethodim)			A		
Potatoes			Command (clomazone)			F		
Carrots	Nematodes		Nemacur (fenamiphos)				Y	Product may cease production. Pursue permits for other nematicides (Rugby?). More developmental work on metham sodium needed.
Carrots			Metham sodium				Y	
Carrots	Cutworm		Chlorpyrifos			1B	Y	More management options needed
Carrots	Aphids	All older chemistries. Pursue permits for Pirimor and Chess?	Thimet (phorate)			1B		
Carrots			Rogor (dimethoate)			1B	Y	
Carrots			Malathion (maldison)			1B	Y	
Carrots	White fringed weevil							
Carrots	Sclerotinia		Sumisclex (procymidone)			B	Y	
			Filan (boscalid)					Permit application pending
Carrots	Cavity spot		Ridomil granules (metalaxyl) (damping off of seedling, reg for pythium)			D		Resistance to metalaxyl exists in WA. Need more management options, including better crop rotations.

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Carrots	Alternaria	Cabrio may be considered for registration	Bravo (chlorothalonil)			Y		
Carrots			Score (difenoconazole)			C		
Carrots			Mancozeb			Y		Very little use in Tas
Carrots			Copper			Y		
Carrots	Tiger stripe (Pythium)		Ridomil granules (metalaxyl)			D		
Carrots	Cercospora		Score (difenoconazole)			C		
Carrots			Bravo (chlorothalonil)			Y		
Carrots			Copper			Y		
Carrots	Weeds generally	Very reliant on just these two products.	Linuron (linuron)			C		Linuron 70d WHP under review - industry has requested 28d
Carrots			Gesagard (prometryn)					
Carrots	Potatoes							
Carrots	Grasses	Localised populations of resistant ryegrass causing problems	Fusilade (fluazifop-p)			A		
Carrots			Sertin (sethoxydim)			A		
Carrots			Targa (quizalofop)			A		Very little usage
Carrots	Hogweed		Stomp (pendimethalin)			D		
Carrots	Cleavers	Command useful on many weeds o/s - consider permit?						
Onions	Thrips	Populations resistant to Diazinon and SPs known to exist in some areas	Supracide (methidathion)	R		1B	Y	
Onions			Diazinon		P	1B	Y	
Onions			Dominex (alpha-cypermethrin)			3A		Permit application being assessed
Onions			Rogor (dimethoate)	R		1B	Y	
Onions			Thimet (phorate)	R		1B		
Onions			Folimat (omethoate)	R		1B	Y	
Onions			Actara (thiamethoxam) and Confidor (imidiacloprid)			, 4A		Being evaluated for suitability

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Appendix i (Cont.) - Gap Analysis Tasmania

Onions	Cutworm	High reliance on chlorpyrifos. Dominex used via thrips. Consider permit for Success?	Chlorpyrifos	R		1B	Y	
Onions	Lucerne flea and spring tails	Over reliance on older chemistries	Chlorpyrifos	R		1B	Y	
Onions			Diazinon		P	1B	Y	
Onions	Onion maggot		Thimet (phorate)			1B		Very low usage in Tas
Onions	Botrytis		Filan (boscalid)		P	G		
Onions			Rovral with Bravo (iprodione / chlorothalonil)		P	B, Y		
Onions			Spin Flo (carbendazim)		P	A		
Onions			Bravo (chlorothalonil)	R		Y		
Onions	Downy Mildew	Over reliance on protectant products, especially mancozeb	Ridomil (metalaxyl)	R		D		
Onions			Mancozeb	R		Y		
Onions			Bravo (chlorothalonil)	R		Y		
Onions			Acrobat (dimethomorph)	R		X		
Onions			Galben (benalaxyl)	R		D		
Onions			Agrifos (phosphorous acid)		P	Y		
Onions			Copper	R		Y		
Onions	White rot	Need more management options - currently being investigated by HAL	Folicur (tebuconazole)	R		C		
Onions			Filan (boscalid)		P	G		
Onions			BAS518					New product under consideration
Onions	Potatoes							
Onions	Ryegrass		Fusilade (fluazifop-p)	R		A		
Onions			Select (clethodim)	R		A		
Onions			Sertin (sethoxydim)	R		A		
Onions			Targa (quizalofop)	R		A		
Onions			Verdict (haloxyfop)	R		A		

