Horticulture Innovation Australia

Final Report

Pyrethrum disease, weeds and crop management

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Botanical Resources Australia

Project Number: OT03001

OT03001

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Media summary

Pyrethrum is a perennial crop grown for the extraction of pyrethrins which are used in many formulations for the control of insect pests. Natural pyrethrum has a market niche in uses where high human safety and a natural image are valued. It is strongly supported by an extensive mammalian and environmental safety data package and many years of effective usage. Synthetic pyrethroids have the lion's share of the market due to their lower costs. However, they are more residual and do not have an equivalent safety profile. This has also led to insect resistance in commercial use.

The main aim of this research project was to continue to improve the yield of pyrethrum crops. This increases the competitive position of the industry relative to overseas suppliers, who are based in developing countries in Africa.
Pyrethrum yields have increased by 50% from the period 2001 to 2003. This was due to the focus applied to the crop by dedicated field staff and IDO's in implementing the gains from R&D. During the term of this project from 2004 to 2006, this yield improvement has been maintained under challenging growing conditions of very dry and very wet seasons. Work is required to lift yields further and meet industry targets.

Gains have been made in areas of weed and disease control, weed and disease resistance management and lower cost of production. These gains have been effectively introduced into commercial practice with the assistance of the HAL funded Industry Development Officer Project OT01003.
Australia now supplies over 40% of the world's demand for natural pyrethrum.

Technical summary

Outcomes of the OTO3001 Pyrethrum diseases, weeds and crop management improvement program

Aims of the project

1. Improved yields through advances in weed and disease control, and other management techniques. Improved yields reduce the unit cost of production and maintain grower and industry margins under increasing competitive pressure.

Specifically, the following yield targets were set:

2004 harvest	yield 42.7 kg/ha
2005 harvest	yield 46.3 kg/ha
2006 harvest	yield 50.0 kg/ha

2. Improved yield reliability, with a reduced spread from upper to lower yield results. The existing benchmark used was from the 2003 harvest where the standard deviation was 13.3 kg/ha
3. An increased yield ceiling, with a target of 85 kg/ha set. The current yield record is 75 kg/ha
4. Reduction of weed escapes and herbicide resistance
5. Improved water use and fertiliser efficiency
6. Reduced reliance on pesticides for weed and disease control

The specific aims of weed control research were

a. Reduction in the cost of the program
b. Development of a management strategy to deal with herbicide resistance
c. Development of options for the control of weed escapes, in particular to commercialise the control options identified in the previous project OT00002

The specific aims of disease control research were

d. Improved long term control of *Sclerotinia minor*, leading to lower levels of crop failure and maintenance of adequate plant density, with consequent benefits to yield
e. Identification of options to Sumisclex for *S minor* control, either alternative fungicides or complementary non chemical control methods
f. Optimum use of fungicides in terms of timing and number of applications for control of *Phoma ligulicola*
g. An environmentally acceptable, low cost solution to nematode control

The specific aims of irrigation and nutrition research were

h. A clearer understanding of yield response resulting from varying levels of irrigation input
i. A clearer understanding of the yield response from nitrogen application
j. Improvement in the responsible use of nitrogen fertiliser

Achievements

1. Improved yields

The majority of the research in this project involved testing treatments in replicated field trials, and assessing the effect of these treatments on crop growth and yield.

Table 1: Yield of commercial crops versus project targets

Year of harvest	***Four year rolling average, kg/ha pyrethrins***	***Project yield target, kg/ha pyrethrins***
2004	36.1	42.7
2005	38.4	46.3
2006	38.2	50.0

Pyrethrum yields were increased by 50% from the period 2001 to 2003. This was due to the focus applied to the crop by dedicated field staff and IDO's in implementing the gains from R&D. During the term of this project from 2004 to 2006, this yield improvement has been maintained under challenging growing conditions of very dry and very wet seasons. The project yield targets have not been met, so there is more work to do.
There has been a good degree of success in further improving the yields of crops coming up to their first harvest as the table below shows.

Table 2: Yield of crops by year of harvest, 4 year rolling average

Year of harvest	***First harvest yields, kg/ha pyrethrins***	***Harvest 2,3,4 yields, kg/ha pyrethrins***
2004	39.6	34.5
2005	44.9	36.1
2006	45.5	35.8

Lower yields have come from older crops (harvest 2, 3 and 4).

There are a number of possible reasons for this.

- First year sites have approximately 16 months from sowing to flowering, providing a longer time frame to produce biomass. Older sites must recover from cutting and harvesting in January to produce vegetative growth in the autumn through to early spring before sending up flowering shoots, a growing period of 10 months. A continued run of very dry autumns has meant that plant stature leading into winter has been small for these H 2, 3 and 4 crops. For example, the Devonport rainfall for the period February to May for the years 2003, 2004 and 2005 was 212, 137, and 72 mm respectively versus a long term average of 226 mm. The February to May rainfall for 2002 that preceded the high yielding year of 2003 was only 71 mm, so clearly there are other factors operating as well.
- Weed control research identified simazine as effective in controlling a range of troublesome weed escapes such as groundsel, burr chervil and knotted hedge parsley in harvest 2, 3 and 4 crops. This herbicide does not control cleavers, and when used in sequence with diflufenican to enable control of this weed, crop damage can result. Consequently, improvement in weed control in commercial crops hit a snag because of

this finding, and good weed control has been difficult to achieve in some commercial crops. Baron WP (a wettable powder formulation of oxyfluorfen) was identified in the last year of the project as capable of controlling groundsel and looks to be compatible with other commercially used herbicides.

- Spring 2005 saw record wet conditions. For example, Devonport rainfall for the period August to December was 607 mm versus a long term average of 344 mm. This led to waterlogging in some sites and high disease pressure. Residual herbicides lost activity, resulting in a flush of weeds leading up to harvest.

2. *Yield reliability*

Table 3: Variability in pyrethrum yields

Year of harvest	***Actual standard deviation, kg/ha pyrethrins***
2004	11.5
2005	11.6
2006	13.1

- The standard deviation of yields in 2003 was 13.3 kg/ha. On average there has been a 9% reduction in the variability of yields from commercial crops over the life of the project.

3. *Yield ceiling*

Table 4: Highest yield achieved

Year of harvest	***Highest yield, kg/ha pyrethrins***
2004	65.5
2005	65.3
2006	55.6

- A target of 85 kg/ha was set. The highest yield achieved over the three year period was 65.5 kg/ha in 2004. Yield potential in very high yielding crops has probably been limited by flower diseases in 2005 and 2006.

4. *Reduction of weed escapes and herbicide resistance*

Table 5: Assessment of weed escapes

Year of harvest	***% sites classed as very weedy at harvest***
2004	11
2005	14
2006	29

- The major weed escapes in the past three years have been a range of thistle and grass species and white clover. Groundsel and cleavers are in the second tier of weed escapes. *Apiaceae* weeds such as burr chervil and knotted hedge parsley are not as significant as they once were due to the introduction of new herbicides into the program. The 2006 harvest was affected by the very wet conditions in the spring of 2005, reducing the activity of residual herbicides.
- Further improvement in weed control will be dependant on a more comprehensive herbicide program with superior crop safety and effective extension to growers.

