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Weed management in peas

Ian Macleod, et al
Serve-Ag Research

Project Number: VG97060

VG97060

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Weed Management in Peas

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Project VG97060 (Project Completion 30/09/01)

Final Report

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Serve-Ag Research

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Media Summary

Green peas are principally grown for the processing industry, with around 6200ha being grown in Australia in 2000. Tasmania is the main production region for processing peas in Australia, producing around 80% of the total crop. There are also production areas in Western Australia and South East Queensland.

Herbicide strategies in processing pea crops commonly involve an application of Stomp, tank-mixed with a non-selective herbicide such as Sprayseed, before the crop emerges. Post-emergent sprays include metribuzin (Lexone/Sencor), Bladex and Basagran (used under permit). Stomp provides reliable control of weeds including hogweed (*Polygonum aviculare*) and wild poppies (*Papaver* spp.), however control of weeds such as wild radish (*Raphanus raphanistrum*) and black nightshade (*Solanum nigrum*) is often not acceptable. Weeds such as wild radish and black nightshade cause significant problems in the processing factories, as their seeds are difficult to separate from the pea crop. The residual nature of Stomp may also present a risk to following crops, particularly poppies. Metribuzin (Lexone/Sencor) is currently used post-emergence to provide reliable control of weeds such as wild radish. However, field experience and research suggests that the use of metribuzin is linked to increased severity of collar rot diseases in pea crops.

The aim of this project was to develop improved herbicide strategies for weeds such as black nightshade and wild radish, and to find alternative herbicides to metribuzin to be used in areas where collar rot could be a problem. Eighteen trials were conducted in the major pea production areas across Australia, to obtain weed efficacy and crop tolerance data across a range of climates, soil types, weed spectra and pea varieties.

Throughout this four-year project, three new herbicides - Brodal, Frontier and Command - have proven effective for use in processing pea crops. Herbicide strategies involving these products have been developed for a range of problem weeds including black nightshade, wild radish, cleavers (*Galium aparine*) and pinkweed (*Fumitory* spp.). All the data generated as part of this project has been supplied to the product manufacturers and/or Crop Protection Approvals to facilitate product registration or permit applications. If these applications are supported by the National Registration Authority and the product manufacturers, Brodal, Frontier and Command will become available to pea growers in the future.

Information generated from this project has been presented to industry representatives and growers through regular field days and conference presentations. These presentations also provided a means of industry feedback that gave valuable input into trial planning.

Technical Summary

Herbicide strategies in pea crops commonly involve an application of Stomp, tank-mixed with a non-selective herbicide such as Sprayseed, before the crop emerges. Post-emergent sprays include metribuzin (Lexone/Sencor), Bladex and Basagran (used under permit). Stomp provides reliable control of weeds including hogweed (*Polygonum aviculare*) and wild poppies (*Papaver* spp.), however control of weeds such as wild radish (*Raphanus raphanistrum*) and black nightshade (*Solanum nigrum*) is often not acceptable. Weeds such as wild radish and black nightshade cause significant problems in the processing factories, as their seeds are difficult to separate from the pea crop. The residual nature of Stomp may also present a risk to following crops, particularly poppies. Metribuzin (Lexone/Sencor) is currently used post-emergence to provide reliable control of weeds such as wild radish. However, field experience suggests that the use of metribuzin is linked to increased severity of collar rot diseases in pea crops.

The aim of this project was to develop improved herbicide strategies for weeds such as black nightshade and wild radish and to find alternative herbicides to metribuzin which can be used in areas where collar rot maybe a problem. Eighteen trials have been conducted in the major pea production areas across Australia, to obtain weed efficacy and crop tolerance data across a range of climates, soil types, weed spectra and pea varieties.

Throughout this four-year project, three herbicides with potential for use in processing pea crops have been identified from 20 active ingredients which were evaluated. Command is a pre-emergent herbicide with activity on a range of broadleaf and grass weed species. Trialed at rates between 125ml and 1L, Command showed efficacy on cleavers (*Galium aparine*) and hogweed (*Polygonum aviculare*). Crop safety of Command was excellent, although on light soils, appropriate low rates must be used. Weed efficacy was improved by tank-mixing Command with Frontier or Brodal. Frontier showed high crop safety and was very active on a range of weeds, including amaranthus (*Amaranthus powellii*), black nightshade and apple of peru (*Nicandra physaloides*), as well as a range of grass weed species. Brodal, despite some minor crop bleaching soon after emergence, especially on light soils, has been shown to give effective control of a range of brassica weeds including wild radish.

All the data generated as part of this project has been supplied to the product manufacturers and/or Crop Protection Approvals to facilitate product registration or permit applications. If these applications are supported by the National Registration Authority and the product manufacturers, Brodal, Frontier and Command will become available to pea growers in the future.

A disease assessment carried out at one trial site showed that the severity of foliar diseases, including *Septoria* and *Ascochyta*, was significantly less on plots sprayed with the experimental pre-emergent herbicides (Command and Frontier), when compared to the registered post-emergence alternatives.

Introduction

Green peas are principally grown for the processing industry, with around 6200ha being grown in Australia in 2000. Tasmania is the main production region for processing peas in Australia, producing around 80% of the total crop. There are also smaller production areas in Western Australia and South East Queensland.

Pre-emergence weed control in peas is heavily reliant on the use of Stomp, the residual nature of which presents a risk to following crops, particularly poppies. However, Stomp does not provide reliable control of wild radish (*Raphanus raphanistrum*) and black nightshade (*Solanum nigrum*). Both of these weeds can cause major problems in the processing factory due to difficulties separating their fruits from the peas.

Metribuzin is currently used for post-emergence weed control and provides effective control of weeds such as poppies (*Papaver* spp.) and wild radish. The use of metribuzin has been associated with the increased incidence of collar rot in pea crops. This means that the farmer is faced with the possibility of a yield reduction from the use of metribuzin, due to collar rot. Studies conducted by Serve-Ag in 1994/95 as part of HRDC project VG418 showed that the use of metribuzin alone under optimal growing conditions did not pre-dispose plants to *Ascochyta* collar rot or affect yields. Use of metribuzin may encourage *Ascochyta* rot problems only when peas were grown under stressful conditions brought about by other factors such as cold climate, poor drainage and soil structure. Research findings were supported by field observations in the 1995/96 season. Serve-Ag agronomists observed yield reductions of up to 70% due to collar rot in paddocks sprayed with metribuzin. Other products, such as Basagran (used under permit) are often used commercially rather than metribuzin, due to improved crop tolerance and lower disease risks.

The aim of this project was to develop effective weed control strategies in pea crops without the risk of damage to the crop from collar rot and without the risk of herbicide carryover to following crops. It is expected that if effective weed management strategies are identified, economic returns will be increased by:

- A reduction in collar rot severity;
- More consistent control of weeds, reducing competition and crop contamination;
- Improved flexibility in subsequent crops.

