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Weed management in onions

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Project Number: VG97038

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

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of the Tasmanian Onion Industry Panel.

ISBN 0 7341 0182 1

Published and distributed by:
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Purpose of report:	To present findings from series of trials investigating improved weed control strategies in onions grown under Tasmanian conditions, for domestic and export markets.
Funding sources:	This research was made possible with the provision of funding from the Horticultural Research and Development Corporation and Webster Horticulture.
Date:	31.07.2000

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Media Summary

In 1996 Agronico Pty Ltd (formerly known as JR and JS Shaw) was approached by The Tasmanian Onion Industry Panel to investigate improved weed control strategies for onions. Weed control in onions was very difficult to achieve safely without a high degree of agronomic experience and many herbicide applications were necessary to achieve adequate weed control. The supply of selective and registered herbicides had become scarce/unreliable and remaining options could result in crop damage.

Extensive field trials have been undertaken over the past three years to identify potential new herbicides for use in onions and to improve the pattern of use of existing herbicides.

It was concluded that:

1. The herbicides Eclipse, Titus, Command and Authority were unsuitable for use in onions.

2. Further development of the herbicides Frontier, Pyramin, Goal WP and Basagran is required in order for the viability of the Australian onion industry to compete in an increasingly competitive, fluctuating commodity market.

Technical Summary

In 1996 Agronico Pty Ltd (formerly known as JR and JS Shaw) was approached by The Tasmanian Onion Industry Panel to investigate improved weed control strategies for onions. Onion weed control in Tasmania was, and remains a refined and highly technical process because weed control in onions is very difficult to achieve safely without a high degree of agronomic experience. Many herbicide applications were necessary to achieve adequate weed control. The average cost of weed control in onions in 1995/1996 was $745 per hectare (figures obtained from Webster Horticulture). Weed control was higher than any other variable cost and did not account for the time needed by specialist agronomists that advise on weed control. This made the margin for onions lower, which in turn made growing unattractive in a very competitive world market. Even with such a high level of input, there were still significant problems with weeds in onions (e.g. wild radish, docks, volunteer potatoes, Californian thistles) that had not been solved.

Multiple herbicide applications were necessary because the onion crop is very intolerant of weeds, being slow growing and uncompetitive, therefore late weed germinations are not controlled by crop growth as is the case with cereals, potatoes etc. Of equal importance, the herbicides in use at that time were barely efficacious at the rates at which they were selective therefore a number of repeat applications at low rates were necessary to control weeds.

In 1995/1996 the supply of selective and registered herbicides such as Probe (methazole) and Tribunil (methabenzthiazuron) had become scarce. This made the task of controlling weeds in onions increasingly difficult because the herbicides that remained were less selective and therefore crop damage may have resulted in some instances.

The primary objective for this project was to develop efficacious, safe and environmentally friendly weed control options for onions, which are of lower cost than those used at that time. Secondary objectives were to include the development of a wild radish control strategy, the development of a dock control strategy and screening new herbicides for use in onions. This would ultimately lead to a reduction in herbicide applications, improved weed control, reduction in the weed burden at harvest therefore reducing harvesting costs and lowering of production costs leading to greater returns to growers.

Extensive field trials have been undertaken over the past three years to identify potential new herbicides for use in onions and to improve the pattern of use of existing herbicides.

It was concluded that:

1. The herbicides Eclipse, Titus, Command and Authority were unsuitable for use in onions.

2. Further development of the herbicides Frontier, Pyramin, Goal WP and Basagran is required in order for the viability of the Australian onion industry to compete in an increasingly competitive, fluctuating commodity market.

Introduction

In 1996 Agronico Pty Ltd (formerly known as JR and JS Shaw) was approached by The Tasmanian Onion Industry Panel to investigate improved weed control strategies for onions. Agronico Pty Ltd had been conducting weed research in onions for a number of years for their own purposes, including the development of Stomp for the control of hogweed in the absence of Probe. The company was also conversant with other processing companies, which carried out their own in-house research and field evaluations of herbicide and herbicide mixtures. This put Agronico Pty Ltd at the leading edge of weed control technology in onions.

Onion weed control in Tasmania was, and remains a refined and highly technical process. In the main (> 90 % of cases) onions are grown by farmers under contract to processing companies. These companies employ their own agronomists to advise growers on all aspects of weed control, making the weed control decisions highly controlled by experienced personnel. This decreases the risks to both the growers and the processors.

This system is in place because weed control in onions is very difficult to achieve safely without a high degree of agronomic experience. Many herbicide applications were necessary to achieve adequate weed control. Even with such a high level of input, there were still significant problems with weeds in onions (e.g. wild radish, docks, volunteer potatoes, Californian thistles) that had not been or only partially solved.

The average cost of weed control in onions in 1995/1996 was $745 per hectare (figures obtained from Webster Horticulture). Weed control was higher than any other variable cost and did not account for the time needed by specialist agronomists that advise on weed control. This made the margin for onions lower, which in turn made growing unattractive in a very competitive world market.