5. *Improved water use efficiency and fertiliser use*

- Most crops are irrigated at flowering during periods of moisture stress, a trend to increased irrigation compared to previous practice. R&D in the area of crop nutrition has confirmed that the crop is not highly responsive to applied fertiliser. Fertiliser practice is aimed mainly at balancing nutrient removal. Further gains in water and fertiliser use efficiency will be dependant on continuing yield improvement.

6. *Reduced reliance on pesticides for weed and disease control*

- The use of micronised gypsum has been introduced as an additive to Sumisclex to improve control of *Sclerotinia minor*.

Specific achievements:

Weed control

1. Reduction in cost

- In 2003 harvest crops the cost of herbicides averaged $818 per hectare for first year crops and $333 per hectare for harvest 2, 3 and 4 crops. In 2006 harvest crops the cost of herbicides averaged $786 per hectare and $322 per hectare for harvest 2, 3 and 4 crops. This equates to a reduction of 4% in first harvest crops and 3% in harvest 2, 3 and 4 crops. On the current production area, this is an overall saving of $17,000 p.a. to growers

2. Development of a management strategy to deal with herbicide resistance

- Two new herbicides dimethenamid-p and imazamox were identified in this project to control ryegrass resistant to the "fop" and "dim" herbicides. Imazamox has been incorporated into the commercial program whilst dimethenamid-p has not yet been registered in Australia.
- Recommendations for the management of paddocks after pyrethrum have been drawn up and communicated to growers

3. Reduction in escapes

- See the information presented above under "reduction of weed escapes and herbicide resistance"
- Baron WP (a wettable powder formulation of oxyfluorfen) has been identified as being capable of controlling groundsel and looks to be compatible with other commercially used herbicides. Further trial work is required.
- Imazamox and carfentrazone-ethyl have been incorporated into the commercial program for control of *Apiaceae* weeds and cleavers.
- Diflufenican has been introduced into the commercial program for the control of seedling weeds in newly sown pyrethrum

Disease control

1. Improved long term control of *Sclerotinia minor*, leading to lower levels of crop failure and maintenance of adequate plant density, with consequent benefits to yield

- The incidence of *Sclerotinia minor* in crops over the three year life of the project is shown in Table 6 below. The incidence has not been that high, but it is difficult to separate the effect of weather conditions and management practices on the low level of incidence.

Table 6: Incidence of Sclerotinia minor

Year of harvest	***% sites severely affected by S minor***
2004	6
2005	0.5
2006	3

2. Identification of options to Sumisclex for *S minor* control, either alternative fungicides or complementary non chemical control methods

- Research during the life of the project identified boscalid and asoxystrobin as alternatives to Sumisclex. Micronised gypsum improved disease control when used as an additive and this has been introduced into commercial practice. Plant growth regulators offer some potential, and should be investigated in a future project.

3. Optimum use of fungicides in terms of timing and number of applications for control of *Phoma ligulicola*

- This work supplemented the research conducted by TIAR under an ARC project. Two new fungicides have been identified as having similar or improved control over the disease compared to products currently in commercial use. Timing of fungicides has been refined to a crop growth stage rather than a calendar date.

4. An environmentally acceptable, low cost solution to nematode control

- Leguminous crops should be avoided in favour of grass species prior to planting pyrethrum into fields containing *Pratylenchus penetrans*
- Some commercial cultivars of pyrethrum supported significantly less multiplication of *Pratylenchus penetrans*
- Insufficient data was collected to assess the value of biofumigant crops prior to planting pyrethrum

Irrigation and nutrition

1. A clearer understanding of yield response resulting from varying levels of irrigation input

- A clear cut positive response to irrigation has not been able to be demonstrated in replicated field trials, despite visual differences in flower maturity between dryland and irrigated treatments and strong evidence from evaluation of commercial results. There was an interaction between flower disease caused by *Botrytis cinerea* and increased irrigation at flowering in a trial conducted in 2004/05. It is possible that flower disease has negated the yield response in these trials. The current commercial fungicide program is relatively ineffective on *Botrytis.* Further R&D is required in this area.

2. A clearer understanding of the yield response from nitrogen application

- Trials conducted during this project indicate that pyrethrum does not respond to nitrogen application, even when soil nitrate levels are very low. Either pyrethrum is a very good scavenger of nitrogen or the response is too small to pick up under the assessment methods used. Increased nitrogen application led to lodging in trials conducted in first harvest crops.

3. Improvement in the responsible use of nitrogen fertiliser

- Research has promoted a minimalist approach to nutrition of pyrethrum. Excessive use of nitrogen is unlikely to occur.

Industry recommendations

- Over the past 9 years HAL funded pyrethrum agronomy projects have been able to establish pyrethrum as a reliable, profitable crop for Australian growers. This has come about through the development of some key technologies including
  a. Establishment by direct seeding rather than transplanting
  b. An effective high quality seed production system and an effective weed control program to support direct seeding
  c. Identification and management of the major disease threats
  d. Identification of the potential benefits of irrigation during flowering
  e. Development of an efficient mechanical harvesting method
- Future agronomic research should focus on fine tuning areas of weed and disease control to provide sustainability in yield improvement as weed spectrums change and pathogens adapt to existing practices. A better understanding of the physiology of the crop will enable an identification of the key parameters that influence yield and the management practices that influence these parameters. Significant cultivar improvement has not occurred since the mid 1990's. The greatest long term gain is now most likely to occur from an emphasis in this area.
- Pyrethrum is a highly variable crop making it very difficult to pick up the effect of treatments in replicated field trials. Further work is required to reduce the cost and improve the reliability of yield assessment in this crop.

Technology transfer

Botanical Resources Australia – Agricultural Services Pty Ltd (BRA) employs 5 agronomists (includes 3 IDO's) whose role it is to provide advice to contracted pyrethrum growers. Crops are inspected on a weekly to fortnightly basis, with regular communication with growers.

Agronomists are kept up to date with R&D developments through regular communication with research staff, visits to trial sites as part of monthly BRA field staff meetings and close involvement with R&D planning.

Growers are informed of developments through contact with these BRA staff, and attendance at grower meetings including a main R&D seminar held in October of each year. Growers also receive periodic updates via a newsletter, "Daisy Chain" that is posted to them by BRA. Research partners produce grower technical leaflets on specific topics as required.

BRA has formed a grower focus group with the specific aim of driving yield improvement and industry cost savings.

WEED CONTROL RESEARCH

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This report contains information on chemicals.
The advice provided in this publication is intended as a source of information only.

No person should act on the basis of the contents of this publication, whether as to matters of fact or opinion or other content, without first obtaining specific, independent professional advice in respect of the matters set out in this publication.

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2 SUMMARY

Weed control in direct seeded first year pyrethrum is a major challenge due to the slow rate of pyrethrum establishment. Also the perennial nature of pyrethrum makes weed control important in first year crops in order to reduce weed pressure through subsequent harvest years. This has created the need for different herbicide strategies in first year and post-harvest pyrethrum crops.