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Onions	Weeds generally	Over reliance on Totril. Pyramin is registered in NZ - consider here?	Ramrod (propachlor)	R				
Onions			Stomp (pendimethalin)	R		D		
Onions			Dacthal (chlorthal-methyl)	R		D		
			Basagran (bentazone)	R		C		
Onions			Bladex (cyanazine)	R		C		
Onions			Goal (oxyflourfen)	R		G		
Onions			Linuron (linuron)	R		C		
Onions			Tribunil (methabenzthiazuron)	R		C		
Onions			Totril (ioxynil)	R		C		
Onions			Asulox (asulam)	R		K		
Onions			Starane (fluroxypyr)		P	I		
Onions			Baron					Registration pending
Brassicas	Aphids	Over reliance on Pirimor	Pirimor (pirimicarb)			1A		Pirimor used almost exclusively
Brassicas			Chess (pymetrozine)			9A		
Brassicas			Dominex (alpha-cypermethrin)			3A		
Brassicas			Chlorpyrifos			1B	Y	
Brassicas			Confidor (imidacloprid)			4A		
Brassicas			Ambush (permethrin)			3A		
Brassicas	Diamondback moth,		Success (spinosad)			5A		
Brassicas	Cabbage white		Bacillus thuringiensis			11		
Brassicas	butterfly, Heliothis		Secure (chlorfenapyr)			13A		
Brassicas	and other		Avatar (indoxacarb)			22A		
Brassicas	Lepidopteran		Regent (fipronil)			2C	Y	
Brassicas			Chlorpyrifos			1B	Y	
Brassicas			Sumi-alpha (esfenvalerate)	R		3A		
Brassicas			Proclaim (emamectin)			6A		
Brassicas			Various synthetic pyrethroids			3A		
Brassicas			BAS320					Registration pending

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Appendix i (Cont.) - Gap Analysis Tasmania

Brassicas	Slugs, snails		Defender (metaldehyde)					Methiocarb possibly being withdrawn. Some problems with staining of pellets on produce.
Brassicas			Multigard (iron chelate)					
Brassicas	White blister	More work required to improve coverage.	Ridomil Gold (metalaxyl, mancozeb)		P	D		Permit expires June06. Renewal applied for.
Brassicas			Acrobat (dimethomorph)			X		Permit pending
Brassicas			Bravo (chlorothalonil)			Y		Permit pending
Brassicas			Mancozeb			Y		Permit pending
Brassicas			Amistar (azoxystrobin)			K		Permit pending
Brassicas			Copper oxychloride			Y		Permit expires Oct05
Brassicas			Phosphorous acid			Y		Permit pending
Brassicas			Cabrio (pyraclostrobin)			K		
Brassicas	Clubroot		Shirlan (fluazinam)			Y		
Brassicas			Terraclor (quintozene)			Y		Very little use of product
Brassicas	Ring spot		Mancozeb			Y		
Brassicas			Bravo (chlorothalonil)			Y		
Brassicas			Bayfidan (triadimenol)			C		
Brassicas	Head rot	Recent R&D work conducted, but more options still needed	Bravo (chlorothalonil)			Y		
Brassicas			Copper oxychloride			Y		
Brassicas	Rhizoctonia		Terraclor (quintozene)	R		Y		Very little use of product. Other management options needed.
Brassicas	Weeds generally	Over reliance on pre-planting products	Dual Gold (s-metolachlor)			K		
Brassicas			Stomp (pendimethalin)			D		
Brassicas			Goal (oxyflourfen)			G		
Brassicas			Baron					Registration pending
Beans	Thrips	Worth seeking permits for Actara and Confidor?	Sumi-alpha (esfenvalerate)			3A		
Beans			Rogor (dimethoate)			1B	Y	Very little use of product
Beans			Malathion (maldison)			1B	Y	Very little use of product
Beans			BAS320					Being considered for registration