The general weed control program for onions in Tasmania in 1996/1997 was:
a. 12.0 L/ha Ramrod + 2.0 – 3.0 L/ha Roundup or Sprayseed + 0.75 – 1.0 L/ha Stomp just before onion emergence.
b. 2.0 L/ha Stomp +/- 3.0 L/ha Allicide at the 0.25 true leaf stage.
c. 800 ml/ha Tramat then 3 days later 750 ml/ha Totril + 750 g/ha Tribunil or 250 g/ha Linuron or 750 g/ha Probe at the 1.5 true leaf stage.
d. 750 ml/ha Totril + 750 g/ha Tribunil or 250 g/ha Linuron or 1.0 kg/ha Probe or 1.0 – 2.0 L/ha Bladex 7 days after the previous spray.
e. 2 x 800 ml/ha Tramat (7 days apart) followed by two applications of Totril + Tribunil/Linuron (7 days apart) for the control of groundkeeper potatoes.
f. Various grass herbicides to kill grasses and *Erodium* spp.

NB. This is a very general program and there are many variations depending on agronomist recommendations, the weed spectrum, the health of the onions etc.

The number of herbicide applications needed for onions at this time was (and still remains), greater than for any other rotation crop (up to 8 herbicide applications are necessary on most crops depending on weed burden) along with spot spraying and hand weeding for escaped weeds. Multiple herbicide applications were necessary

because the onion crop is very intolerant of weeds, being slow growing and uncompetitive, therefore late weed germinations are not controlled by crop growth as is the case with cereals, potatoes etc. Of equal importance, the herbicides in use at that time were barely efficacious at the rates at which they were selective therefore a number of repeat applications at low rates were necessary to control weeds.

In 1995/1996 the supply of selective and registered herbicides such as Probe (methazole) and Tribunil (methabenzthiazuron) had become scarce. Production of Probe had ceased and the production levels of Tribunil were uncertain in the medium term, with very little produced in 1996. This made the task of controlling weeds in onions increasingly difficult because the herbicides that remained were less selective and therefore crop damage may have resulted in some instances. In addition, few developments in onion weed control had occurred in the past thirty years and this needed to be addressed - particularly considering the disappearance of products and the narrowing margins of onion production and export. New products were emerging from use in horticulture such as Eclipse (metosulam), Boxer, Tough, Frontier, Command and Authority and these herbicides needed to be tested on onions as potential replacement for older products.

The primary objective for this project was to develop efficacious, safe and environmentally friendly weed control options for onions, which are of lower cost than those used at that time. Secondary objectives were to include the development of a wild radish control strategy, the development of a dock control strategy and screening new herbicides for use in onions. This would ultimately lead to a reduction in herbicide applications, improved weed control when spraying conditions are poor, greater grower acceptance of the onion crop and therefore greater ease of the onion companies to get the required hectares, reduction in the weed burden at harvest therefore reducing harvesting costs, lowering of production costs leading to greater returns to growers.

It was calculated that lowering the cost of weed control from $745 per hectare to $600 per hectare would save the industry $290 K per annum. The viability of the Tasmanian onion industry is rapidly decreasing due to a more competitive export market (e.g. New Zealand production had increased by 100 % in the 4 years prior to this project starting). More cost effective onion production will lead to higher returns for onion producers at a time when margins were poor due to an increased level of international competitiveness.

Materials and Methods

Procedure

A series of field trials have been carried out over the past three years to assess onion tolerance and herbicide efficacy under Tasmanian conditions.

All trials were situated in commercial paddocks and subject to nutrition and irrigation measures as per the commercial crop. Where applicable, plots were hand-lifted when approximately 75 % of the pseudostems softened on the onions. Plots were then bagged after 28 days on the ground and stored at ambient temperature or placed in a freezer pending residue analysis.

Experimental design and layout

An extensive range of herbicides have been trialled over the life of the project at various stages in onions including:

1. Basagran
2. Totril
3. Afalon
4. Eclipse
5. Command
6. Authority
7. Stomp
8. Allicide
9. Ramrod
10. Frontier
11. Pyramin
12. Browndown
13. Titus
14. Goal

All field trials were established as either a randomised complete block or a crossover design (with "A" treatments perpendicular to the "B" treatments). Plots were 5.0 – 10.0 metres by 1.6 – 2.0 metres. There were three - four replicates per treatment.

Treatments were applied using either a pressurised PET bottle sprayer or a tractor-mounted boom. The PET sprayer was fitted with a 2.0 metre wide boom. Nozzles used were Hardi 4110 – 12 with an output volume of 240 L/ha at 200 kPa pressure. The tractor-mounted boom, of width 3.0 metres, also used Hardi 4110 - 12 nozzles delivering 240 L/ha.

Assessment

Assessments of phytotoxicity to weeds and crop were made using a rating scale of 1 - 9 (1 = total kill; 9 = no effect) as described by Anonymous (1979). Randomised quadrat counts were used to assess weed and crop densities and results were analysed using either the CSS Statistics Package or MS Excel.

Results

Summary Results 1997/1998

The focus of trials in the first season was the evaluation of Eclipse in onions and a post-emergence screening trial for the control of bindweed and fumitory in onions.

Eclipse in onions

One of the biggest problems facing the onion industry in Tasmania is wild radish, which sometimes takes 5 or 6 herbicide applications to kill, often accompanied by severe crop setback. Five trials were conducted in onions in 1997 – 1998 to examine the efficacy of the new herbicide metosulam (Eclipse) for control of wild radish in onions. Eclipse was tested at 3.0 – 12.0 g/ha +/- Totril at 250 ml – 2.0 L/ha in onions at the flag - 2 true leaf stages.

While in some situations Eclipse was tolerated by the onions and offered very good control of wild radish and appeared to be a simple and cheap way to control wild radish and shepherds purse in onions, in other trials Eclipse had a detrimental effect on onion crops, especially when mixed with Totril. In all cases increases in Eclipse and Totril rates increased wild radish control, especially when mixed together. Eclipse alone was quite effective, but did not fully kill the wild radish plants, although it did dwarf them and restricted their growth. There was no long-term residual effect on wild radish with Eclipse and Totril.