Research conducted from 1997-2003 has contributed to the development of an economically viable industry, however a number of weeds have escaped the commercial program, leading to the need for continued spot spraying.

The major objective of this project was to reduce the intensity and cost of the current herbicide program without comprising weed control. This was carried out by focussing on the integration of Raptor and Affinity for use in first year crops, improving white clover control and evaluating the safety of the residual herbicide simazine and other residual herbicides for use in post harvest pyrethrum crops.

As a result of research conducted over the past three years Raptor and Affinity have been integrated into the commercial program and possible alternatives to the Tramat program have been identified such as the use of pre and post-emergent Brodal in combination with post-emergent Raptor. However, safety concerns with this alternative restrict its integration into the commercial program on a large scale.

The use of simazine, which provides good residual control of a broad spectrum of weeds, has been shown to be unsafe when combined with other herbicides such as Brodal. Alternatives such as Baron WP, Goltix and On-Duty have been tested and show promise in providing good efficacy for some of the escaped weeds (eg Baron WP's control of groundsel). Further work needs to be conducted with these residual herbicides.

The major objective of reducing spray intensity especially in first year crops could be possible at sites which are clean and have good pyrethrum establishment, if Gallery applications are brought forward from the current 6 true leaf application time to 2 – 4 true leaf growth stage. This however, needs further investigation in order to form part of an integrated program.

The identification of new residual herbicides for use in post-harvest crops still requires further attention. More research also needs to be conducted into the control of escaped weeds in first year crops in order to reduce the intensity of weed pressure in subsequent post-harvest crops.

3 INTRODUCTION

Weed control in direct seeded first year pyrethrum is a major challenge due to the slow rate of pyrethrum establishment. Also the perennial nature of pyrethrum makes weed control important in first year crops in order to reduce weed pressure through subsequent harvest years. This has created the need for different herbicide strategies in first year and post-harvest pyrethrum crops.

Research conducted from 1997 to 2000 assisted in the development of an economically viable industry, with successful crop establishment achieved through pre-emergent applications of Stomp followed by Totril or Stomp/Totril tank mixes. Weed control in established or post-harvest crops, has relied primarily upon applications of Stomp, Goal and Brodal. While this program is quite successful escape weeds have led to the need for expensive spot spraying.

White clover (*Trifolium repens*) has been identified as a problem weed in both first year and post-harvest pyrethrum. The escape of white clover in first year sites can lead to problems in post-harvest sites and the need for expensive spot spraying. Effective control of white clover relies on applications of Tramat followed by combinations of Stomp, Totril and Linuron; these applications are quite intensive and can be hard on the crop. Several herbicides for the control of white clover have been identified. These include Brodal in new crops, and Eclipse/Brodal combinations in established sites. The use of Eclipse in combination with Brodal has led to significant pre-emergent control of white clover and reduced the need for spot spraying. However, as Eclipse and Brodal only suppress the growth of established white clover, successful control in first year crops still rely on the Tramat program mentioned above.

Wild radish (*Raphanus raphanistrum*) is one of the most competitive weeds in North West Tasmania. This weed can be a particular problem in pyrethrum due to its germination and establishment rates when compared with those of pyrethrum. The current program for first year sites provides good control of wild radish, although the program relies heavily on Gallery leading to the need to identify alternative 'backup' herbicides. Research conducted during 2000-2003 has identified Raptor as a substitute for herbicides such as Brodal and Totril for early wild radish control, particularly in situations where Amaranthus is expected to cause problems

In both first year and post-harvest crops *Apiaceae* weeds such as burr chervil (*Anthriscus caucalis*) and knotted hedge parsley (*Torilis nodosa*) were identified as a serious problem. Initial screening trials identified a number of potential control measures including Diuron Flo, Command and Bladex. However inconsistent efficacy and crop safety results with the use of Diuron Flo and Bladex have left few control options for *Apiaceae* weeds.

Groundsel (*Senecio vulgaris*) germinates from autumn to spring, and has been identified as a problem weed in established crops. Goal is currently recommended but will not provide the required level of residual control at the rates that are safe to the crop when applied in the autumn. Simazine has demonstrated good control of weeds including thistles and groundsel and provides good residual activity; however, negative interactions can occur with simazine and Brodal. These previous results highlight the need for increased safety trials and the screening of new herbicides for the control of weeds such as groundsel.

The majority of highlighted escaped weeds in established crops have seeds which germinate in late winter and early spring, a period when the tolerance of pyrethrum to herbicides is particularly low. Therefore the identification of longer term residual herbicides which can be applied in autumn and offer control well into spring may present solutions to the control of many escaped weeds.

The main objective of the current project was to find safe and effective solutions to the major escaped weeds (White clover, burr chervil, knotted hedge parsley and groundsel) in order to reduce the need for costly spot spraying. Another objective was to identify alternative pre and post emergent herbicides that were able to offer at least the current level of weed control whilst reducing the intensity of the current herbicide program. This report describes the research behind achieving these objectives.

4 GENERAL MATERIALS AND METHODS

4.1 Location

These trials were conducted at various locations along the North West coast of Tasmania on soils ranging from red ferrosols to sandy loams.

4.2 Equipment

All treatments were applied with a PET sprayer with either a 1.5 metre boom (2 metre swathe width) or a 2 metre boom (2.5 metre swathe width). The boom was fitted with Hardi 4110-12 nozzles or the corresponding Hardi ISO nozzles (number 025; lilac 110°). A carrier volume of approximately 250L/ha was applied at 200kPa (2 bar).

4.3 Assessments

Assessments were carried out on the basis of pyrethrum density/health and the weed density/health. Pyrethrum density was determined by counting the number of plants per 0.25m^2 quadrat. The same counts were carried out for determining weed density. Where densities at the pre-treatment assessments were variable between treatments, data has been presented as the change in plant density for the trial period. From this data representation, negative results indicated a reduction in plant density over the trial period. Also pyrethrum health as a percentage of ground cover over the whole plot was estimated where this was a better representation of crop health.

Crop safety as well as target weed damage was assessed using the EWRC rating system for herbicide efficacy (Table 1).

Table 1. EWRC rating scheme for crop safety and weed efficacy

EWRC Score	Weed control Efficacy (%weed kill)	Crop Tolerance
1	Complete kill (100%)	No effect
2	Excellent (98 to 99%)	Very slight effects
3	Very good (95 to 94%)	Slight effects; stunting and yellowing obvious; effects reversible
4	Good – acceptable (90 to 94%)	Substantial chlorosis and/or stunting; probably no effect on yield; most effects reversible
5	Moderate but not generally acceptable (83 to 89%)	Strong chlorosis/stunting; thinning of crop; some yield loss expected
6	Fair (70 to 82%)	
7	Poor (56 to 69%)	Increasing severity of damage
8	Very poor (30 to 55%)	
9	None (0 to 30%)	Total loss of crop

5 IMPROVING CHEMICAL WEED CONTROL IN FIRST YEAR PYRETHRUM CROPS

5.1 SELECTIVE WEED CONTROL IN FIRST YEAR PYRETHRUM

5.1.1 INTRODUCTION

There has been extensive screening of pre-emergent and early post emergent herbicides for selective weed control in first year pyrethrum crops prior to the commencement of this project. Of the many herbicides screened Brodal, Raptor, Affinity and Gallery were identified as products for inclusion into the commercial herbicide program. After work completed in this project during 2002/03, Raptor and Affinity have been integrated successfully into the commercial herbicide program.