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Beans	Slugs, snails		Defender (metaldehyde)					
Beans			Multigard (iron chelate)					
Beans	Cutworm		Chlorpyrifos			1B	Y	
Beans			Ambush (permethrin)			3A		
Beans	Heliothis, loopers		Sumi-alpha (esfenvalerate)	R		3A		Few options, but not seen as a major problem
Beans	Sclerotinia		Spin Flo (carbendazim)			A		
Beans			Sumisclex (procymidone)			B	Y	Still under review - may be allowed for use in future
Beans			Filan (boscalid)		P	G		
Beans			Amistar (azoxystrobin)		P	K		
Beans	Black root rot	Lack of options - seed treatment being investigated						
Beans	Rhizoctonia	Lack of options - seed treatment being investigated						
Beans	Weeds generally	Need more post-emergent options	Basagran (bentazone)			C		
Beans			Command (clomazone)			F		
Beans			Bladex (cyanazine)		P	C		
Beans			Dual Gold (s-metolachlor)			K		
Beans			Stomp (pendimethalin)			D		
Beans			Frontier (dimethenamid-p)			K		Registration application pending
Peas	Slugs and snails		Defender (metaldehyde)					
Peas			Multigard (iron chelate)					
Peas	Heliothis (seasonal)		Ambush (permethrin)			3A		
Peas			Sumi-alpha (esfenvalerate)			3A		
Peas	Collar rot		Bravo (chlorothalonil)			Y		
Peas			Phosphorous acid			Y		
Peas			Seed treatments					
Peas			Cabrio (pyraclostrobin)			K		Registration being considered

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Appendix i (Cont.) - Gap Analysis Tasmania

Peas	Downy Mildew	Seed treatments being	Mancozeb			Y		
Peas		investigated. Resistant	Phosphorous acid			Y		
Peas		varieties near commercialisation.	various seed treatments					
Peas	Powdery mildew	Resistant varieties near commercialisation.	Folicur (tebuconazole)			C		
Peas	Weeds generally		Sencor (metribuzin)			C		
Peas			Brodal (diflufenican)		P	F		
Peas			Bladex (cyanazine)			C		
Peas			Stomp (pendimethalin)			D		
Peas			MCPA			I		
Peas			Frontier (dimethenamid-p)			K		Registration application pending

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Appendix ii - Frontier-p permit and draft label

Australian Pesticides & Veterinary Medicines Authority

PERMIT TO ALLOW RESEARCH USE AND SUPPLY OF AN AGVET CHEMICAL PRODUCT

PERMIT NUMBER – PER8499

This permit is issued to the Permit Holder in response to an application granted by the APVMA under section 112 of the Agvet Codes of the jurisdictions set out below. This permit allows a Supplier (as indicated) to possess the product for the purposes of supply and to supply the product to a person who can use the product under permit. This permit also allows a person, as stipulated below, to use the product in the manner specified in this permit in the designated jurisdictions. This permit also allows the Permit Holder, the Supplier (if not one and the same) and any person stipulated below to claim that the product can be used in the manner specified in this permit.

THIS PERMIT IS IN FORCE FROM 12 SEPTEMBER 2005 to 30 JUNE 2008.

Permit Holder:
BASF AUSTRALIA LTD
10/10 Gladstone Street
CASTLE HILL NSW 2154

Supplier:
BASF Australia Limited.

Persons who can use the product under this permit:
Persons employed by, contracted to, or engaged by Nufarm Australia Limited or Serve Ag Pty Ltd, and their co-operators, who are conducting trials under the trial protocols relevant to this product.