Given the reduction in crop stature in the trials it was recommended that Totril and Eclipse are not used on the same crop. As the spectrum of weeds controlled by Eclipse is small compared with Totril, it is unlikely that Eclipse will become a replacement herbicide in onions.

Fumitory and bindweed control in onions

A crossover trial was initiated at A. Wilson's property at Wesley Vale to investigate alternative control measures for fumitory (*Fumaria muralis*), using Afalon (125 – 500 ml/ha), Basagran (500 ml – 2.0 L/ha) and Totril (500 ml – 2.0 L/ha). Treatments were applied post emergence to onions at the 2 - 3 true leaf stage. Fumitory was at the seedling - 50 mm diameter stage and bindweed at the seedling - 150 mm diameter stage.

It was found that Totril gave very good control of fumitory (Table 2). Totril alone did not control bindweed but Basagran plus Totril mixes gave very good control (Table 3). Afalon had little effect on these weeds. The onion crop tolerated all treatments (Table 1).

It was recommended that:

1. Basagran plus surfactant be tested for fumitory and bindweed control in onions.
2. Totril 1.0 L/ha + Basagran 1.0 L/ha is safe to use in onions at the 2 - 3 leaf stage, for control of fumitory and bindweed.
3. A series of trials are developed for the registration of Basagran in onions.

Summary Results 1998/1999

In 1998/99, weed control trials were conducted at seven onion sites, the emphasis being the development of new broad-spectrum pre-emergence herbicides and early post-emergence weed control.

Pre-emergence weed control

Two pre-emergence herbicide trials were conducted in which the following new products were evaluated: Command, Authority and Frontier. From this research, Frontier was well tolerated by the onions when applied pre-emergence, but the level of control of "difficult" weed species such as wild radish, was inadequate (Table 4). Command and Authority produced excellent weed control but were poorly tolerated by onions. Stomp, Allicide and Ramrod were used as control treatments and provided good control of weed species known to be susceptible to these herbicides e.g. Stomp for wireweed control.

Early post-emergence weed control

Pyramin and Frontier in onions

Onion tolerance to both Frontier and Pyramin was good at both trial sites, with better results seen at Chaplin Bros. where the onions were at the 2 - 2 ¼ true leaf stage at the time of application (Table 5).

Both Pyramin and Frontier gave some, but incomplete, control of fumitory, with Frontier the better of the two treatments. Over spray by commercial applications accounts for some of the variability seen with the results and the low stature scores in the controls. In addition, Stomp had been applied to the site as part of the commercial program prior to the initiation of the trial, and due to wet conditions the fumitory was affected hence the low stature scores in the controls.

At the initial assessment nightshade was present in all plots treated with Pyramin and absent in all plots, with the exception of one, treated with Frontier (Table 6). Pyramin offered some control of the weed when reassessed 48 days after treatment application but Frontier was still controlling the nightshade.

It was concluded that Frontier applied as a post-emergence treatment, offered improved control of weeds including fumitory than as a pre-emergence treatment. Frontier may have a role in onions as an early post-emergence herbicide but will need further evaluation. Pyramin is an expensive product that produced a relatively low level of control of weeds in the trial conducted but may potentially be used as a sequentially applied, pre-emergence herbicide in onions, with each application at lower than the standard rate.

The control of fumitory, potatoes, thistles and bindweed in onions.
A trial was initiated at Boat Harbour, Tasmania, for the control of fumitory (*Fumaria* spp.), thistles (*Cirsium vulgare*), and bindweed (*Polygonum nigrum*), in onions and at Table Cape, Tasmania, for the control of volunteer potatoes in onions. Titus, Totril, Browndown and Linuron, in various combinations, were tested in onions for the control of these weeds with Totril and Linuron included in the trial as commercial controls for the previously unscreened Titus and Browndown.

The onions were at the 1 - 1½ true leaf stage, fumitory was at the cotyledon - 2 true leaf stage, Bindweed was at the 1 true leaf stage and the volunteer potatoes 10.0 cm high at the time of application.

Titus proved to be of no use in onions and it was recommended that Titus is not used in onions at this crop stage (Table 7).

Browndown is a similar product to Goal in that both have oxyflurofen as the active ingredient. The level of oxyfluorfen is much lower in Browndown than in Goal and in addition it also contains a wetting agent. The results with Browndown were encouraging, (particularly in that it is a less expensive treatment than the current herbicides used for control of these weeds), and further trials were recommended to examine the possibility of using Linuron plus Browndown for the control of fumitory and bindweed in onions. Totril plus either Browndown or Linuron offered good control of volunteer potatoes and recovery in stature scores at the second assessment may be attributed to regrowth, escapes and new growth. While none of the treatments offered complete control of the potatoes with a single application, all treatments had some effect on potato stature, with the lowest score recorded with Totril plus Linuron. It is envisaged that large gains in the control of this volunteer potatoes can be attained through further evaluation of herbicide combinations

Basagran, Stomp, Totril for the control of fumitory and wild radish in onions.
The early post-emergence control of fumitory (*Fumaria* spp.) and wild radish (*Raphanus raphanistrum*), in onions at the 1 - 1½ true leaf stage had been unsatisfactory. Low availability of onion herbicides in some seasons meant that alternative herbicides were required which could be drawn on in periods of poor supply. Basagran was investigated as an alternative post-emergence herbicide in onions and was applied in combination with other herbicides or with a wetting agent.