Gallery is normally applied when the pyrethrum is at approximately 6 true leaf (late summer/early autumn). At this application time, excellent control of emerging weeds is gained. However, Gallery is only efficacious when applied to a clean seed bed. If Gallery is able to be applied earlier then 6 true leaf there is the possibility for spray intensity to be reduced as further sprays may be minimised.

The following trials were focused on finding ways to reduce the intensity of the herbicide program for first year pyrethrum crops without compromising the success of the current commercial program. As a result, the residual herbicide Gallery was examined in relation to safety and efficacy at an earlier period than its current commercial use in first year pyrethrum crops. In addition, new residual herbicides or formulations were screened at this early stage to determine if the use of later herbicide application could be reduced without compromising weed control, especially on escaped weeds such as *Apiaceae*, cleavers, groundsel, wild radish and grasses. The control of white clover will be discussed in the following section 5.2.

5.1.2 MATERIALS AND METHODS

5.1.2.1 Trial locations

Table 2. Trial location and details

Trial no.	Year	Title	Location	Application Growth stage	Herbicides	Target weeds	Period
03-PY-015	2003/04	Gallery applied at different growth stages	Forth - Yaxley's farm	Pre-emergent Cotyledon 2 – 4TL 4 + TL	Gallery	White clover	Oct-Jan
04-PY-011	2004	Gallery interaction	Wesley Vale - Colin Chaplin	2 – 4 TL	Gallery Various	Various	Sep-Nov

04-PY-013	2004	Brodal program variation	Sassafras - Lehman's farm	Coty – 2TL 2 – 4TL	Brodal Various	Various	Sep-Nov
04-PY-014	2004	Gallery rate and timing	Forth - Bonney's farm	Coty – 2TL 2 – 4TL	Gallery Stomp Brodal Totril Affinity	Various	Sep-Nov
05-PY-018	2005/06	Alternative early weed control	Kindred - Ian Charleston	Early weed, March 8th	Command Gallery Baron WP Simazine	Various	Oct-Jan
05-PY-021	2005/06	Post-emergent screening trial	Abbotsham - N. Johnson	2 – 4TL	Baron WP On-Duty Goltix Commercials	Various	Oct-Jan

Trials conducted during 2003 were broadcast seeded with "Huia Super Strike" white clover, before being planted with "Pyrite" pyrethrum.

5.1.2.2 Application methods

All trials had treatments applied using a gas powered PET sprayer with a boom width of 1.5 metres (2 metre swathe width), fitted with Hardi 4110-12 nozzles and a carrier volume of 250L/ha at 200kPa, with the exception of trial 04-PY-014 (Bonney's 2004) which used Hardi 4680-13E nozzles with spray drift covers.

Application timing varied throughout the trials and is outline in Table 2.

5.1.2.3 Assessment methods

All trials were assessed using randomised quadrat counts to determine pyrethrum and weed density. Pyrethrum and weed stature was assessed using the EWRC rating scheme outlined in Table 1.

Where applicable, statistics have been carried out using the professional statistics package, Statgraphics Plus 2.1, for Windows. The use of statistical analysis is noted by the significance groupings to the right of tabulated figures and LSD calculated at the bottom of corresponding tables.

5.1.3 RESULTS

Gallery has commonly been used in pyrethrum from the 6 true-leaf stage. Trial 03-PY-015 in 2003 evaluated the use of Gallery at younger growth stages. In this trial Gallery was applied at either 125 or 250g/ha at different growth rates, pre-emergent, cotyledon, 2 – 4 true leaf and +4 true leaf. Prior to these treatments being applied Sprayseed 2.4L/ha, Stomp 1L/ha and Lorsban 700mL/ha was applied over the whole trial area.

Pre-emergent application of Gallery at both 125 and 250g/ha considerably reduced pyrethrum count when compared with untreated plots (Table 3). Applications of Gallery at cotyledon , 2-4 true leaf and +4 true leaf did not appear to impact on pyrethrum establishment and count at rates up to 250g/ha.

Table 3. Pyrethrum count, per m^2 (trial 03-PY-015, Bonney's Farm 2003)

Treatment	Time of Application (Pye growth stage)	Count
Gallery 125 g/ha	Pre-emergent	12.0
Gallery 250 g/ha	Pre-emergent	1.2
Gallery 125 g/ha	Cotyledon	72.0
Gallery 250 g/ha	Cotyledon	58.4
Gallery 125 g/ha	2-4 True Leaf	41.2
Gallery 250 g/ha	2-4 True Leaf	30.8
Gallery 125 g/ha	4+ True Leaf	47.2
Gallery 250 g/ha	4+ True Leaf	55.6
Untreated Control	-	48.8

Trial 04-PY-011 in 2004 was conducted to investigate possible interactions between Gallery and other chemicals used in the commercial herbicide program. In this trial Gallery was applied at 250g/ha immediately before separate applications of Totril, Brodal, Affinity, Linuron, Stomp, Command, Frontier, and Raptor as well as various combinations of the above. All the treatments were applied at the 2- 4 true leaf stage. Prior to treatments being applied, Stomp 3L/ha, Brodal 75mL/ha (pre-emergent), and Stomp 3L/ha, Brodal 50mL/ha (cotyledon to 2 true leaf) were applied.

Pyrethrum count was not significantly reduced ($P<0.05$) by any of the treatments, however, Gallery/Frontier P applications did reduce density by 7.3 plants/m^2 and severely stunted surviving plants. Visual observations (data not presented) indicated Gallery mixes with Brodal, Affinity, Linuron and Stomp stunted plants but did not reduce counts.

Table 4. Mean change in pyrethrum count, per m^2, between 28 days and 56 days after applications of treatments, (trial 04-PY-011, Colin Chaplin's 2003)

Product (rate/ha)	Mean count reduction
Gallery (250g) / Totril (200mL)	-0.8
Gallery (250g) / Brodal (200mL)	-0.3
Gallery (250g) / Affinity (60g)	-1.0
Gallery (250g) / Linuron (200g)	-0.9
Gallery (250g) / Stomp (3L)	-1.6
Gallery (250g) / Command (250ml)	-0.5
Gallery (250g) / Frontier P (4L)	-7.3
Gallery (250g) / Raptor (45g)	-2.5
Gallery (250g) / Totril (200mL) / Brodal (200mL)	0.9
Gallery (250g) / Stomp (3L) / Totril (200mL) / Brodal (200mL)	-3.6
Gallery (250g)	2.5
Untreated	-0.3

The residual activity of Gallery was evaluated in trial 04-PY-014, which was conducted in 2004. Gallery was applied at three rates, 125, 250, and 500g/ha, and in combination with Totril and Affinity (Table 5). Applications of Gallery were applied at 2 – 4 true leaf or seven days after the initial application of main plot treatments of Brodal at 50mL/ha and Raptor at 45g/ha applied at cotyledon to 2 true leaf. Pre-emergent application of Stomp

3L/ha, and Brodal 100mL/ha, was applied across the site and a week prior to the sub plot treatments an application of Stomp 2L/ha, Brodal 200mL/ha and Totril 200mL/ha was also made across the site.