Materials and Methods

Trial Details

Annual Report	Site Number	Number of Replicates	Plot Size (meters)	Soil Texture	Location	Variety
1997/98	1	4	2 x 10	Ferrosol	East Devonport, North-West Tasmania	Small Sieve Freezer
1997/98	2	4	1.5 x 9	Black Clay	Broadmarsh, Southern Tasmania	Small Sieve Freezer
1997/98	3	4	2 x 10	Ferrosol	Kindred, North-West Tasmania	Horizon
1997/98	4	4	2 x 8	Sandy Loam	Hagley, Northern Tasmania	Resal
1998/99	1	4	2 x 5	Sandy Loam	Kendenup, Western Australia	Quantum
1998/99	2	4	2 x 8	Ferrosol	Forth, North-West Tasmania	Aladin
1998/99	3	4	2 x 8	Sandy Loam	Coal River Valley, Southern Tasmania	Small Sieve Freezer
1998/99	4	4	1.5 x 10	Black Clay	Mt Tarampa, Queensland	Bounty
1998/99	5	4	2 x 8	Ferrosol	Sassafras, North-West Tasmania	Small Sieve Freezer
1998/99	6	4	2 x 8	Alluvial	MerseyLea, North-West Tasmania	Resal
1999/00	1	4	2 x 5	Sandy Loam	Kendenup, Western Australia	Quantum
1999/00	2	4	2 x 8	Sandy Loam	Coal River Valley, Southern Tasmania	Small Sieve Freezer
1999/00	3	4	2 x 10	Ferrosol	Wesley Vale, North-West Tasmania	Trounce
1999/00	4	4	2 x 7	Sandy Loam	Harford, North-West Tasmania	Resal
2000/01	1	4	2 x 8	Alluvial	Coal River Valley, Southern Tasmania	Alladin
2000/01	2	4	2 x 8	Ferrosol	Moriarty, North-West Tasmania	Small Sieve
2000/01	3	4	16.5 m^2	Black Clay	Lowood, Queensland	Bounty
2000/01	4	4	2 x 5	Karri Loam	Kendenup, Western Australia	Quantum

Note – Further details for individual trial sites can be obtained from the annual reports for this project.

Materials and Methods (cont.)

Product Formulations

Product	Active Ingredient	Concentration of Active	Formulation	Herbicide Group*
AC299263	Imazamox	700 g/kg	Water Dispersible Granules	B
Activator	Non ionic surfactant	900 g/L	Aqueous Concentrate	N/A
Affinity (F8426)	Carfentrazone – Ethyl	240 g/L	Emulsifiable Concentrate	G
Agaprop	Propazine	500 g/L	Suspension Concentrate	C
Agral	Nonyl phenol ethylene	600 g/L	Liquid	N/A
Authority	Sulfentrazone	750 g/kg	Water Dispersible Granules	G
Balance (RP97001)	Isoxaflutole	750 g/kg	Water Dispersible Granules	F
Basagran	Bentazone	480 g/L	Aqueous Concentrate	C
Bladex	Cyanazine	500 g/L	Suspension Concentrate	C
Broadstrike	Flumetsulam	800 g/kg	Water Dispersible Granules	B
Brodal	Diflufenican	500 g/L	Suspension Concentrate	F
Command	Clomazone	480 g/L	Emulsifiable Concentrate	F
Dual	Metolachlor	720 g/L	Emulsifiable Concentrate	K
Eclipse	Metosulam	714 g/kg	Water Dispersible Granule	B
Facet (BAS514-H)	Quinclorac	250 g/L	Suspension Concentrate	I
Flame	Imazapic	700 g/kg	Water Dispersible Granules	B
Frontier	Dimethenamid	900 g/L	Emulsifiable Concentrate	K
Gardoprim	Terbuthylazine	750 g/kg	Water Dispersible Granules	C
Gardoprim	Terbuthylazine	500 g/L	Suspension Concentrate	C
Gesagard	Prometryn	500 g/L	Suspension Concentrate	C
Kerb	Propyzamide (Pronamide)	250 g/kg	Wettable Powder	K
Lexone	Metribuzin	750 g/kg	Water Dispersible Granules	C
MCPA	MCPA (Dimethylamine Salt)	500 g/L	Aqueous Concentrate	I
Raft (EXP3316B)	Oxadiargyl	400 g/L	Suspension Concentrate	G

Materials and Methods (cont.)

Product Formulations (cont.)

Product	Active Ingredient	Concentration of Active	Formulation	Herbicide Group*
Sencor	Metribuzin	700 g/kg	Water Dispersible	C
Spinnaker	Imazethapyr	200 g/L	Aqueous Concentrate	B
Starane	fluroxypyr	200 g/L	Emulsifiable Concentrate	I
Stomp	Pendimethalin	330 g/L	Emulsifiable Concentrate	D
Titus	Rimsulfuron	250 g/kg	Water Dispersible	B
Uptake	Paraffinic Oil Non Ionic Surfactant	582 g/L 208 g/L	Emulsifiable Concentrate	N/A

* The herbicide group, used for resistance management, was developed by Avcare (Appendix iii)

Application Details

EQUIPMENT	Pressurised knapsack precision sprayers
NOZZLES	Flat Fan Jets
VOLUME	220 – 600 Litres per ha
PRESSURE	210 - 300kPa

Materials and Methods (cont.)

Weed List

Bayer Code *	Weed
AMAMA	*Amaranthus macrocarpus* (dwarf amaranth)
AMAPO	*Amaranthus powellii* (amaranthus)
AROCA	*Arctotheca calendula* (cape weed)
BRSRA	*Brassica rapa* (canola)
CAPBP	*Capsella bursa-parstoris* (shepherds purse)
CHEAL	*Chenopodium album* (fat hen)
COPDI	*Coronopus didymus* (swinecress)
DATST	*Datura stramonium* (thornapple)
EMEAU	*Emex australis* (doublegee)
EROMO	*Erodium moschatum* (crowsfoot or musk storksbill)
FUMSS	*Fumaria* spp. (pinkweed or fumitory)
GALAP	*Galium aparine* (cleavers)
LAMAM	*Lamium amplexicaule* (henbit or deadnettle)
LOLPE	*Lolium perenne* (perennial ryegrass)
LOLSS	*Lolium* spp. (ryegrass)
NICPH	*Nicandra physaloides* (apple of peru/wild hops)
PAPDU	*Papaver dubium* (long-headed poppy)
PAPSO	*Papaver somniferum* (opium poppy)
PAPSS	*Papaver* spp. (wild poppy)
PHAMI	*Phalaris minor* (annual canary grass)
POLAV	*Polygonum aviculare* (hogweed or wireweed)
POLCO	*Polygonum convolvulus* (black bindweed)
POLPE	*Polygonum persicaria* (redshank)
RAPRA	*Raphanus raphanistrum* (wild radish)
SOLNI	*Solanum nigrum* (black nightshade)
SOLTU	*Solanum tuberosum* (volunteer potato)
SONOL	*Sonchus oleraceus* (sow thistle)
STEME	*Stellaria media* (chickweed)
TRFSS	*Trifolium* spp. (clover)
TRFSU	*Trifolium subterraneum* (subterranean clover)
URTUR	*Urtica urens* (stinging nettle)

* Codes as outlined in "Important Crops of the World and their Weeds" (2nd edn. 1992), published by Business Group Crop Protection, Bayer Ag, Germany.

Assessment Details

1. Crop Tolerance Assessments

TIMING - 9-91 days after pre-emergent treatments
SAMPLE SIZE - Whole Plot
METHOD - Subjective Rating
RATING SCALE - EWRS (Appendix i)
SUMMARISED RESULTS - Table 1
COMPLETE DATA - Appendix iv and Annual Reports

2. Weed Assessments

TIMING - 9-91 days after pre-emergent treatments
SAMPLE SIZE - Whole Plot
METHOD - Subjective Rating
RATING SCALE - EWRS (Appendix ii)
SUMMARISED RESULTS - Table 2
COMPLETE DATA - Annual Reports

3. Weed Counts

TIMING - 25-45 days after treatments were applied
SAMPLE SIZE - Various quadrat sizes (0.5-1m^2)
METHOD - Seedlings counted in randomly placed quadrats
SUMMARISED RESULTS - Refer to Annual Reports
COMPLETE DATA - Refer to Annual Reports
STATISTICAL ANALYSES - Refer to Annual Reports

4. Disease Assessment

TIMING - 104 days post-plant
SAMPLE SIZE - 20 Plants per plot
METHOD - Recorded number of nodes (from the base of the plant) infected with *Ascochyta* collar rot or *Septoria* blotch
SUMMARISED RESULTS - Table 3
COMPLETE DATA - Refer to Annual Report 1999
STATISTICAL ANALYSES - Refer to Annual Report 1999

Assessment Details (cont.)