The results showed that the onions tolerated Basagran at all rates tested at the 1 - 1½ true leaf stage (Table 8). All treatments gave some control of both fumitory and wild radish although Basagran at 1.0 L/ha + Activator was less effective than other treatments.
Totril at 500 ml/ha + Basagran at 1.0 - 2.0 L/ha or Stomp at 2.0 l/ha + Basagran at 1.0 - 2.0 L/ha may be used to control wild radish and fumitory in onions at the 1 - 1½ true leaf stage but due to concerns regarding reduced stature in some plots, it was recommended that further trials are carried out to validate crop tolerance prior to commercial acceptance and that it proceed to registration.

Summary Results 1999/2000

The objectives of these trials were to develop new weed control strategies in onions that aimed to reduce the number of herbicide applications and reduce the overall cost and to conduct registration trials for both new products and those that have significant changes in use patterns.

Areas of investigation focused on:

a. Pre-emergence weed control
b. Early post-emergence weed control
c. Generation of data for registration of Basagran in onions
d. Comparison of Goal WP versus Goal EC in onions

Pre-emergence Weed Control

Pre-emergence weed control in onions
The herbicide Pyramin was screened at a range of rates, with sequential applications, for improved residual weed control in onions. When applied at 0.5 - 2.0 Kg/ha in three sequential applications 5 -13 days apart, Pyramin was well tolerated by the crop and had no effect on onion density (Table 9). Pyramin did not offer effective control of fumitory, sow thistle or wild radish nor significantly reduce weed density. It was recommended that further work should be undertaken to fully assess the efficacy and tolerance of Pyramin in onions given that the herbicide is effective for several weeks after application, and there may not have been sufficient time between treatment application and assessment, for the full effects to be seen. Pyramin should be further evaluated in combination with other herbicides to determine if efficacy could be improved eg. Totril, Tribunil, Linuron i.e. in a similar manner to Alicep.

Early Post-emergence Weed Control

Frontier for early post-emergence weed control in onions
Crop tolerance to Frontier was good at all rates tested and there were no significant differences between treatments with respect to onion density (Tables 10 and 11). Frontier at did not offer significant control of hogweed, sow thistle, wild radish, sorrel, fat hen or clover. It was recommended that Frontier is safe to use at the ½ true leaf stage in onions at 1.0 – 4.0 L/ha and while post-emergence applications of Frontier will not control established weeds, it will extend the period of residual weed control.

Generation of data for registration of Basagran in onions
Basagran was tested for post emergence tolerance in onions, its affect on crop yield and efficacy on various weed species. The chemicals were applied at the 2 - 4 true leaf stage. Basagran was shown to have no significant effect on onion yield or density (Tables 13 and 14). There was some initial reduction in plant stature related to Basagran application but the crop recovered from this (Table 12). Basagran did not reduce the stature of clover but was very effective on field madder at rates greater

than 1.0 L/ha. Basagran reduced the stature of nightshade at 2.0 L/ha alone and at 1.0 – 4.0 l/ha +/- Activator. Field madder density was also significantly reduced at all rates tested. It was recommended that further trials be initiated to investigate the use of sequential applications of Basagran for the control of wild radish in onions.

Comparison of Goal WP versus Goal EC in onions

Onion tolerance to post-emergence applications of Goal WP and Goal EC were evaluated. Goal WP was applied as a single or a sequential application. There were no obvious differences between Goal EC and Goal WP, with two applications of Goal WP being tolerated by the onions (Table 15). Goal WP appeared to have a slight advantage over Goal EC and was safe to use on onions at the 6 – 8 true leaf stage at the rates tested. Additional trials were recommended to confirm this prior to commercial adoption of the herbicide. It was further recommended that trials are carried out to determine potential use patterns of Goal WP in onions under Tasmanian conditions to determine crop tolerance at the 1 – 2 true leaf stage or earlier and at a range of rates.

Table 1 - Onion stature 1st December 1997, 34 DAT (1 = total kill; 9 = no effect).

"A" treatments →	Basagran			
"B" treatments ↓	500 ml/ha	1.0 L/ha	2.0 L/ha	Untreated
Totril: 500 ml/ha	9	9	9	9
Totril: 1.0 L/ha	9	9	9	9
Totril: 2.0 L/ha	9	9	9	9
Afalon: 125 ml/ha	9	9	9	9
Afalon: 250 ml/ha	9	9	9	9
Afalon: 500 ml/ha	9	9	9	9
Untreated	9	9	9	9

Table 2 - Fumitory stature 1st December 1997, 34 DAT (1 = total kill; 9 = no effect).

"A" treatments →	Basagran			
"B" treatments ↓	500 ml/ha	1.0 L/ha	2.0 L/ha	Untreated
Totril: 500 ml/ha	1	2	1	1
Totril: 1.0 L/ha	2	2	2	2
Totril: 2.0 L/ha	1	2	1	2
Afalon: 125 ml/ha	9	9	9	9
Afalon: 250 ml/ha	9	9	9	9
Afalon: 500 ml/ha	9	9	9	9
Untreated	9	9	9	9

Table 3 - Bindweed stature 1st December 1997, 34 DAT (1 = total kill; 9 = no effect).