Rates of Gallery up to 500g/ha did not significantly ($P<0.05$) reduce pyrethrum count (Table 5). Cotyledon applications of Raptor and Brodal did not reduce plant counts but did slow the rate of plant development when compared to the commercial crop (visual observations, results not presented) which did not receive either product at the cotyledon stage.

No difference in weed control was observed between 125g/ha and 500g/ha of Gallery. The only weed that persisted in the trial was nightshade with Raptor showing much better control having an average of 7 plants/m^2 compared to 32 plants/m^2 in the Brodal treatments (results not presented).

Table 5. Mean change in pyrethrum count, plants per m^2, between 28 days and 56 days after applications of treatments (trial 04-PY-014, Bonney's Farm 2003)

	Main Plot Trt[a] (rate/ha)	
Sub Plot Trt[b] (rate/ha)	**Brodal (50ml)**	**Raptor (45g)**
Gallery (125g)	-3.5	-3.1
Gallery (125g)**	-2.9	-8.4
Gallery (250g)	-3.8	-11.5
Gallery (250g)**	-5.0	-0.9
Gallery (250g), Affinity (60g)**	-9.5	-6.0
Gallery (250g), Totril (200g)**	-8.5	-6.6
Gallery (500g)	-4.3	-9.5
Gallery (500g)**	0.8	-11.8
Untreated	-6.5	-6.1

[a] Main plot treatments applied at cotyledon to 2 true leaf stage
[b] Sub plot treatments applied at 2 to 4 true leaf stage
** Applications were applied 7 days after the initial application of Gallery to the Sub plots

Trial 04-PY-013 conducted during 2004 evaluated the interactions and efficacy of Brodal, Raptor, Affinity and Gallery, applied alone or in combination at different growth stages of pyrethrum with the aim of finding alternatives to Brodal. Brodal/Gallery mixtures may effect crop growth when applied earlier than the current 6 true leaf stage. Sub plot treatments were applied at the 2 – 4 true leaf stage, with a main plot treatment of Brodal or Raptor being applied at cotyledon to 2 true leaf (Table 6). A pre-emergent application of Stomp 3L/ha, and Brodal 100mL/ha was applied prior to the commencement of the trial.

Affinity reduced pyrethrum counts by 2-3 plants/m^2 when applied at the 2-4 true leaf stage but the effect was not statistically significant (Table 6). Stature assessments also indicated some phototoxicity in treatments receiving Affinity. The remaining 2-4 true leaf treatments did not reduce pyrethrum count or development. Applications of Brodal and Raptor at cotyledon stage did not reduce pyrethrum counts; however, both appeared to slow plant development when compared to untreated controls.

Table 6. Mean change in pyrethrum count over trial length, per m^2 (trial 04-PY-013, Lehman's Farm 2004)

	Main Plot Trt[a] (rate/ha)	
Sub Plot Trt[b] (rate/ha)	**Brodal (50ml)**	**Raptor (45g)**
Stomp (2L),Brodal (200ml),Totril (200ml)	0.9	-0.6
Stomp (2L),Brodal (200ml),Affinity (60g)	-2.1	-2.1
Stomp (2L),Brodal(200ml),Linuron(200g)	-0.4	2.9
Stomp (2L),Gallery (250g),Totril (200ml)	-1.6	0.1
Stomp (2L),Gallery (250g),Affinity (60g)	-3.3	-3.4
Stomp (2L),Gallery (250g),Linuron (200g)	2.3	0.0
Stomp (2L),Gallery (250g),Brodal (200ml)	1.9	1.8
Untreated	0.8	-0.3

[a] Main plot treatments applied at cotyledon to 2 true leaf stage
[b] Sub plot treatments applied at 2 t o4 true leaf stage

A major weed of interest in this trial was groundsel. No groundsel was present prior to applications at the 2-4 true leaf stage. Assessments conducted 31 DAT showed groundsel almost completely controlled with Gallery in both Raptor and Brodal main plots (Table 7). In comparison, the other treatments had groundsel levels between 34 and 64 plants/m^2. The effect of Gallery applications was still evident at 64 DAT (Table 8).

Table 7. Groundsel count 31 DAT[a], per m^2 (trial 04-PY-013, Lehman's Farm 2004)

	Main Plot Trt[c] (rate/ha)			
	Brodal (50ml)		**Raptor (45g)**	
Sub Plot Trt[b] (rate/ha)	**Count**	**Stature**	**Count**	**Stature**
Stomp (2L),Brodal (200ml),Totril (200ml)	54	2	34	2
Stomp (2L),Brodal (200ml),Affinity (60g)	36	0	38	2
Stomp (2L),Brodal (200ml),Linuron (200g)	62	2	51	2
Stomp (2L),Gallery (250g),Totril (200ml)	0	-	0	-
Stomp (2L),Gallery (250g),Affinity (60g)	0	-	0	-
Stomp (2L),Gallery (250g),Linuron (200g)	2	0	0	-
Stomp (2L),Gallery (250g),Brodal (200ml)	0	-	0	-
Untreated	47	2	64	2

[a] DAT = days after treatment
[b] Sub plot treatments applied at 2 t o4 true leaf stage
[c] Main plot treatments applied at cotyledon to 2 true leaf stage

Table 8. Groundsel count 61 DAT[a], per m^2 (trial 04-PY-013, Lehman's Farm 2004)

	Main Plot Trt (rate/ha)			
	Brodal (50ml)		**Raptor (45g)**	
Sub Plot[b] (rate/ha)	**Count**	**Stature**	**Count**	**Stature**
Stomp (2L),Brodal (200ml),Totril (200ml)	42.0	1.0	53.0	1.0
Stomp (2L),Brodal (200ml),Affinity (60g)	60.0	1.1	51.0	1.0
Stomp (2L),Brodal (200ml),Linuron (200g)	57.0	1.0	60.0	1.0
Stomp (2L),Gallery (250g),Totril (200ml)	2.0	1.0	2.0	1.0
Stomp (2L),Gallery (250g),Affinity (60g)	0.0	-	1.0	1.0
Stomp (2L),Gallery (250g),Linuron (200g)	9.0	1.0	7.0	1.0
Stomp (2L),Gallery (250g),Brodal (200ml)	2.0	1.0	1.0	1.0
Untreated	43.0	1.0	65.0	1.0

[a] DAT = days after treatment
[b] Sub plot treatments applied at 2 t o4 true leaf stage
[c] Main plot treatments applied at cotyledon to 2 true leaf stage

Trials conducted in 2005 evaluated Baron WP, On Duty and Goltix for weed efficacy and crop safety in first year pyrethrum.

Trial 05-PY-018 evaluated these herbicides in comparison to the commercial control of Stomp, Totril and Brodal. Each treatment of Baron WP, On Duty and Goltix were applied at two different rates. These treatments were applied at the 2 – 4 true leaf growth stage of the crop. Both before and after treatment applications the standard commercial herbicide program was applied over the trial area.