5 Senescence Assessment

TIMING -	Commercial Harvest
SAMPLE SIZE -	Whole Plot
METHOD -	Visual Rating
RATING SCALE -	1-10 (1 = No Senescence, 10 = Complete Senescence)
COMPLETE DATA -	Refer to Annual Report 1998
STATISTICAL ANALYSES -	Refer to Annual Report 1998

Table 1 - Pea Crop Tolerance

Treatment Timing		Average crop EWRS Rating	Number of sites
Pre-emergence	Post-emergence		
Authority 125g		**3.60**	2
Authority 250g		**3.25**	3
Authority 400g		**3.65**	5
Authority 500g		**1.00**	1
BAS514-H 600g		**7.50**	2
Bladex 2.5L	Bladex 1.5L	**1.00**	1
Brodal 400ml		**1.00**	1
Command 125ml		**1.38**	2
Command 250ml		**1.63**	2
Command 500ml		**2.03**	9
Command 1L		**1.50**	3
Command 250ml + Brodal 100ml		**1.50**	2
Command 250ml + Brodal 200ml		**1.00**	1
Command 250ml + Frontier 750ml		**1.67**	3
Command 500ml	Brodal 200ml	**3.29**	2
Command 500ml	Basagran 1.5L + Bladex 1.5L	**2.25**	1
Command 500ml	Basagran 2L + Activator 100ml/100L	**3.13**	2
Command 500ml + Authority 250g		**1.75**	2
Command 500ml + Brodal 200ml		**2.18**	7
Command 500 ml + Authority 400g		**2.42**	2
Command 500ml + Frontier 1L		**1.75**	1
Command 500ml + Frontier 1.5L		**2.30**	10
Command 500ml + Frontier 2L		**2.25**	2
Command 500ml + Gardoprim 2L		**2.50**	1
Dual 4L	Lexone 300g	**2.75**	1
EXP3316B 410ml		**3.50**	1
EXP3316B 820ml		**3.00**	1
F8426 150ml	F8426 150ml	**9.00**	1
F8426 300ml	F8426 300ml	**9.00**	1

Table 1 - Pea Crop Tolerance (cont.)

Treatment Timing		Average crop EWRS Rating	Number of sites
Pre-emergence	Post-emergence		
Flame 25g		**2.42**	2
Frontier 1.5L		**1.69**	8
Frontier 2L		**2.00**	1
Frontier 3L		**2.75**	2
Frontier 750ml		**1.50**	2
Gardoprim 1334g		**1.00**	2
Gardoprim 2L		**1.92**	3
Gardoprim 4L		**3.00**	2
Gardoprim 667g		**1.00**	1
RP97001 120g (Balance)		**4.00**	1
RP97001 60g (Balance)		**3.00**	1
Spinnaker 300ml		**1.00**	1
Stomp 3L	Broadstrike 50g	**3.00**	1
Stomp 3L	Basagran 2L + Activator 100ml/100L	**3.25**	2
Stomp 3L	Lexone 300g	**2.75**	2
Stomp 3L	Broadstrike 50g + Uptake 500ml/100L	**4.25**	1
Stomp 3L	Basagran 1.5L + Bladex 1.5L	**2.00**	1
Stomp 3L	Bladex 2L + Lexone 300g	**3.50**	1
	AC299263 150g	**3.50**	1
	AC299263 75g	**4.00**	1
	Basagran 1.5L + Bladex 1.5L	**2.94**	4
	Basagran 2L + Activator 100ml/100L	**3.00**	1
	Broadstrike 25g	**3.00**	2
	Broadstrike 50g + Uptake 500ml/100L	**4.38**	2
	Eclipse 15g	**6.00**	2
	Eclipse 7.5g	**6.17**	2
	EXP3316B 1L	**4.00**	2
	EXP3316B 500ml	**3.50**	2
	Gesagard 1.5L	**4.25**	2

Table 1 - Pea Crop Tolerance (cont.)

Treatment Timing Post-emergence	Average crop EWRS Rating	Number of sites
Gesagard 3L	**4.50**	2
Kerb 1kg	**2.00**	1
Kerb 2kg	**2.00**	1
RP97001 120g (Balance)	**6.50**	1
RP97001 60g (Balance)	**6.00**	1
Spinnaker 200ml	**1.75**	2
Spinnaker 300ml + Agral 200ml/100L	**1.00**	1
Starane 1L	**7.50**	1
Starane 2L	**8.00**	1
Titus 120g	**6.67**	2
Titus 60g	**6.34**	2

Table 2 - Weed Susceptibility

Pre-emergence	Post-emergence	AMAPO	AROCA	BRSRA	CAPBP	CHEAL	CODPI	EROMO	FUMSS	GALAP	LAMAM	LOLPE	NICPH	PAPDU	PAPSS	POLAV	RAPRA	SOLNI	SONOL
Authority			MS	S-MS		S		S	S			S-MS	S	MS-MR	S	S-MS		S	S
Bladex	Bladex		S	MR								S							
Brodal						R							MR						
Command		MS	MS	MS		S-MS	S	S	MR			S	S	MR		S	S	S-MS	S
Command	Basagran + Bladex	S				S			S						S			S	
Command	Basagran + Activator					S			S						S	S			
Command + Authority		S				S	S		S						MS	S	S	S	
Command + Brodal		S	MR	MR		S-R	S	S	S-MR			MR	S-R	MR	S	S	S	S-MS	S
Command + Frontier		S	S	MS-MR		S	S	S	S			S	S	S	S	S	S	S-MS	S
Command + Gardoprim		S				S	S		S-MS	S						S	S	S	

Susceptibility of weeds to various herbicides based on EWRS (Appendix i) - **S**-susceptible (1 - 4), **MS**-moderately susceptible (4 - 5.5), **MR**-moderately resistant (5.5 - 7), **R**-resistant (7 - 9).

Table 2 - Weed Susceptibility (cont.)

Pre-emergence	Post-emergence	AMAPO	AROCA	BRSRA	CAPBP	CHEAL	CODPI	EROMO	FUMSS	GALAP	LAMAM	LOLPE	NICPH	PAPDU	PAPSS	POLAV	RAPRA	SOLNI	SONOL
Dual	Lexone							S								MS			
EXP3316B									S						S			S	
F8426	F8426								S						S	S			
Flame						S			MR							S			
Frontier		S	S	MS		S-MS	S		S			S	S	MS		S	MS	S	S
Gardoprim		S	S	MR		S	S		S	MR		S-MS		S	S	S	S	S-MS	
RP97001									MS-MR						MR-R	MS		MS	
Spinnaker						S							MS						MS
Stomp	Basagran + Bladex	S				S			S					S	S			S	
Stomp	Basagran + Activator					S			S	S					S	S	S	S	
Stomp	Lexone + Bladex	S				S	S		S							S	S	S	

Susceptibility of weeds to various herbicides based on EWRS (Appendix i) - **S**-susceptible (1 - 4), **MS**-moderately susceptible (4 - 5.5), **MR**-moderately resistant (5.5 - 7), **R**-resistant (7 - 9).