"A" treatments →	Basagran			
"B" treatments ↓	**500 ml/ha**	**1.0 L/ha**	**2.0 L/ha**	**Untreated**
Totril: 500 ml/ha	2	1	2	9
Totril: 1.0 L/ha	2	1	1	9
Totril: 2.0 L/ha	1	1	1	9
Afalon: 125 ml/ha	9	9	9	9
Afalon: 250 ml/ha	9	9	9	9
Afalon: 500 ml/ha	9	9	9	9
Untreated	9	9	9	9

Table 4 - Mean crop and weed stature and density. Stature scores assessed as 1 = total kill, 9 = no effect, density measured as count per m^2 quadrat.

	S. Radford			I. Charleston		
	Onion stature	Wild Radish stature	Wild Radish density	Onion stature	Onion density	Wild Radish density
Treatment	**19 DAT**	**19 DAT**	**22 DAT**	**40 DAT**	**40 DAT**	**40 DAT**
Command: 100 ml/ha	2.50	4.75	8.33	5.75	23.25a	32.00
Command: 200 ml/ha	1.50	3.50	33.25	8.00	32.00	29.75
Command: 400 ml/ha	1.00	2.00	62.66	7.75	40.00	24.25b
Authority: 100 g/ha	2.75	8.00	37.25	6.50	41.00	36.00
Authority: 200 g/ha	1.75	7.75	19.75	6.00	31.00	19.00b
Authority: 400 g/ha	1.00	1.00	51.00	6.50	34.25	9.00b
Frontier: 500 ml/ha	9.00	9.00	49.33	8.50	53.50	21.25b
Frontier: 1.0 L/ha	8.75	9.00	20.66	6.25	30.25	30.00
Frontier: 2.0 L/ha	7.50	6.75	24.00	8.00	41.25	40.75
CIPC: 3.6 L/ha	8.25	2.00	33.75	5.75	23.25a	32.00
Stomp: 1.0 L/ha	8.25	6.25	29.00	8.00	32.00	29.75
Ramrod: 12.0 L/ha	8.25	9.00	58.33	7.75	40.00	24.25b
Untreated	8.50	9.00	21.00	6.50	41.00	36.00

Note: a = significantly lower than untreated (p = 5 %; LSD = 14.40).

Note: b = significantly lower wild radish density than untreated (p = 5 %; LSD = 15.34).

Analysis of variance onion density I. Charleston trial site:

Effect	Degrees of freedom	Mean square	F	P
Treatment	8	306.9028	3.151762	0.013853
Block	3	100.3333	1.030381	0.396802
Error	24	97.37500		
Total	35			

There were significant differences between treatments (p = 5 %; LSD = 14.40)

Analysis of variance wild radish density I. Charleston trial:

Effect	Degrees of freedom	Mean square	F	P
Treatment	8	370.0695	3.351151	0.010181
Block	3	133.5556	1.209408	0.327677
Error	24	100.4306		
Total	35			

There were significant differences between treatments ($p = 5$ %; LSD = 15.34)

Table 5 - Mean crop and stature scores; 1 = total kill, 9 = no effect

	Craigie Bros.		**Chaplin Bros.**	
	Onion	**Fumitory**	**Onion**	
Treatment	22 DAT	22 DAT	21 DAT	48 DAT
Pyramin: 1.0 kg/ha	8.50	5.25	9.00	9.00
Pyramin: 2.0 kg/ha	8.75	5.00	9.00	9.00
Pyramin: 4.0 kg/ha	8.00	5.75	9.00	9.00
Frontier: 1.0 L/ha	8.75	2.75	9.00	9.00
Frontier: 2.0 L/ha	8.00	4.00	9.00	9.00
Frontier: 4.0 L/ha	8.00	3.00	9.00	9.00
Untreated	8.75	5.50	9.00	9.00

Table 6 - Mean percentage nightshade presence in plots in Chaplin Bros. trial site.

Treatment	21 DAT	48 DAT
Pyramin: 1.0 kg/ha	100	50
Pyramin: 2.0 kg/ha	100	25
Pyramin: 4.0 kg/ha	100	75
Frontier: 1.0 L/ha	0	0
Frontier: 2.0 L/ha	0	0
Frontier: 4.0 L/ha	25	50
Untreated	100	50

Table 7 - Mean crop and weed stature scores; 1 = total kill, 9 = no effect

	M. Beswick				C. Daking			
	Onion	Fumitory	Thistle	Bindweed	Onion		Potato	
Treatment	19 DAT	19 DAT	19 DAT	19 DAT	27 DAT	65 DAT	27 DAT	65 DAT
Titus 30 g/ha*	6.00	3.75	8.00	9.00	6.50	6.50	6.25	6.25
Titus 60 g/ha*	5.00	1.00	6.00	-	5.75	6.75	7.25	6.25
Totril 500 ml/ha*	7.50	3.00	5.67	8.00	8.75	8.50	4.00	6.50
Totril 500 ml/ha + Browndown 500 ml/ha*	8.00	4.67	6.75	9.00	6.25	7.75	2.25	6.25
Totril 500 ml/ha + Linuron 250 ml/ha*	6.50	3.25	6.00	-	7.00	8.50	2.25	5.25
Browndown 500 ml/ha + Linuron 250 ml/ha	7.75	1.50	8.00	-	8.00	8.00	4.50	6.75
Untreated*	9.00	6.67	6.33	8.00	8.75	9.00	8.25	9.00

Note: * = possible commercial overspray of replicates within trial

Note: - = absent

Table 8 - Crop and weed stature assessed on 21st October 1998 - 12 days after treatment application; 1 = total kill, 9 = no effect.