CONDITIONS OF USE

Product to be used:
FRONTIER-P HERBICIDE
Containing 720 g/L DIMETHENAMID-P as their only active constituent.

Directions for Use:

Crop	Pest	Rate
POPPIES, PROCESSING PEAS GREEN BEANS, KABOCHA, PUMPKIN, SWEET CORN, MAIZE	WEEDS AS PER PRODUCT LABEL (Refer to Attachment 1)	500 mL to 1.4 L/ha As per product label

Appendix ii (Cont.) - Frontier-p permit and draft label

Critical Use Comments:
DO NOT apply to poppies within 100 days of harvest.

Withholding Period:
HARVEST: Not required when used as directed.
GRAZING: DO NOT graze or cut for stockfeed for 4 weeks after application.

Jurisdiction:
ALL States.

Additional Conditions:
THIS PERMIT provides for the use of a product in a manner other than specified on the approved label of the product. Unless otherwise stated in this permit, the use of the product must be in accordance with instructions on its label.

PERSONS who wish to prepare for use and/or use products for the purposes specified in this permit must read, or have read to them, the details and conditions of this permit.

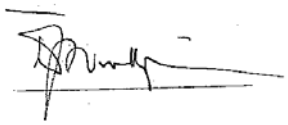
TO AVOID CROP DAMAGE:
The sensitivity of some species and varieties of the crops to be treated under this permit has not been fully evaluated. It is advisable, therefore, to only treat a small number of plants to ascertain their reaction before treating the whole crop.

SUPPLY:
The supplier must supply the product in a container that complies with the requirements of section 18(1) of the Agricultural and Veterinary Chemicals Code Regulations. Attached to this container must be a label which is identical in content and format to the label in Attachment 1.

TRIAL RECORDS:
The permit holder must maintain records of the trials performed under this permit. Specifically details must include the date and location where the trials were conducted, commodities treated, rates and frequency of application, total amount of product used and the names and addresses of the persons conducting the trial. These details must be maintained for a minimum period of two years from the date of expiry of this permit and must be made available to the APVMA upon request.

Maximum Area to be Treated:
Maximum of 200 ha.

Issued by



Delegated Officer

Appendix ii (Cont.) - Frontier-p permit and draft label

ATTACHMENT 1

POISON
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING

FRONTIER®- P
Herbicide

ACTIVE CONSTITUENT: 720 g/L DIMETHENAMID-P

GROUP K HERBICIDE

For the control of certain broadleaf and grass weeds in green beans, kabocha, poppies, processing peas, pumpkins, maize and sweet corn, as specified in the DIRECTIONS FOR USE table.

FOR EXPERIMENTAL USE ONLY. THIS USE PATTERN IS NOT REGISTERED.

IMPORTANT: READ THE ATTACHED LEAFLET BEFORE USE

BASF

Appendix ii (Cont.) - Frontier-p permit and draft label

FRONTIER-P 56059 V080905
Label
Text above the line is not part of the label

STORAGE AND DISPOSAL
Store in the closed, original container in a cool, well-ventilated area. Do NOT store for prolonged periods in direct sunlight. Triple or preferably pressure rinse containers before disposal. Add rinsings to spray tank. Do NOT dispose of undiluted chemicals on-site. If recycling, replace cap and return clean containers to recycler or designated collection point. If not recycling, break, crush, or puncture and bury empty containers in a local authority landfill. If no landfill is available, bury the containers below 500 mm in a disposal pit specifically marked and set up for this purpose clear of waterways, desirable vegetation and tree roots. Empty containers and product should NOT be burnt.

SAFETY DIRECTIONS
Harmful if swallowed. Will irritate the eyes and skin. Repeated exposure may cause allergic disorders. Sensitive workers should use protective clothing. Avoid contact with eyes and skin. If product in eyes, wash it out immediately with water. When opening the container and preparing spray wear cotton overalls buttoned to the neck and wrist, a washable hat, elbow-length PVC gloves and faceshield or goggles. When using the prepared spray wear cotton overalls buttoned to the neck and wrist, a washable hat and elbow-length PVC gloves. Wash hands after use.