The only treatment that had a significantly reduced pyrethrum count was Goltix at 5kg/ha (Table 9). No treatment effects on pyrethrum stature were observed at 29 or 71 DAFA.

Table 9. Pyrethrum count and stature at 29 and 71 days after final application, per m^2 (trial 05-PY-018, Ian Charleston's 2005)

Treatment	Rate (per ha)	29 DAFA[a]		71 DAFA[a]	
		Count	Stature	Count	Stature
Baron WP	0.5kg	14.12 cd	2.75	12.12 cd	1.50
Baron WP	1kg	20.62 ab	1.75	17.74 ab	1.00
On Duty	20g	22.36 a	2.50	18.62 a	1.00
On Duty	55g	17 bc	2.75	13.74 bcd	1.50
Goltix	1.7kg	18.5 abc	2.25	13.12 cd	1.00
Goltix	5kg	11.36 d	2.25	9.5 d	1.50
Stomp + Totril + Brodal	2L + 200mL + 200mL	17.36 bc	2.75	16 abc	1.25
Untreated		17 bc	2.00	14.62 abc	1.25
LSD		4.94	N/S[1]	4.94	N/S[1]

[a] DAFA = days after final application
N/S[1] = not significant to P<0.05
Values with the same symbol are not significant to P<0.05 as calculated from LSD

The only weeds present in high numbers at this site were black nightshade and potato. At 29 DAFA both rates of Baron WP and On-Duty at 55g/ha had significantly improved control of nightshade (Table 10). At 71 DAFA, no treatments gave significantly better control of groundsel compared with the untreated control. The control of potato under all treatments was not improved to a significant extent at either of the assessments.

Table 10. Weed density, per m^2, (trial 05-PY-018, Ian Charleston's 2005)

Treatment	Rate (per ha)	29 DAFA[a]		71 DAFA[a]	
		Nightshade	Potato	Nightshade	Potato
Baron WP	0.5kg	7.5 a	0.24 a	17 bc	1.74 ab
Baron WP	1kg	11.24 a	0 a	8.5 abc	0.5 a
On Duty	20g	23.5 bc	2 ab	7.24 a	3.24 b
On Duty	55g	12.74 ab	1.24 ab	11.24 abc	1.5 ab
Goltix	1.7kg	24.24 bc	2.5 b	8.5 abc	0.74 a
Goltix	5kg	24.74 bc	0.5 ab	11.24 abc	1.74 ab
Stomp + Totril + Brodal	2L + 200mL + 200mL	29 c	0.5 ab	17.24 c	1.74 a
Untreated		30.74 c	1.5 ab	7.5 ab	0 ab
LSD		12.08	2.02	9.54	1.92

[a] DAFA = days after final application
Values with the same symbol are not significant to P<0.05 as calculated from LSD

Trial 05-PY-021 conducted in 2005 was identical to trial 05-PY-018 (above), with trial location changed to evaluate efficacy against a wide range of problem weeds. Both before and after treatment applications the standard commercial herbicide program was applied over the trial area.

At 28 DAFA Goltix at 5kg/ha caused a significant reduction in pyrethrum count compared to the commercial control (Table 11).

Table 11. Pyrethrum count m^2 (trial 05-PY-021, Neil Johnson's 2005)

Treatment	Rate (per ha)	14 DAFA[a]		28 DAFA[a]		64 DAFA[a]	
Baron WP	0.5kg	3.5	a	13.24	a	15.00	a
Baron WP	1kg	6.0	cd	12.86	a	14.12	a
On Duty	20g	3.0	a	14.74	a	16.12	a
On Duty	55g	5.0	bc	12.86	a	16.00	a
Goltix	1.7kg	5.5	c	12.62	a	18.36	a
Goltix	5kg	7.0	d	6.36	b	8.12	b
Stomp + Totril + Brodal	2L + 200mL + 200mL	5.5	c	13.5	a	13.24	ab
Untreated		4.0	ab	13.0	a	17.86	a
LSD		1.36		4.22		5.16	

[a] DAFA = days after final application

The major weeds in trial 05-PY-021 were potato, groundsel, nightshade and thistles. No improvement in control of the weed species present at 28 DAFA was observed in comparison with the untreated control (Table 12). Control of nightshade at 64 DAFA was significantly improved with Baron WP at 1kg/ha (Table 13). Improved control of groundsel at 64 DAFA was only achieved with Goltix at 5kg/ha. The number of sow thistles and potato was not reduced with any treatments.

Table 12. Weed density 28 days after application, per m^2, (trial 05-PY-021, Neil Johnson's 2005)

Treatment	Rate (per ha)	Potato	Groundsel
Baron WP	0.5kg	5.48	4
Baron WP	1kg	7	2.48
On Duty	20g	2	3
On Duty	55g	4.48	1
Goltix	1.7kg	7	3.48
Goltix	5kg	5.48	0.48
Stomp + Totril + Brodal	2L + 200mL + 200mL	3	1
Untreated		7	1.48
LSD		N/S[1]	N/S[1]

N/S[1] = not significant to P<0.05

Table 13. Density 64 days after application, per m^2, (trial 05-PY-021, Neil Johnson's 2005)

Treatment	Rate (per ha)	Nightshade		Sow Thistle		Potato		Groundsel	
Baron WP	0.5kg	3	ab	5	c	0.48	a	13.00	bc
Baron WP	1kg	0	a	0	a	0	a	18.00	de
On Duty	20g	1.48	ab	0	a	0	a	19.00	e
On Duty	55g	8	c	0	a	5	c	11.48	b
Goltix	1.7kg	2	ab	3	b	0	a	16.48	cde
Goltix	5kg	0.48	ab	0	a	2	b	6.00	a
Stomp + Totril + Brodal	2L + 200mL + 200mL	9.48	c	4	b	0	a	10.48	ab
Untreated		4	b	1	a	0.48	a	15.00	bcd
LSD		3.6		1.76		1.24		4.68	

Values with the same symbol are not significant to P<0.05 as calculated from the LSD.

5.1.4 DISCUSSION

At all rates, pre-emergent applications of Gallery significantly reduced pyrethrum establishment. In contrast, Gallery applied at 250g/ha at cotyledon, 2 – 4 true leaf, and 6 true leaf did not reduce pyrethrum germination and establishment. Safety was shown to be excellent when applied on its own, when the pyrethrum was at the cotyledon stage. However, because of the variability in pyrethrum germination and establishment times, Gallery applications should be delayed until a high proportion of pyrethrum is at the 2 – 4 true leaf stage. At this growth stage if the site is clean of weeds then Gallery can be safely applied earlier than the current 6 true leaf stage.

The application of Gallery at 250g/ha when mixed with other herbicides showed good weed efficacy. However plant density reductions occurred when Galley was combined with Frontier P. Due to the trial design, it cannot be determined if the plant density reduction observed between Gallery and Frontier P is caused by interacting herbicides or Frontier P alone. Visual observations also indicated Gallery mixed with Brodal, Affinity, Linuron or Stomp caused some stunting and holding back of the plants but did not reduce density. Until further trial work has been conducted the application of Gallery in combination with these herbicides should be avoided to ensure pyrethrum safety.