Table 2 - Weed Susceptibility (cont.)

Pre-emergence	Post-emergence	AMAPO	AROCA	BRSRA	CAPBP	CHEAL	CODPI	EROMO	FUMSS	GALAP	LAMAM	LOLPE	NICPH	PAPDU	PAPSS	POLAV	RAPRA	SOLNI	SONOL
Stomp	Broadstrike					S			MS							S			
Stomp	Broadstrike + Uptake	S				S													
Stomp	Lexone						S	S	S						S	S	S	S	
	AC299263								MS						MR			MS-MR	
	Basagran + Bladex				S	S		S	S		S		S		S	MS-MR			
	Broadstrike				S	MS			MS-MR		S-MS		MR			MS-MR			R
	Broadstrike + Uptake							MS	MS						R	MR-R			
	Eclipse				S				MS-MR		S					MS-MR			
	EXP3316B							MS-MR	S						S	MS-MR			
	Gesagard							S-MS	S						S	S			

Susceptibility of weeds to various herbicides based on EWRS (Appendix i) - **S**-susceptible (1 - 4), **MS**-moderately susceptible (4 - 5.5), **MR**-moderately resistant (5.5 - 7), **R**-resistant (7 - 9).

Table 2 - Weed Susceptibility (cont.)

Pre-emergence	Post-emergence	AMAPO	AROCA	BRSRA	CAPBP	CHEAL	CODPI	EROMO	FUMSS	GALAP	LAMAM	LOLPE	NICPH	PAPDU	PAPSS	POLAV	RAPRA	SOLNI	SONOL
	Kerb								R						R	R			
	RP97001								MS-MR						R			MS-MR	
	Spinnaker					R							MS						MR
	Starane							R								R			
	Titus				S				MR		S					MS-MR			

Susceptibility of weeds to various herbicides based on EWRS (Appendix i) - **S**-susceptible (1 - 4), **MS**-moderately susceptible (4 - 5.5), **MR**-moderately resistant (5.5 - 7), **R**-resistant (7 - 9).

Table 3 - Disease Assessment 30/9/98 - Forth

No.	TREATMENT TIMING		Severity Rating* - No. Nodes Infected (From Base of Plant)			
	Pre-Emergence (Applied 26/6/98)	Post-Emergence (Applied 24/8/98)	*Ascochyta*	Sig*	*Septoria*	Sig*
3	Command 500ml	Basagran 2L + Activator 100ml/100L	6.40	bc	5.30	ab
5	Command 500ml + Frontier 1.5L		5.13	ab	4.50	a
7	Stomp 3L	Basagran 2L + Activator 100ml/100L	6.77	c	5.03	ab
9	Command 250ml	Lexone 300g + Bladex 1.5 L	7.13	c	5.20	ab
10	Command 250ml	Lexone 300g	7.43	c	5.37	b
11		Lexone 300g + Bladex 1.5 L	6.07	bc	4.83	ab
12		Basagran 2L + Bladex 1.5 L	7.37	c	5.43	b
14	Untreated Control		4.37	a	5.33	ab

* Means followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Note: *Ascochyta* disease complex caused by the *Ascochyta* pathogens:
- *Ascochyta pinodella (Phoma medicarginis var. pinodella)*
- *Ascochyta pinodes (Mycosphaerella pinodes)*
- *Ascochyta pisi*

Common disease names for Ascochyta:
- *Ascochyta* blight
- *Ascochyta* rot
- Black spot
- Black stem
- Collar rot
- Foot rot
- Leaf spot
- Stem rot

Septoria blight or Bloch is caused by the pathogen *Septoria pisi.*

Discussion

Current Commercial Herbicide Strategies

Stomp is a commonly used pre-emergent herbicide in pea production. Stomp is particularly active on POLAV, CHEAL and PAPDU, with some activity on weeds such as SOLNI and FUMSS. Generally, follow-up sprays of one or more of the post-emergent herbicides Metribuzin, Bladex and Basagran (used under permit) are required for adequate weed control. Data from the 1998-99 season showed that Bladex and Metribuzin increased the severity of certain foliar diseases. Basagran provides effective control of weeds such as GALAP, RAPRA and FUMSS.

Potential Herbicide Strategies

Three products with potential for use in commercial processing pea crops have been identified throughout this project from the 20 active ingredients screened. These herbicides have been found to be suitable alternatives to current practice. Used individually, or in combinations, these products have resulted in improved efficacy on many weed species that were previously difficult to control, as well as reducing the potential for crop damage due to disease or contamination.

Command

Command is a residual herbicide with pre- and early post-emergent activity on a range of broadleaf and grass weeds. This product has been developed globally in a range of crops including soybeans, rice and potatoes. Command is taken up by the roots and shoots of emerging weeds, and acts by inhibiting the synthesis of both chlorophyll and carotenes in the plant.

Command is registered for the control of a range of broadleaf weeds, being particularly active on weeds such as GALAP and POLAV, as well as showing activity on SOLNI and NICPH. However, it does not control weeds such as RAPRA, AMAPO and FUMSS, which are common in pea crops.

Crop safety of Command is acceptable where appropriate rates are used. Like other pre-emergent soil active herbicides, soil type and characteristics have a major influence on herbicide activity. Activity of Command is heavily dependent on organic carbon and clay, to which Command is adsorbed, becoming less available in the soil. On heavier textured soils, rates of up to 1L were required for efficacy on weeds such as SOLNI, CHEAL and NICPH, while maintaining crop safety. Some transient bleaching of the crop occurred soon after emergence at sites where higher rates were used on light textured soils. On lighter textured soils, rates of 250ml were sufficient to obtain acceptable efficacy on weeds such as POLAV and CODPI.

Efficacy of Command on AROCA, CHEAL and NICPH was improved by adding Frontier in a tank mix (Photograph 2). Mixing Brodal with Command also resulted in good crop safety and improved control of weeds such as RAPRA.

Command was first registered in Australia in 1999 for use in cucurbits, green and navy beans, poppies, potatoes and tobacco. Efficacy, crop safety and residue data generated from this project has been supplied to Crop Protection Approvals Ltd to support an application for a minor use permit for Command in processing peas.

Frontier

Frontier is a pre-emergent herbicide with activity on a range of grass and broadleaf weeds. The product was developed principally for grass weed control in corn, but is also used in crops such as soybeans and sugar beet. Dimethenamid, the active ingredient in Frontier, belongs to the chloroacetamide chemical group and is taken up primarily by emerging shoots (coleoptile), and acts by reducing cell division and growth.

Frontier resulted in excellent crop safety when used pre-emergence on pea crops. Frontier controls a number of grass and broadleaf weeds, including FUMSS and AMAPO, but is less effective on broadleaf weeds such as RAPRA, CHEAL and POLAV. Mixing Command with Frontier improves control of a number of weeds including POLAV, GALAP and CHEAL (Photograph 4).

Frontier is not currently registered in any Australian crops. After a number of recent mergers between manufacturing companies, Frontier now belongs to BASF. The status of Frontier in Australia is currently uncertain, however all data collected in processing peas has been forwarded to BASF.