FIRST AID
If poisoning occurs, contact a doctor or Poisons Information Centre, telephone 131126 Australia-wide.

MSDS
Additional information is listed in the Material Safety Data Sheet.

CONDITIONS OF SALE
All conditions and warranties rights and remedies implied by law or arising in contract or tort whether due to the negligence of BASF Australia Ltd or otherwise are hereby expressly excluded so far as the same may legally be done provided however that any rights of the Buyer pursuant to non excludable conditions or warranties of the Trade Practices Act 1974 or any relevant legislation of any State are expressly preserved but the liability of BASF Australia Ltd or any intermediate Seller pursuant thereto shall be limited if so permitted by the said legislation to the replacement of the goods sold or the supply of equivalent goods and all liability for indirect or consequential loss or damage of whatsoever nature is expressly excluded. This product must be used or applied strictly in accordance with the instructions appearing hereon. This product is solely sold for use in Australia and must not be exported without the prior written consent of BASF Australia Ltd.

THIS PRODUCT IS NOT CONSIDERED TO BE A DANGEROUS GOOD UNDER THE AUSTRALIAN CODE FOR THE TRANSPORT OF DANGEROUS GOODS BY ROAD AND RAIL.

FOR SPECIALIST ADVICE IN AN
EMERGENCY ONLY
PHONE 1 800 803 440
TOLL FREE - ALL HOURS - AUSTRALIA WIDE

APVMA Permit Number PER8499
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® = Registered trademark of BASF
Label Version: V080905

Batch Number:

Date of Manufacture:

Customer Service Hotline: 1800 635 550
Website: www.agro.basf.com.au

BASF Australia Ltd
ABN 62 008 437 867
500 Princes Highway
Noble Park VIC 3174

Appendix ii (Cont.) - Frontier-p permit and draft label

POISON
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING

FRONTIER®- P
Herbicide

ACTIVE CONSTITUENT: 720 g/L DIMETHENAMID-P

GROUP K HERBICIDE

For the control of certain broadleaf and grass weeds in green beans, kabocha, poppies, processing peas, pumpkins, maize and sweet corn, as specified in the DIRECTIONS FOR USE table.

FOR EXPERIMENTAL USE ONLY. THIS USE PATTERN IS NOT REGISTERED.

THIS LEAFLET IS PART OF THE LABEL.

Appendix ii (Cont.) - Frontier-p permit and draft label

FRONTIER-P 56059 V080905
Label
Text above the line is not part of the label

BASF

DIRECTIONS FOR USE:

RESTRAINTS:
Do NOT apply to green beans, kabocha, processing peas, pumpkins, maize or sweet corn crops grown on soils with a cation exchange capacity of less than 5 meq / 100g (or cmol / kg) OR soils with a clay content of less than 10 % AND organic carbon content of less than 2%.

Do NOT apply more than one application per year.

Do NOT apply through aircraft or irrigation equipment.