Baron WP and On-Duty are safe to use on first year pyrethrum at 1kg and 55g/ha respectively. The use of Goltix demonstrated crop safety at the lowest rate 1.7kg/ha. Baron WP at 1kg/ha showed good efficacy against nightshade. However, due to the poor weed pressure experienced in these screening trials further weed efficacy trials in new crops are recommended.

5.2 WHITE CLOVER CONTROL IN FIRST YEAR PYRETHRUM

5.2.1 INTRODUCTION

White clover control is one of the major issues for pyrethrum crops because if it is not controlled in first year crops, it becomes a major problem for subsequent post harvest crops. Control of white clover in first year crops is reasonably successful if the Tramat herbicide program is used, but this is a very intensive and relatively expensive program.

Brodal has been identified as having good pre-emergent control of white clover, with some residual activity. If Brodal can be successfully used for control of white clover in the very early stages of crop establishment, and other residual herbicides such as Gallery can provide continuing control, reliance on the Tramat program for clover control may be able to be reduced.

In research conducted from 2000 to 2003 pre-emergent Brodal applications showed good selectivity in pyrethrum at rates below 200mL/ha, however, weed control at these low rates was much lower than at higher rates above 200mL/ha. These results warranted further research into factors effecting efficacy and crop safety. During 2003 the efficacy of Brodal against white clover and crop safety were investigated at a range of different crop growth stages and application rates. Previous work conducted in 1997 to 2000 identified Stomp as an excellent broad spectrum pre-emergent with selectivity; therefore trials were conducted in 2003 to evaluate the efficacy and crop safety of Stomp when applied in combination with Brodal to control white clover emergence. With the aim of identifying ways to maintain white clover control while reducing the reliance on the expensive and intensive Tramat program.

Promising results during the 2003 trials led to Brodal being trialled in more extensive field trials across numerous sites along the North West coast of Tasmania ranging from Table Cape to Sassafras. These trials conducted in 2004 were un-replicated and demonstrated variable results warranting more extensive research into chemical activation and action on differing soil types and under different weather conditions.

5.2.2 MATERIALS AND METHODS

5.2.2.1 Trial locations

Table 14. Trial location and details

Trial no.	Year	Title	Location	Growth stage	Herbicides	Target weeds	Period
03-PY-013	2003	Pre-emergent control of White Clover with Brodal	Forth - Yaxley's farm	Pre-emergent	Brodal Stomp	White clover	Oct-Nov
03-PY-014	2003	Brodal safety at different growth stages	Forth - Yaxley's farm	Pre-emergent Cotyl – 2TL 2 – 4TL	Brodal	White clover	Oct-Dec
04-PY-012	2004	Pre-emergent Brodal trial	Various - Across NW	Pre-emergent	Brodal	White clover	Sep-Nov
04-PY-013	2004	Brodal program variation	Sassafras - Lehman's farm	Coty – 2TL 2 – 4TL	Brodal Various	Various	Sep-Nov

Trials conducted during 2003 were broadcast seeded with "Huia Super Strike" white clover, before being planted with "Pyrite" pyrethrum.

5.2.2.2 Application methods

All trials had treatments applied using a gas powered PET sprayer with a boom width of 1.5 metres (2 metre swathe width), fitted with Hardi 4110-12 nozzles and a carrier volume of 250L/ha at 200kPa. With the exception of trial 04-PY-012 which used Hardi 4680-13E nozzles with spray drift covers.

Application timing varied throughout the trials conducted and is outlined above in Table 14.

5.2.2.3 Assessment methods

All trials were assessed using randomised quadrat counts to determine pyrethrum and weed density. Pyrethrum and weed stature was assessed using the EWRC rating scheme outlined in Table 1.
Where applicable statistics have been carried out using the professional statistics package, Statgraphics Plus 2.1, for Windows. The use of statistical analysis is noted by the significance groupings to the right of tabulated figures and LSD calculated at the bottom of corresponding tables.

5.2.3 RESULTS

Trial 03-PY-013 was conducted in 2003 to evaluate Brodal in combination with Stomp for pre-emergent control of white clover. All treatments were applied as pre-emergents, with rates of Brodal consisting of 50, 100, 150 and 200mL/ha, with the rate of Stomp applied ranging from 0 to 4L/ha as shown in Table 15.

Treatments that had the smallest effect on pyrethrum counts were those containing Brodal at rates of 100mL/ha. Higher combined Stomp/Brodal rates demonstrated an increased impact on pyrethrum count when compared with control treatments (Table 15).

Table 15. Pyrethrum count, per m^2 (trial 03PY013, Yaxley's Farm 2003)

Treatment	Rate (per/ha)	Count 06-Nov-03	Count 26-Nov-03
Brodal	50 mls	54	38
Brodal	100 mls	82	60
Brodal	150 mls	42	44
Brodal	200 mls	36	42
Stomp	2 L	80	82
Stomp + Brodal	2 L + 50 mls	76	68
Stomp + Brodal	2 L + 100 mls	56	38
Stomp + Brodal	2 L + 150 mls	54	46
Stomp + Brodal	2 L + 200 mls	52	46
Stomp	3 L	92	80
Stomp + Brodal	3 L + 50 mls	74	72
Stomp + Brodal	3 L + 100 mls	42	44
Stomp + Brodal	3 L + 150 mls	60	56
Stomp + Brodal	3 L + 200 mls	42	48
Stomp	4 L	28	76
Stomp + Brodal	4 L + 50 mls	58	74
Stomp + Brodal	4 L + 100 mls	34	38
Stomp + Brodal	4 L + 150 mls	44	38
Stomp + Brodal	4 L + 200 mls	20	18
Untreated control		84	58

All the applied treatments, with the exception of Stomp at rates of 3L/ha or below, demonstrated good control of clover, considerably reducing clover densities when compared with the untreated control (Table 16). At the second assessment clover numbers were still low in many treatments showing residual activity against new germinating clover seedlings.

Table 16. Clover count, per m^2 (trial 03PY013, Yaxley's Farm 2003)

Treatment	Rate (per/ha)	Count 06-Nov-03	26-Nov-03
Brodal	50 mls	14	28
Brodal	100 mls	10	10
Brodal	150 mls	2	0
Brodal	200 mls	4	0
Stomp	2 L	100	70
Stomp + Brodal	2 L + 50 mls	18	14
Stomp + Brodal	2 L + 100 mls	10	2
Stomp + Brodal	2 L + 150 mls	2	2
Stomp + Brodal	2 L + 200 mls	2	0
Stomp	3 L	66	34
Stomp + Brodal	3 L + 50 mls	4	6
Stomp + Brodal	3 L + 100 mls	4	4
Stomp + Brodal	3 L + 150 mls	4	0
Stomp + Brodal	3 L + 200 mls	0	0
Stomp	4 L	28	10
Stomp + Brodal	4 L + 50 mls	0	0
Stomp + Brodal	4 L + 100 mls	14	4
Stomp + Brodal	4 L + 150 mls	4	2
Stomp + Brodal	4 L + 200 mls	0	0
Untreated control		92	150

Trial 03-PY-014 evaluated the safety of Brodal when applied pre-emergent and in early growth. Brodal applications were applied sequentially at growth stages, pre-emergent, cotyledon and 2 – 4 true leaf. At each application time Brodal rates were varied from 50 to 200mL/ha as outlined below in Table 17.