Treatment	Onion	Wild radish	Fumitory
Totril: 500 ml/ha + Basagran: 1.0 L/ha	7.25	2.00	2.25
Totril: 500 ml/ha + Basagran: 2.0 L/ha	7.25	1.50	2.00
Basagran: 1.0 L/ha + Activator	7.25	4.00	3.25
Basagran: 2.0 L/ha + Activator	7.50	2.00	2.00
Stomp: 2.0 L/ha + Basagran: 1.0 L/ha	7.50	2.50	2.25
Stomp: 2.0 L/ha + Basagran: 2.0 L/ha	7.00	2.75	2.00
Untreated	8.50	5.75	6.50

Table 9 - Mean crop and weed stature and density at A. Gilham site assessed 35 days after first treatment application, 22 days after second treatment application, 10 days after third treatment application. Stature scores assessed as 1 = total kill, 9 = no effect, density recorded per 0.75 m^2 quadrat.

Treatment		Onion stature	Onion density	Fumitory stature	Fumitory density	Sow thistle stature	Sow thistle density
Pyramin 0.5 kg/ha	**(x 1)**	8.33	52.67	9.00	1.33	8.33	1.00
	(x 2)	8.00	39.33	8.00	2.00	8.33	1.00
	(x 3)	8.33	45.00	7.50	1.00	8.00	0.00
Pyramin 1.0 kg/ha	**(x 1)**	8.33	47.33	8.00	2.00	8.00	0.33
	(x 2)	8.00	40.67	9.00	0.33	8.00	1.33
	(x 3)	8.33	46.00	8.00	2.00	7.00	1.00
Pyramin 1.5 kg/ha	**(x 1)**	8.33	35.33	7.70	1.67	8.50	1.33
	(x 2)	8.33	37.33	7.70	1.67	-	0.00
	(x 3)	8.33	49.00	8.50	1.00	8.00	0.33
Pyramin 2.0 kg/ha	**(x 1)**	8.00	46.33	8.00	1.33	8.50	2.00
	(x 2)	8.00	42.33	7.70	2.00	8.50	0.67
	(x 3)	7.67	42.00	8.00	1.33	8.00	0.33
Untreated		8.33	39.33	-	0.00	8.00	1.33
		8.33	31.33	7.30	2.67	9.00	0.33
		8.67	51.67	8.00	0.67	9.00	1.00

There were no significant differences between treatments with respect to onion, fumitory or sow thistle density (p = 5%).

Table 10 - Mean stature scores 8th November 1999 – 17 days after treatment application ; 1= total kill, 9 = no effect

Treatment	Onion	Hogweed	Sow thistle	Wild radish	Sorrel	Fat hen	Clover
Frontier 1.0 L/ha	8.33	9.00	9.00	8.67	8.50	8.00	8.67
Frontier 2.0 L/ha	8.33	9.00	9.00	-	7.33	8.33	8.67
Frontier 3.0 L/ha	8.00	8.67	9.00	8.50	-	8.00	8.33
Frontier 4.0 L/ha	7.33	8.67	9.00	9.00	8.00	8.33	7.67
Untreated	8.67	9.00	9.00	9.00	8.50	8.67	9.00

Table 11 - Mean density per 1.0 m^2 quadrat 8th November 1999 – 17 days after treatment application

Treatment	Onion	Hogweed	Sow thistle	Wild radish	Sorrel	Fat hen	Clover
Frontier 1.0 L/ha	23.00	1.33	2.33	0.00	0.33	6.67	19.67
Frontier 2.0 L/ha	20.67	5.00	2.00	0.00	0.67	8.00	16.67
Frontier 3.0 L/ha	28.33	3.67	1.00	0.00	0.00	6.33	14.67
Frontier 4.0 L/ha	21.33	3.67	1.33	0.00	0.00	6.33	15.67
Untreated	30.00	3.00	1.00	0.00	0.00	6.67	20.67

There were no significant differences between treatments (p = 5 %).

Table 12 – Mean crop and weed stature scores; 1= total kill, 9 = no effect

	FVRS										N. Johnson					
	Onion		Nightshade		Field madder		Wild radish		Clover		Onion		Wild radish		Potato	
Treatment	19 DAT	42 DAT	19 DAT	42 DAT	19 DAT	42 DAT	19 DAT	42 DAT	19 DAT	42 DAT	20 DAT	40 DAT	20 DAT	40 DAT	20 DAT	40 DAT
Basagran 1.0 L/ha	8.50	8.25	8.00	NR	3.30	NR	1.00	8.00	8.0	NR	9.00	8.50	8.00	NR	8.00	0.25
Basagran 2.0 L/ha	8.00	8.00	9.00	NR	1.00	NR	-	9.00	8.5	NR	8.50	8.25	8.70	NR	7.50	0.75
Basagran 4.0 L/ha	7.50	8.00	9.00	NR	1.00	NR	9.00	9.00	6.8	NR	8.00	7.50	7.80	NR	7.50	0.50
Basagran 1.0 L/ha + Activator	8.00	7.75	9.00	NR	4.00	NR	9.00	9.00	8.3	NR	7.50	8.25	8.00	NR	7.25	1.25
Basagran 2.0 L/ha + Activator	6.75	7.50	9.00	NR	1.00	NR	-	9.00	8.3	NR	6.50	7.50	8.00	NR	6.75	1.00
Basagran 4.0 L/ha + Activator	5.00	6.50	8.50	NR	3.00	NR	3.70	8.50	7.5	NR	5.75	7.75	8.00	NR	7.00	0.00
Untreated	8.50	8.75	9.00	NR	8.00	NR	7.30	9.00	8.0	NR	8.75	8.75	8.70	NR	8.50	4.50

Where NR = Not recorded

Table 13 – Mean crop and weed density per 1.0 m^2 quadrat. N. Johnson site assessed 40 days after treatment application; FVRS site assessed 19 days after treatment application.