CROP	WEEDS CONTROLLED	RATE PER ha	STATES	CRITICAL COMMENTS
Early post emergence use				
Poppies	Pink weed / fumitory (*Fumaria* spp)	1.4 L	Tas	Apply FRONTIER-P when the pinkweed / fumitory is at the cotyledon to 2 leaf stage, but not before the crop is at the early 2 leaf stage. A follow up spray of Starane™ 1.5 L/Ha must be applied within 15 days for complete control of pinkweed / fumitory. For improved control of other weeds such as hogweed (*Polygonum aviculare*), fat hen (*Chenopodium album*) and black nightshade (*Solanum nigrum*) Command™ Herbicide should be tank mixed with Frontier. Do NOT tank-mix with Brodal ™.
Pre-emergence use				
Processing peas	Crowsfoot grass (*Eleusine indica*)	500 mL	All States	FRONTIER-P must be applied post-plant before the crop and weeds emerge. Emerged weeds present at the time of application must be controlled by other means. Use the low rate on light textured low organic matter soils and the high rate on heavier textured soils as per the tables below. See **CROP SAFETY** section. For optimal performance, irrigation or rainfall is required within seven days of application.
	Barnyard grass (*Echinochloa crus-galli*), potato weed (*Galinsoga parviflora*), summer grass (*Digitaria ciliaris*)	700 mL to 1.0 L		
	Amaranthus (*Amaranthus powellii*), fumitory / pinkweed (*Fumaria* spp), wild hops (*Nicandra physaloides*)	1.0 L		
Green beans, kabocha (Japanese squash), pumpkin, maize, sweet corn	Crowsfoot grass (*Eleusine indica*)	500 mL	All states except Qld	
	Barnyard grass (*Echinochloa crus-galli*), potato weed (*Galinsoga parviflora*), summer grass (*Digitaria ciliaris*)	700 mL to 1.0 L		
	Amaranthus (*Amaranthus powellii*), fumitory / pinkweed (*Fumaria* spp), wild hops (*Nicandra physaloides*)	1.0 L		

PER8499 Permit Version 1 Page 6 of 9

Appendix ii (Cont.) - Frontier-p permit and draft label

NOT TO BE USED FOR ANY PURPOSE, OR IN ANY MANNER, CONTRARY TO THIS LABEL UNLESS AUTHORISED UNDER APPROPRIATE LEGISLATION.

WITHHOLDING PERIODS

HARVEST: NOT REQUIRED WHEN USED AS DIRECTED.
GRAZING: DO NOT GRAZE OR CUT FOR STOCKFEED FOR 4 WEEKS AFTER APPLICATION.

GENERAL INSTRUCTIONS
FRONTIER-P is a selective pre-emergence herbicide for control of weeds in green beans, kabocha, poppies, processing peas, pumpkins and sweet corn. FRONTIER-P controls susceptible germinating seedlings before or soon after they emerge from the soil. FRONTIER-P will not control emerged weeds. FRONTIER-P will be most effective when incorporated by rainfall or overhead irrigation prior to weed emergence. Poor weed control may occur when trickle irrigation is used and there is insufficient surface moisture.

MIXING
Add the required amount of herbicide directly to the partly filled spray tank with agitation running. Complete filling and maintain agitation until spraying is complete.

APPLICATION
Apply treatments with a calibrated boom spray equipped with flat fan nozzles in a spray volume of 200 to 300 L/ha. Do NOT apply by aircraft.

EQUIPMENT CLEAN-UP
Clean application equipment thoroughly using a strong detergent or tank cleaner. Rinse equipment thoroughly before re-use.

COMPATIBILITY
Frontier P is compatible with Command, atrazine and Stomp®. Do NOT mix with Brodal.

RESISTANT WEEDS WARNING **GROUP K HERBICIDE**

FRONTIER-P Herbicide is a member of the amide group of herbicides. The product has the herbicides with diverse sites of action mode of action. For weed resistance management, the product is a Group K herbicide.

Some naturally occurring weed biotypes resistant to the product and other amide herbicides may exist through normal genetic variability in any weed population. The resistant individuals can eventually dominate the weed population if these herbicides are used repeatedly. These resistant weeds will not be controlled by this product or other amide herbicides.

Since the occurrence of resistant weeds is difficult to detect prior to use, BASF Australia accepts no liability for any losses that may result from the failure of this product to control resistant weeds.

PROTECTION OF CROPS, NATIVE AND OTHER NON-TARGET PLANTS
Do NOT apply under weather conditions or from spraying equipment that may cause spray to drift onto nearby susceptible plants/crops, cropping lands or pastures.
Do NOT plant crops **other than** green beans, kabocha, processing peas, pumpkins, maize, sweet corn, transplanted brassicas or potatoes within 6 months of application of FRONTIER-P. Do NOT plant carrots or pyrethrum within 12 months of application of FRONTIER-P.