Brodal

Diflufenican, the active ingredient of Brodal, is a group F herbicide, which acts by inhibiting the synthesis of photosynthetic pigments. Brodal has a relatively limited spectrum of activity, but provides excellent control of weeds belonging to the brassica family, such as RAPRA, which other products developed in this work are weak on. The use of this product in pea crops would be relatively small, and it would be most useful as a tank mix with Command to improve the control of RAPRA. For this reason, it is recommended that Brodal be permitted through the AusVeg Minor Use program. A request for Brodal for post-emergence use in green peas is already underway, with a further extension to include a pre-emergence tank mix with Command.

Gardoprim

Gardoprim is a triazine compound with both pre- and post-emergent weed activity. The product is registered for a range of crops in other countries, including forestry and sweet corn. Gardoprim has been found to control a range of common weeds in processing pea crops such as CHEAL, SOLNI, and AROCA, and has excellent crop safety. Due to the fact that Gardoprim has similar chemistry to other triazine herbicides currently registered in peas, and the fact that the manufacturers are not willing to support the registration of this product in processing peas, further development of this product in processing peas is not recommended.

Other Herbicides

Other herbicides screened in this project include, AC299263, Affinity, Authority, Balance (RP97001), Broadstrike, Dual, Eclipse, Facet (BAS514-H), Flame, Gardoprim, Gesagard, Kerb, Raft (EXP3316B), Spinnaker, Starane and Titus. These products were not further developed due to earlier crop safety or weed efficiency, or other issues, such as the manufacturers not supporting their development.

Disease / Herbicide Interactions

One trial at Forth, in North-West Tasmania (Site 2, 1998/1999) had a high incidence of both *Septoria* (leaf blotch) and *Ascochtya* (collar rot) pathogens. A disease assessment was conducted to see if the different herbicide treatments affected the severity of disease symptoms caused by these pathogens. It was found that post-emergent sprays of either Lexone or Bladex significantly increased the severity of collar rot, while the pre-emergent treatment of Command + Frontier resulted in similar disease levels to the untreated control.

Grower and Industry Information Sessions

Regular field days and visits were made to trial sites throughout the life of the project. These sessions involved agronomic/field staff, growers, processing company staff from Simplot, McCains and Vital Foods, representatives of the WA Pea Growers Association, as well as herbicide manufacturers. Field days and visits have allowed participants to observe the efficacy and crop safety of the various herbicide strategies. The input of participants aided in the planning of subsequent trials.

A number of presentations at various conferences and meetings were conducted throughout the project, including the Tasmanian Agricultural Research and Advisory Committee's (ARAC's) annual presentations. These presentations allowed communication of results to growers, processing companies, agronomic/field staff and other researchers.

A poster presentation was made at the 12th Australian Weeds Conference in 1999. This presentation highlighted the problems associated with weed management in processing peas, as well as including a summary of the progress of the project at that stage.

Publications

Publicity of the project in the HRDC annual reports and the 1999 Australians Weeds Conference proceedings generated inquiries from processing pea production areas across Australia. These reports kept growers up to date with the project, particularly regarding the registration of new products.

Product Development

Product development, with the aim of obtaining registration, has been an important aspect of this project, which required close liaison with a number of companies. Meetings were held with staff from the various chemical companies and Crop Protection Approvals Ltd to facilitate product registration/permit applications.

Once any new herbicides are registered for use in processing peas, further training for growers on the use of these herbicides will be required. It is possible that this training will be done as part of the product training conducted by the manufacturer/distributor.

As a result of grower requests, data supplied from this project is being collated by Crop Protection Approvals Ltd to apply for a minor use permit for Command and Brodal in processing peas.

Note: A brief outline of individual technology transfer events is included in Table 4.

Technology Transfer (cont.)

Table 4 - Technology Transfer

Technology Transfer Activity	Date
Annual report sent to all voluntary contributors and the HRDC.	June 1998
Presentation of the project at the annual ARAC presentations.	August 1998
Field day at NW Tasmanian trial site for local Agronomists.	August 1998
FMC staff from Australia and Hong Kong visited trial site in NW Tasmania.	August 1998
Field day at Cambridge trial site for Southern Tasmanian pea growers and processing company staff.	November 1998
Meeting with BASF in Sydney to discuss Frontier.	December 1998
Meeting with FMC and BASF staff in America to discuss Command and Frontier.	March 1999
Meeting with FMC in Brisbane to discuss Command.	June 1999
Presentation of the project at the annual ARAC presentations.	July 1999
Annual report sent to all voluntary contributors and the HRDC.	September 1999
Presentation of poster at the 12th Australian Weeds Conference – Hobart.	September 1999
Field Day for McCain and Simplot staff at East Sassafras trial site.	October 1999
Field Day for McCain staff at Wesley Vale trial site.	October 1999
Meeting with BASF and FMC in Brisbane to discuss Frontier and Command.	February 2000
Meeting with FMC in Tasmania to discuss Command.	March 2000
Meeting with Pea Growers Committee and representatives from Vital Foods at Mt Barker in Western Australia.	June 2000
Presentation of the project at the annual ARAC presentations.	August 2000
Annual report sent to all voluntary contributors and the HRDC.	September 2000

Recommendations

- FMC to proceed with the registration of Command using the data generated in this project.

- BASF to proceed with the registration of Frontier using the data generated in this project.

- Serve-Ag Research to further investigate with Crop Protection Approvals Ltd., based on the data generated through this project, the extension of a current grower application for post-emergent use of Brodal in peas to include pre-emergent use of this product.

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Appendices

Appendix i

EWRS SCALE :-

(for crop tolerance)

RATING	% EFFECT	
1	0	Healthy plant
2	0.1 - 2	Very mild symptoms
3	2.1 - 5	Mild but clearly recognisable symptoms
4	5.1 - 10	More severe symptoms without necessarily an effect on yield
	----------	Limit of commercial acceptability
5	10.1 - 18	Reduction in yield expected
6	18.1 - 30	
7	30.1 - 45	Heavy damage to total kill
8	45.1 - 70	
9	70.1 - 100	

EWRS SCALE :-

(for weed control)

RATING	% EFFECT	
1	100	Complete weed kill
2	99.9 - 98	
3	97.9 - 95	
4	94.9 - 90	
	----------	Limit of commercial acceptability
5	89.9 - 82	
6	81.9 - 70	
7	69.9 - 55	
8	54.9 - 30	
9	29.9 - 0	Little to no effect on weeds

Appendix iii

Herbicide grouping based on mode of action (Developed by Avcare)

Group	Mode of Action	Chemical Group
A	Inhibitors of acetyl CoA carboxylase	Aryloxyphenoxypropionate ("fops") Cyclohexanedione ("dims)
B	Inhibitors of acetolactate synthase	Sulfonyl urea Imidazolinone Sulfonamid
C	Inhibitors of photosynthesis at photosystem II	Triazine Triazinone Urea Nitrile Benzothiadiazole Acetamide Pyridazinone Phenyl-pyridazinone Uracil
D	Inhibitors of tubulin formation	Dinitroaniline Benzoic acid
E	Inhibitors of mitosis	Thiocarbamate Carbamate Organophosphorus
F	Inhibitors of carotenoid biosynthesis	Nicotinanilide Triazole Pyridazinone
G	Inhibitors of *protoporphyrinogen oxidase*	Diphenyl ether Oxidiazole
H	Inhibitors of protein synthesis	Thiocarbamate
I	Disrupters of cell growth	Phenoxy Benzoic acid Pyridine
J	Inhibitors of fat synthesis	Alkanoic acid
K	Herbicides with diverse sites of action	Amide Organoarsenic Carbamate Aminopropionate Benzofuran Phthalamate Nitrile
L	Inhibitors of photosynthesis at photosystem I	Bipyridyl
M	Inhibitors of EBSP synthase	Glycine (glyphosate; glyphosate-trimesium)
N	Inhibitors of glutamine synthetase	Glycine