	N. Johnson		*FVRS*				
Treatment	**Onion**	**Potato**	**Onion**	**Field madder**	**Wild radish**	**Nightshade**	**Clover**
Basagran 1.0 L/ha	49.75	1.50a	21.25	0.25b	0.00	3.75	1.25
Basagran 2.0 L/ha	53.75	0.00	18.25	0.25b	0.00	1.25c	0.75
Basagran 4.0 L/ha	43.00	0.50	21.75	0.00b	0.00	2.75	0.75
Basagran 1.0 L/ha + Activator	45.50	0.50	20.00	1.00b	0.00	1.00c	1.25
Basagran 2.0 L/ha + Activator	41.25	1.25	22.75	0.25b	0.00	0.50	1.75
Basagran 4.0 L/ha + Activator	44.25	1.00	15.75	0.00b	0.25	1.50c	1.50
Untreated	48.00	0.00	18.25	3.25	0.00	3.75	1.25

Note: a = Significantly higher potato density than untreated and Basagran at 2.0 L/ha (p = 5%; LSD =1.48).

Note: b = Significantly lower field madder density per m^2 than untreated (p = 5%; LSD =1.28).

Note: c = Significantly lower nightshade density per m^2 than untreated and Basagran at 1.0 L/ha (p=5%; LSD = 1.85).

Analysis of variance for potato density:

Effect	Degrees of freedom	Mean Squares	F	P
Treatment	6	1.39286	3.00	0.02813
Block	3	1.08333	1.75	0.18363
Error	18	0.36111		
Total	27			

There were significant differences between treatments (p = 5%; LSD = 1.48)

Analysis of variance for nightshade density:

Effect	Degrees of freedom	Mean Squares	F	p
Treatment	6	23.869048	3.488372	0.01496
Block	3	13.142857	1.693548	0.19502
Error	18	1.5555556		
Total	27			

There were significant differences between treatments (p=5%; LSD = 1.85)

Analysis of variance for field madder density:

Effect	Degrees of freedom	Mean Squares	F	p
Treatment	6	23.869048	6.73529	0.00044
Block	3	13.142857	0.59259	0.62589
Error	18	0.7539683		
Total	27			

There were significant differences between treatments (p=5%; LSD = 1.28)

Table 14 - Onion yield (g/1.0 m^2 quadrat)

	N. Johnson	**FVRS**
Treatment	**96 DAT**	**96 DAT**
Basagran 1.0 L/ha	4318.75	4637.50
Basagran 2.0 L/ha	4100.00	5818.75
Basagran 4.0 L/ha	3718.75	4825.00
Basagran 1.0 L/ha + Activator	3950.00	5037.50
Basagran 2.0 L/ha + Activator	3437.50	5406.25
Basagran 4.0 L/ha + Activator	3912.50	4268.75
Untreated	4100.00	4506.25

There were no significant differences between treatments with respect to onion yield at either trial site (p = 5%)

Table 15 - Crop and weed stature scores; 1 = total kill, 9 = no effect.

Treatment	Onion		Wild radish		Hogweed	
	19 DAT	36 DAT	19 DAT	36 DAT	19 DAT	36 DAT
Goal WP 150g/ha	7.75	7.75	6.75	2.33	NR	7.25
Goal WP 300g/ha	6.75	6.75	6.33	3.67	NR	7.00
Goal WP 450g/ha	8.00	8.00	6.25	4.00	NR	7.25
Goal WP 600g/ha	7.25	7.25	5.00	1.50	NR	7.25
Goal EC 500ml/ha	7.00	7.00	4.50	1.33	NR	7.00
Goal WP 150g/ha (x2 applications)	7.75*	7.75	6.75*	2.33	NR	7.00
Goal WP 300g/ha (x2 applications)	7.50*	7.50	5.50*	2.67	NR	7.25
Goal WP 450g/ha (x2 applications)	7.75*	7.75	4.25*	2.33	NR	7.00
Goal WP 600g/ha (x2 applications)	7.00*	7.00	3.00*	1.00	NR	6.75
Untreated	7.75*	7.75	7.75*	2.25	NR	7.25

Where * = 1 of 2 applications completed

Where NR = Not recorded

Discussion

This project was initiated because weed control in onions was very difficult to achieve safely without a high degree of agronomic experience and many herbicide applications were necessary to achieve adequate weed control. The supply of selective and registered herbicides had become scarce/unreliable and remaining options could result in crop damage.

The primary objective for this project was to develop efficacious, safe and environmentally friendly weed control options for onions, which are of lower cost than those used at that time. Secondary objectives were to include the development of a wild radish control strategy, the development of a dock control strategy and screening new herbicides for use in onions.

Current control strategy

The number of herbicide applications needed for onions remains greater than for any other rotation crop. With the withdrawal of Probe from the market and the future supply of Tribunil uncertain, industry has had to rely on use of low dose, multiple applications of less selective, herbicides which are poorly tolerated by the crop unless used in strict accordance with agronomist guidelines.