Appendix ii (Cont.) - Frontier-p permit and draft label

FRONTIER-P 56059 V080905
Label
Text above the line is not part of the label

Crop safety:
Injury to green beans, kabocha, processing peas, pumpkins, maize and sweet corn may occur at label rates on soils with very low cation exchange capacity (CEC). Soils containing low levels of clay and organic matter normally have a low CEC. **Do NOT apply to green beans, kabocha, processing peas, pumpkins, or sweet corn crops grown on soils with a cation exchange capacity of less than 5 meq / 100g (or cmol / kg) OR soils with a clay content of less than 10 % AND organic carbon content of less than 2%.**

CEC (meq/100g or cmol/kg)	FRONTIER-P Rate per ha
<5	Do not use Frontier P
5-9	500 to 700 mL
9-14	700 mL to 1.0 L
>14	1.0 L

Soil Texture	Clay Content	Organic Carbon Content	
		<2%	>2%
Sand, Loamy Sand, Silt	<10%	Do not use Frontier P	500 - 700 mL
Loam, Sandy Loam, Silt Loam	10-15%	500 - 700 mL	700 mL – 1 L
Sandy Clay Loam, Clay Loam, Silt Clay Loam, Silty Clay, Sandy Clay, Clay	>15%	1 L	1 L

PROTECTION OF WILDLIFE, FISH, CRUSTACEANS AND ENVIRONMENT
Toxic to fish. Do NOT contaminate streams, rivers or waterways with the chemical or used containers. Do NOT apply under conditions which favour run-off. Do NOT incorporate this product by flood or furrow irrigation.
Toxic to bees.

STORAGE AND DISPOSAL
Store in the closed, original container in a cool, well-ventilated area. Do NOT store for prolonged periods in direct sunlight. Triple or preferably pressure rinse containers before disposal. Add rinsings to spray tank. Do NOT dispose of undiluted chemicals on-site. If recycling, replace cap and return clean containers to recycler or designated collection point. If not recycling, break, crush, or puncture and bury empty containers in a local authority landfill. If no landfill is available, bury the containers below 500 mm in a disposal pit specifically marked and set up for this purpose clear of waterways, desirable vegetation and tree roots. Empty containers and product should NOT be burnt.

SAFETY DIRECTIONS
Harmful if swallowed. Will irritate the eyes and skin. Repeated exposure may cause allergic disorders. Sensitive workers should use protective clothing. Avoid contact with eyes and skin. If product in eyes, wash it out immediately with water. When opening the container and preparing spray wear cotton overalls buttoned to the neck and wrist, a washable hat, elbow-length PVC gloves and faceshield or goggles. When using the prepared spray wear cotton overalls buttoned to the neck and wrist, a washable hat and elbow-length PVC gloves. Wash hands after use.

RE_ENTRY
Do not allow entry into treated areas until the spray has dried unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves.

FIRST AID
If poisoning occurs, contact a doctor or Poisons Information Centre, telephone 131126 Australia-wide.

MSDS
Additional information is listed in the Material Safety Data Sheet.

Appendix ii (Cont.) - Frontier-p permit and draft label

CONDITIONS OF SALE
All conditions and warranties rights and remedies implied by law or arising in contract or tort whether due to the negligence of BASF Australia Ltd or otherwise are hereby expressly excluded so far as the same may legally be done provided however that any rights of the Buyer pursuant to non excludable conditions or warranties of the Trade Practices Act 1974 or any relevant legislation of any State are expressly preserved but the liability of BASF Australia Ltd or any intermediate Seller pursuant thereto shall be limited if so permitted by the said legislation to the replacement of the goods sold or the supply of equivalent goods and all liability for indirect or consequential loss or damage of whatsoever nature is expressly excluded. This product must be used or applied strictly in accordance with the instructions appearing hereon. This product is solely sold for use in Australia and must not be exported without the prior written consent of BASF Australia Ltd.

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