Pea Crop Tolerance Data

Pre-emerg	Post-emerg	Crop EWRS	Site	Year
Authority 125g		6.25	1	2000/2001
Authority 125g		1.00	4	2000/2001
Authority 250g		7.75	1	2000/2001
Authority 250g		1.00	3	2000/2001
Authority 250g		1.00	4	2000/2001
Authority 400g		1.50	4	1997/1998
Authority 400g		2.50	1	1998/1999
Authority 400g		3.50	2	1998/1999
Authority 400g		8.50	3	1998/1999
Authority 400g		2.25	4	1998/1999
Authority 500g		1.00	3	2000/2001
BAS514-H 600g		8.50	1	1999/2000
BAS514-H 600g		6.50	2	1999/2000
Bladex 2.5L	Bladex 1.5L	1.00	4	2000/2001
Brodal 400ml		1.00	3	2000/2001
Command 125ml		1.75	1	2000/2001
Command 125ml		1.00	4	2000/2001
Command 1L		2.00	4	1999/2000
Command 1L		1.50	2	2000/2001
Command 1L		1.00	3	2000/2001
Command 250ml + Brodal 200ml		1.00	3	2000/2001
Command 250ml		2.25	1	2000/2001
Command 250ml		1.00	4	2000/2001
Command 250ml + Brodal 100ml		2.00	1	2000/2001
Command 250ml + Brodal 100ml		1.00	4	2000/2001
Command 250ml + Frontier 750ml		3.00	1	2000/2001
Command 250ml + Frontier 750ml		1.00	3	2000/2001
Command 250ml + Frontier 750ml		1.00	4	2000/2001
Command 500ml + Authority 400g		2.33	3	1997/1998
Command 500ml + Authority 400g		2.50	4	1997/1998
Command 500ml	Basagran 1.5L + Bladex 1.5L	2.25	6	1998/1999
Command 500ml	Basagran 2L + Activator 100ml/100L	3.25	2	1998/1999
Command 500ml	Basagran 2L + Activator 100ml/100L	3.00	3	1997/1998
Command 500ml	Brodal 200ml	4.33	3	1997/1998
Command 500ml	Brodal 200ml	2.25	6	1998/1999
Command 500ml		1.25	4	1997/1998
Command 500ml		1.00	1	1998/1999
Command 500ml		4.75	3	1998/1999
Command 500ml		1.25	4	1998/1999
Command 500ml		2.50	2	1999/2000
Command 500ml		4.00	1	2000/2001
Command 500ml		1.50	2	2000/2001
Command 500ml		1.00	3	2000/2001
Command 500ml		1.00	4	2000/2001
Command 500ml + Authority 250g		1.00	1	1999/2000
Command 500ml + Authority 250g		2.50	2	1999/2000
Command 500ml + Brodal 200ml		1.50	4	1997/1998
Command 500ml + Brodal 200ml		2.00	1	1998/1999
Command 500ml + Brodal 200ml		2.00	2	1998/1999
Command 500ml + Brodal 200ml		4.75	3	1998/1999
Command 500ml + Brodal 200ml		1.00	4	1998/1999
Command 500ml + Brodal 200ml		2.00	4	1999/2000
Command 500ml + Brodal 200ml		2.00	2	2000/2001

Appendix iv

Pea Crop Tolerance Data

Pre-emerg	Post-emerg	Crop EWRS	Site	Year
Command 500ml + Frontier 1.5L		1.25	1	1998/1999
Command 500ml + Frontier 1.5L		2.25	2	1998/1999
Command 500ml + Frontier 1.5L		6.25	3	1998/1999
Command 500ml + Frontier 1.5L		1.50	4	1998/1999
Command 500ml + Frontier 1.5L		1.00	1	1999/2000
Command 500ml + Frontier 1.5L		3.75	2	1999/2000
Command 500ml + Frontier 1.5L		2.25	4	1999/2000
Command 500ml + Frontier 1.5L		1.00	3	2000/2001
Command 500ml + Frontier 1.5L		2.75	1	2000/2001
Command 500ml + Frontier 1.5L		1.00	4	2000/2001
Command 500ml + Frontier 1L		1.75	2	2000/2001
Command 500ml + Frontier 2L		1.50	4	1997/1998
Command 500ml + Frontier 2L		3.00	2	2000/2001
Command 500ml + Gardoprim 2L		2.50	4	1999/2000
Dual 4L	Lexone 300g	2.75	3	1998/1999
EXP3316B 410ml		3.50	5	1998/1999
EXP3316B 820ml		3.00	5	1998/1999
F8426 150ml	F8426 150ml	9.00	2	1998/1999
F8426 300ml	F8426 300ml	9.00	2	1998/1999
Flame 25g		2.33	3	1997/1998
Flame 25g		2.50	4	1997/1998
Frontier 1.5L		2.50	1	1998/1999
Frontier 1.5L		1.00	4	1998/1999
Frontier 1.5L		1.00	1	1999/2000
Frontier 1.5L		2.25	2	1999/2000
Frontier 1.5L		2.50	4	1999/2000
Frontier 1.5L		2.25	1	2000/2001
Frontier 1.5L		1.00	3	2000/2001
Frontier 1.5L		1.00	4	2000/2001
Frontier 2L		2.00	2	2000/2001
Frontier 3L		2.50	4	1999/2000
Frontier 3L		3.00	3	2000/2001
Frontier 750ml		2.00	1	2000/2001
Frontier 750ml		1.00	4	2000/2001
Gardoprim 1334g		1.00	4	2000/2001
Gardoprim 1334g		1.00	2	2000/2001
Gardoprim 2L		2.50	4	1999/2000
Gardoprim 2L		1.25	2	2000/2001
Gardoprim 2L		2.00	2	1998/1999
Gardoprim 4L		2.00	2	1998/1999
Gardoprim 4L		4.00	4	1999/2000
Gardoprim 667g		1.00	4	2000/2001
RP97001 120g (Balance)		4.00	5	1998/1999
RP97001 60g (Balance)		3.00	5	1998/1999
Spinnaker 300ml		1.00	1	1999/2000
Stomp 3L	Basagran 1.5L + Bladex 1.5L	2.00	6	1998/1999
Stomp 3L	Basagran 2L + Activator 100ml/100L	3.50	2	1998/1999
Stomp 3L	Basagran 2L + Activator 100ml/100L	3.00	3	1997/1998