The use of Ramrod for residual pre-emergence weed control has been withdrawn in most cases on the basis that it is extremely expensive (approximately $125 per hectare). Early weed control currently relies on the use of Stomp followed by Bladex/Linuron – the latter being very hard on the crop, affects yield and can only be used after the 1.25 true leaf stage. Spot spraying and hand weeding escaped weeds such as wild radish and volunteer potatoes are a significant problem not to mention expense, if weeds are not controlled at the crucial early stages of the crop. Experience in weed control has definitely resulted in a reduction of the weed burden at harvest thus reducing harvesting costs.

Identification of new products/new use patterns

Extensive field trials concluded that Eclipse, Titus, Command and Authority were unsuitable for use in onions. While some new products have been identified as potential weed control options, this project also concentrated on improving the pattern of use of existing herbicides.

Pyramin was screened at a range of rates, with sequential applications, for improved residual weed control in onions and while well tolerated by the crop it did not offer effective control of fumitory, sow thistle or wild radish nor significantly reduce weed density. It was recommended that further work should be undertaken to fully assess the efficacy and tolerance of Pyramin in onions including in combination with other herbicides to determine if efficacy could be improved eg. Stomp, Totril, Tribunil, Linuron etc.

Crop tolerance to Frontier was good when applied at early post-emergence. While post-emergence applications of Frontier will not control established weeds, it will extend the period of residual weed control.

Goal EC is currently used in onions for the control of seedling wild radish but due to poor crop tolerance, it cannot be used prior to the 2 – 3 true leaf stage – by which stage the weed may have escaped. Browndown is a similar product to Goal in that both have oxyflurofen as the active ingredient. The level of oxyfluorfen is much lower in Browndown than in Goal and in addition it also contains a wetting agent. The results with Browndown were encouraging, (particularly in that it is a less expensive treatment than the current herbicides used for control of these weeds), and further trials were recommended to examine the possibility of using Totril/Linuron plus Browndown for the control of fumitory, volunteer potatoes and bindweed in onions.

Goal in a wettable powder formulation has been registered in New Zealand for early weed control in onions and reportedly does not result in the severe crop damage as that of the emulsifiable concentrate (EC). Preliminary screening of this product in later crop stages did not offer significant advantages over the EC formulation, but further trials were recommended in early crop stages. Use of this product at this early stage will have obvious benefits.

Basagran has been identified in field trials as a potential effective herbicide in onion weed control programs. The combination of Basagran plus Totril produced effective control of fumitory and field madder. Field madder and a close relative, cleavers can be very difficult to control in commercial onions. Basagran was also identified as a possible alternative to Totril for the control of wild radish at early post-emergence. Basagran is much more selective to the crop than Totril and has no affect on yield. Discussions are currently underway with Aventis regarding the possible registration of Basagran in onions.

Grower acceptance of the onion crop

One of the aims of this project was to increase the ease of contracting growers for the onion industry through grower acceptance. While onions remain a commodity crop and the Tasmanian industry was in a strong position in the export marketplace with high prices for the product and experienced agronomy advice, grower acceptance of the product was excellent. Increased overseas competition and low commodity prices experienced recently has reinforced the need for improved weed control strategies for the Australian onion industry to remain viable.

Reduction in weed control cost

The cost of weed control in onions has decreased from $745 per hectare to $360 - $400 per hectare and is primarily a result of a reduction in the use of Ramrod ($125 per hectare in 1998/99) but may also be attributed to increased agronomist and grower experience. While this is a significant reduction in production costs, this figure

remains high as the need for multiple, low dose herbicide applications for weed control in onions remains.

Recommendation

Onions remain an intensive, highly technical crop. Weed control strategies require highly skilled agronomists and the availability of selective herbicides. Given the unreliability of Tribunil supply, alternative herbicides remain a priority for the Tasmanian onion industry. It is recommended that further development of the herbicides Frontier, Pyramin, Goal WP and Basagran is required in order for the viability of the Australian onion industry to compete in an increasingly competitive, fluctuating commodity market.

Technology Transfer

This research was commissioned with the support of the he peak association for onion production in Tasmania. It is composed of representatives from all the major packing companies (Field Fresh (formerly Clements and Marshall, Roberts, Vecon and Webster Horticulture), Perfecta, and Forth Farm), growers, consultants and government.

Industry support has been excellent throughout this project. Industry was consulted as to the direction of the research program prior to the start of each season, and once approved trials were initiated.

Final reports were presented to the Tasmanian Onion Industry Panel summarizing field trial results and recommendations and researchers attended any research seminars conducted by the panel.

Regular updates of trial progress were made through attendance at weekly Webster Horticulture field meetings, (at which Agronico Pty Ltd representative attended on a weekly basis and which members of the panel were present).

All of the processing companies on the panel have their own agronomy staff that regularly visits onion growers (weekly to fortnightly) and results are extended directly to growers in this way. Field staff were approached for trial sites in commercial paddocks and made regular inspections of the trials.

Acknowledgements

The production of this report would not have been possible without the contributions of the following people (in alphabetical order):

Stewart McKay: For assisting with trial practicalities and assessments.

Craig Shalders: For assisting with trial practicalities and assessments.

Julian Shaw: For finding trial sites, offering suggestions for treatments, proof reading documents and offering insights.

Ian McLeod: For suggesting new chemicals to trial.

Also the following growers for trial sites: M. McKenna, A. Bramich, M. Radcliff, A. Wilson, M. Beswick, M. Baker, C. Daking, S. Radford, I. Charleston, Chaplin Bros., Craigie Bros., A. Gilham, A. Johnson, P. Page, N. Johnson, L. Butler and M. Ryan.

This work was funded by the Horticultural Research and Development Corporation and the Tasmanian Onion Industry Panel.

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