Pea Crop Tolerance Data

Pre-emerg	Post-emerg	Crop EWRS	Site	Year
Stomp 3L	Bladex 2L + Lexone 300g	3.50	2	1999/2000
Stomp 3L	Broadstrike 50g	3.00	3	1997/1998
Stomp 3L	Broadstrike 50g + Uptake 500ml/100L	4.25	6	1998/1999
Stomp 3L	Lexone 300g	2.25	3	1998/1999
Stomp 3L	Lexone 300g	3.25	2	1999/2000
	AC299263 150g	3.50	5	1998/1999
	AC299263 75g	4.00	5	1998/1999
	Basagran 1.5L + Bladex 1.5L	2.25	3	1998/1999
	Basagran 1.5L + Bladex 1.5L	5.75	1	1998/1999
	Basagran 1.5L + Bladex 1.5L	2.25	4	1998/1999
	Basagran 1.5L + Bladex 1.5L	1.50	1	1999/2000
	Basagran 2L + Activator 100ml/100L	3.00	4	1997/1998
	Broadstrike 25g	3.00	1	1997/1998
	Broadstrike 25g	3.00	2	1997/1998
	Broadstrike 50g + Uptake 500ml/100L	4.75	3	1998/1999
	Broadstrike 50g + Uptake 500ml/100L	4.00	2	1998/1999
	Eclipse 15g	5.67	1	1997/1998
	Eclipse 15g	6.33	2	1997/1998
	Eclipse 7.5g	5.67	1	1997/1998
	Eclipse 7.5g	6.67	2	1997/1998
	EXP3316B 1L	5.50	2	1998/1999
	EXP3316B 1L	2.50	3	1998/1999
	EXP3316B 500ml	5.00	2	1998/1999
	EXP3316B 500ml	2.00	3	1998/1999
	Gesagard 1.5L	4.00	2	1998/1999
	Gesagard 1.5L	4.50	3	1998/1999
	Gesagard 3L	3.50	2	1998/1999
	Gesagard 3L	5.50	3	1998/1999
	Kerb 1kg	2.00	2	1998/1999
	Kerb 2kg	2.00	2	1998/1999
	RP97001 120g (Balance)	6.50	5	1998/1999
	RP97001 60g (Balance)	6.00	5	1998/1999
	Spinnaker 200ml	1.75	1	1998/1999
	Spinnaker 200ml	1.75	4	1998/1999
	Spinnaker 300ml + Agral 200ml/100L	1.00	1	1999/2000
	Starane 1L	7.50	3	1998/1999
	Starane 2L	8.00	3	1998/1999
	Titus 120g	6.67	1	1997/1998
	Titus 120g	6.67	2	1997/1998
	Titus 60g	6.00	1	1997/1998
	Titus 60g	6.67	2	1997/1998

Residue Samples
1998/99

Crop Part	Site	Product	Rate/Ha	Sampling Date	Total Samples
Pods	Site 2 - Forth	Command	500ml	10/11/98	2
Straw	Site 2 - Forth	Command	500ml	10/11/98	2
Pods	Site 2 - Forth	Untreated	NA	10/11/98	2
Straw	Site 2 - Forth	Untreated	NA	10/11/98	2
Straw	Site 6 - MerseyLea	MCPA	500ml	19/1/99	3
Pods	Site 6 - MerseyLea	MCPA	500ml	19/1/99	3
Straw	Site 6 - MerseyLea	MCPA	250ml	19/1/99	3
Pods	Site 6 - MerseyLea	MCPA	250ml	19/1/99	3
Straw	Site 6 - MerseyLea	Untreated	NA	19/1/99	3
Pods	Site 6 - MerseyLea	Untreated	NA	19/1/99	3

Residue Samples

1999/00

Crop Part	Site	Product	Rate/Ha	Sampling Date	Total Samples
Pods	Site 3 - Wesley Vale	Gardoprim	3L	24/11/99	2
Straw	Site 3 - Wesley Vale	Gardoprim	3L	24/11/99	2
Pods	Site 3 - Wesley Vale	Gardoprim	1.5L	24/11/99	2
Straw	Site 3 - Wesley Vale	Gardoprim	1.5L	24/11/99	2
Pods	Site 3 - Wesley Vale	Command	0.5L	24/11/99	2
Straw	Site 3 - Wesley Vale	Command	0.5L	24/11/99	2
Pods	Site 3 - Wesley Vale	Frontier	1.5L	24/11/99	2
Straw	Site 3 - Wesley Vale	Frontier	1.5L	24/11/99	2
Pods	Site 3 - Wesley Vale	Untreated	-	24/11/99	6
Straw	Site 3 - Wesley Vale	Untreated	-	24/11/99	6
Pods	Site 4 - Harford	Gardoprim	2L	24/12/99	2
Straw	Site 4 - Harford	Gardoprim	2L	24/12/99	2
Pods	Site 4 - Harford	Gardoprim	4L	24/12/99	2
Straw	Site 4 - Harford	Gardoprim	4L	24/12/99	2
Pods	Site 4 - Harford	Command	0.5L	24/12/99	2
Straw	Site 4 - Harford	Command	0.5L	24/12/99	2
Pods	Site 4 - Harford	Command	1L	24/12/99	2
Straw	Site 4 - Harford	Command	1L	24/12/99	2
Pods	Site 4 - Harford	Frontier	1.5L	24/12/99	2
Straw	Site 4 - Harford	Frontier	1.5L	24/12/99	2
Pods	Site 4 - Harford	Frontier	3L	24/12/99	2
Straw	Site 4 - Harford	Frontier	3L	24/12/99	2
Pods	Site 4 - Harford	Untreated	-	24/12/99	6
Straw	Site 4 - Harford	Untreated	-	24/12/99	6

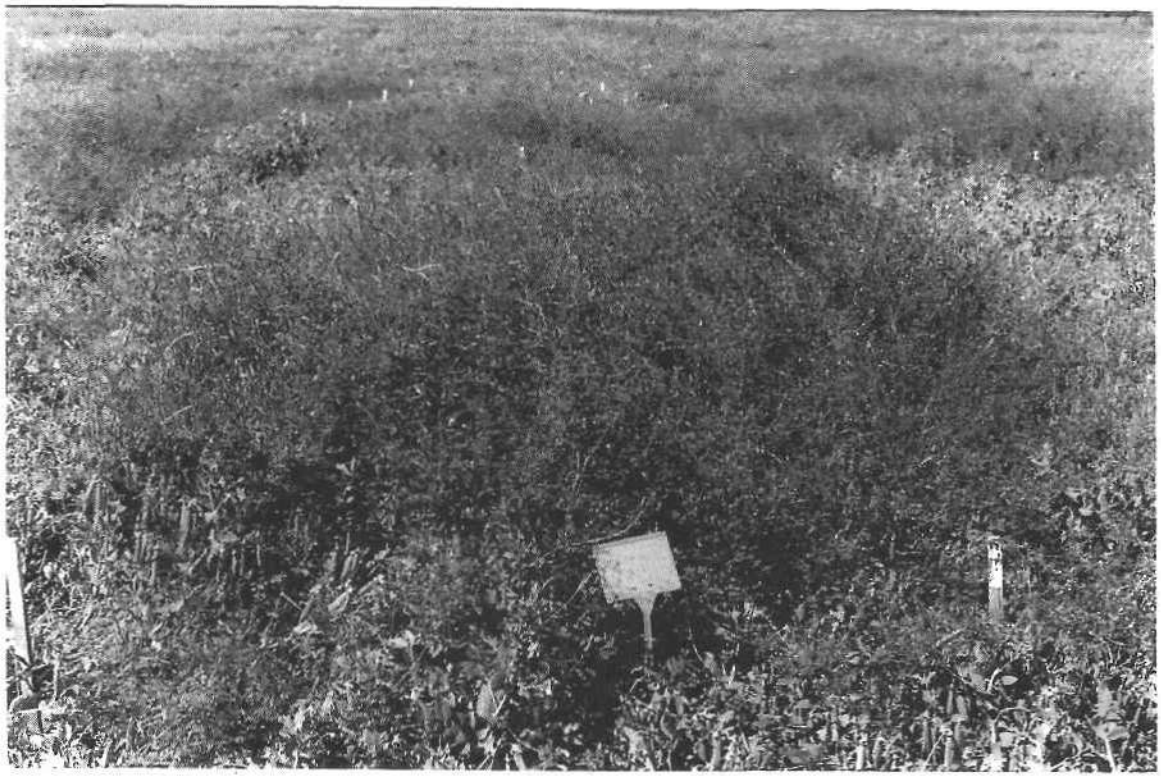
Residue Samples

2000/2001

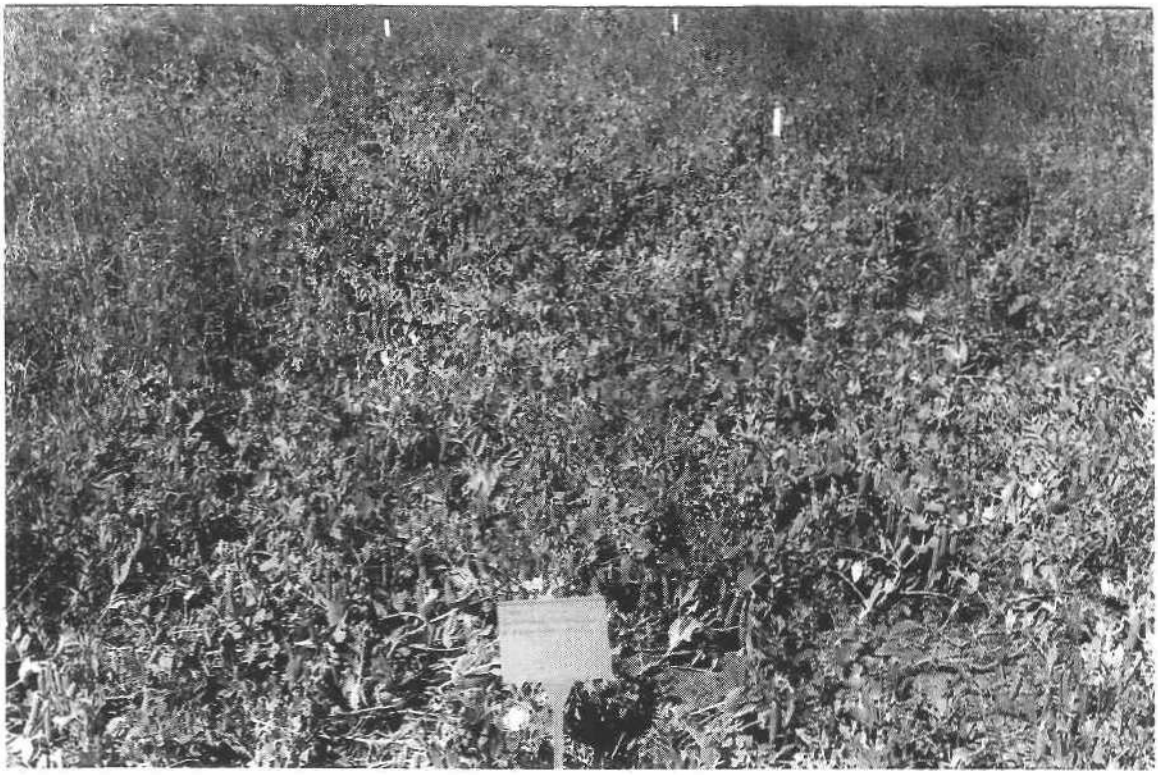
Crop Part	Site	Product	Rate/Ha	Sampling Date	Total Samples
Forage*	Site 2 Moriarty	Command	1L	10/10/00	2
Forage*	Site 2 Moriarty	Frontier	2L	10/10/00	2
Forage*	Site 2 Moriarty	Untreated	-	10/10/00	4
Pods	Site 2 Moriarty	Brodal	500ml	6/12/00	1
Straw	Site 2 Moriarty	Brodal	500ml	6/12/00	1
Pods	Site 2 Moriarty	Command	1L	6/12/00	1
Straw	Site 2 Moriarty	Command	1L	6/12/00	1
Pods	Site 2 Moriarty	Frontier	2L	6/12/00	1
Straw	Site 2 Moriarty	Frontier	2L	6/12/00	1
Pods	Site 2 Moriarty	Untreated	-	6/12/00	4
Straw	Site 2 Moriarty	Untreated	-	6/12/00	4

* Forage was collected at the 7-8 node crop stage for failed crop residue analysis.

Photographs

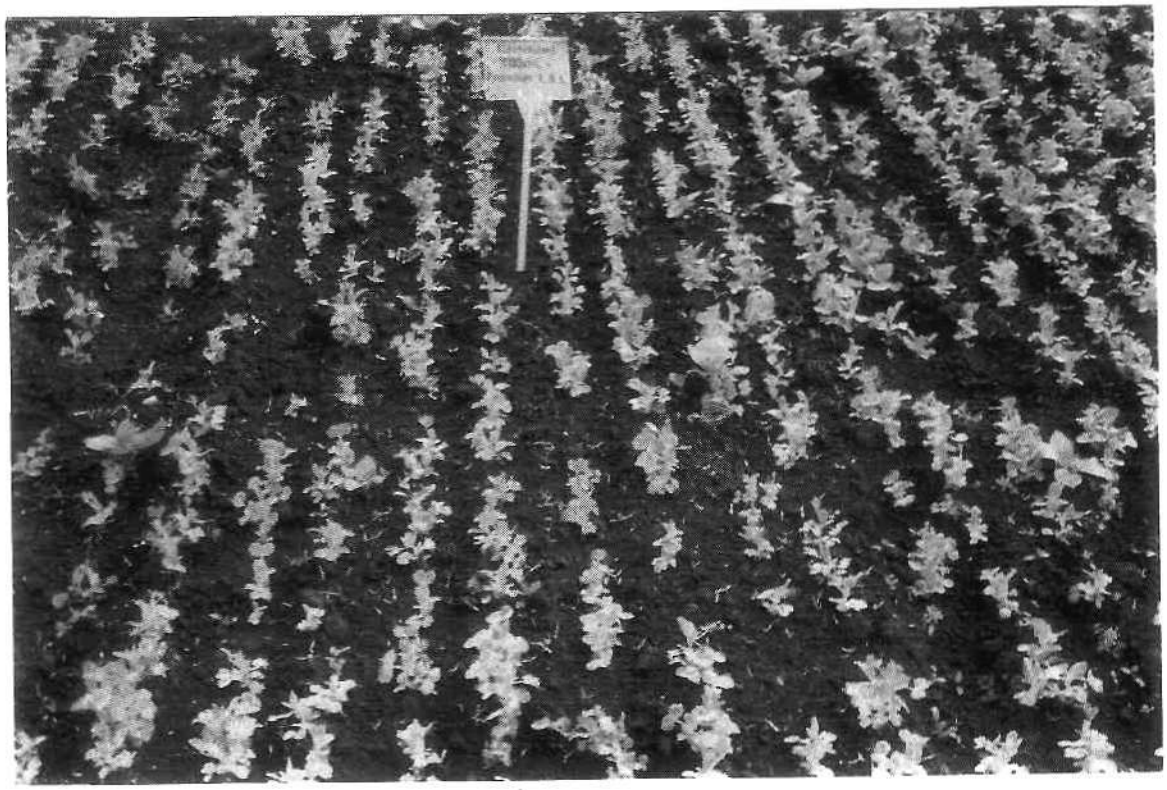


Photograph 1 – Untreated Control – Kenendup, Western Australia (1999)



Photograph 2 – Command 500ml + Frontier 1.5L, Kenendup, Western Australia (1999)

Photograph 3 – Untreated Control – Wesley Vale, North West Tasmania (7/9/99)



Photograph 4 – Command 500ml + Frontier 1.5L, Wesley Vale, North West Tasmania (7/9/99)

Photograph 5 – Trial View, Mt Tarampa, Queensland (1998)