The emergence of pyrethrum was reduced in treatments where Brodal was applied above 150mL/ha in the pre-emergent applications alone (Table 17). Assessments conducted after the final application (2 – 4 TL) showed that treatments which received pre-emergent applications of 50-100mL/ha had similar counts to the untreated control.

Table 17. Pyrethrum count, per m^2 (trial 03PY014, Yaxley's Farm 2003)

Treatment	Rate (mls/ha)	Application times pre-emg	coty – 2TL[a] (+ 14 DAIA[b])	2 - 4TL[a] (+ 34 DAIA[b])
Untreated		57.2	46.8	44
Brodal	50 + 50 + 200	47.2	54	44.8
Brodal	50 + 100 + 200	51.6	50.8	48.4
Brodal	100 + 50 + 200	51.2	47.6	42
Brodal	100 + 100 + 200	46.4	45.2	39.6
Brodal	150 + 50 + 200	41.2	46.8	36.8
Brodal	150 + 100 + 200	43.2	55.2	34
Brodal	200 + 50 + 200	37.6	38.4	26
Brodal	200 + 100 + 200	43.2	43.2	31.2

[a] TL = true leaf
[b] DAIA = days after initial application (pre-emergent)

All the treatments which received a pre-emergent application of Brodal showed a much lower white clover density when compared with the untreated control (Table 18), with the higher rates giving improved control. This is

similar to results at the second assessment where applications of Brodal above 150mL/ha as a pre-emergent prevented Clover emergence.

Table 18. White clover count, per m^2 (trial 03PY014, Yaxley's Farm 2003)

Treatment	Rate (mls/ha)	Application times pre-emg	coty – 2TL[a]	2 - 4TL[a]
Untreated		39.2	8.8	17.2
Brodal	50 + 50 + 200	3.6	0.8	0.4
Brodal	50 + 100 + 200	2.8	0	0
Brodal	100 + 50 + 200	2.8	0	0
Brodal	100 + 100 + 200	0.8	0.4	0
Brodal	150 + 50 + 200	0.8	0	0
Brodal	150 + 100 + 200	1.2	0	0
Brodal	200 + 50 + 200	1.2	0	0
Brodal	200 + 100 + 200	0.4	0	0

[a] TL = true leaf

Trial 04-PY-012 was conducted to evaluate the pre-emergent control of white clover with Brodal across various sites and soil types. Brodal was applied at 100, 150 and 200mL/ha. The trial sites ranged from Sassafras to Table Cape. Across the entire trial area the standard commercial was applied in addition to pre-emergent Brodal applications.

Pre-emergent Brodal applications of 150 ml/ha did not reduce pyrethrum counts compared to applications at 100 ml/ha. Brodal applications at 200 ml/ha led to reductions in pyrethrum emergence at various sites (Table 19).

Table 19. Pyrethrum count per m^2, (trial 04-PY012, various 2004)

	30 DAT[a]			60 DAT[a]			90 DAT[a]		
Brodal Rate/ha	**100 ml**	**150 ml**	**200 ml**	**100 ml**	**150 ml**	**200 ml**	**100 ml**	**150 ml**	**200 ml**
Site 1 (Sassafras)	13	18	16	35	36	25	44	45	30
Site 2 (Wesley Vale)	32	37	12	32	37	17	29	33	28
Site 3 (Don)	16	23	15	33	31	29	38	44	34
Site 4 (Forth)	7	13	5	27	31	26	45	52	49
Site 5 (Upper Gawler)	33	28	18	42	40	31	56	47	48
Site 6 (Kindred)	17	8	4	23	17	20	35	31	20
Site 7 (Kindred)	22	20	22	25	24	24	24	35	22
Site 8 (Penguin)	16	13	18	37	28	32	43	40	53
Site 9 (Table Cape)	26	18	19	47	34	33	55	43	49

[a] DAT = Days after treatment

Complete clover control was not achieved when Brodal was applied at 200 ml/ha. Brodal at 150 ml/ha had emerging clover at 3 out of 9 sites 30 DAT however after 60 days clover was observed in 4 out of the 9 sites at levels no higher than 0.5 plants/m^2. Clover was observed in low numbers at 8 out of 9 sites when Brodal was applied at 100ml/ha. However by 60 days after pre emergent application 5 out of 9 sites had no clover present.

Table 20. Clover count per m^2, (trial 04-PY-012, various 2004)

	30 DAT[a]			60 DAT[a]		
Brodal Rate/ha	**100 ml**	**150 ml**	**200 ml**	**100 ml**	**150 ml**	**200 ml**
Site 1 (Sassafras)	0.3	0.0	0.0	3.8	0.3	1.8
Site 2 (Wesley Vale)	0.3	0.0	0.0	0.0	0.0	0.0
Site 3 (Don)	0.3	0.5	0.3	0.3	0.3	0.0
Site 4 (Forth)	0.0	0.0	0.0	0.0	0.0	0.0
Site 5 (Upper Gawler)	0.3	0.0	0.0	0.0	0.0	0.0
Site 6 (Kindred)	0.5	0.5	1.3	1.0	0.0	0.5
Site 7 (Kindred)	0.5	0.0	0.5	0.0	0.3	0.0
Site 8 (Penguin)	1.3	0.0	0.0	0.0	0.0	0.0
Site 9 (Table Cape)	0.3	0.3	0.0	0.5	0.3	0.0

[a] DAT = Days after treatment

Trial 04-PY-013 conducted during 2004 evaluated the efficacy of Brodal, Raptor and Gallery when applied at different growth stages and in various combinations, for the control of white clover in first year pyrethrum crops, with the aim of finding alternatives for early Brodal applications. Sub plot treatments of Stomp at 2L/ha, Brodal at 200mL/ha or Gallery at 250g/ha, and Totril, Affinity and Linuron were applied at the 2 – 4 true leaf stage. Main plot treatments of Brodal or Raptor were applied at cotyledon-2 true leaf stage. A pre-emergent application of Stomp 3L/ha and Brodal 100mL/ha was applied prior to the commencement of the trial.

Brodal applications at 2 – 4 true leaf stage provided better control of white clover than applications of Gallery at the same growth stage.

Table 21. Clover count 31 DAT[a], per m^2 (trial 04-PY-013, Lehman's Farm 2004)

	Main Plot Trt[b] (rate/ha)			
	Brodal (50ml)		Raptor (45g)	
Sub Trt[c] (rate/ha)	**Count**	**Stature**	**Count**	**Stature**
Stomp (2L),Brodal (200ml),Totril (200ml)	26.7	2.0	6.0	3.0
Stomp (2L),Brodal (200ml),Affinity (60g)	15.0	2.0	14.0	2.0
Stomp (2L),Brodal (200ml),Linuron (200g)	13.3	2.0	6.0	2.0
Stomp (2L),Gallery (250g),Totril (200ml)	28.0	2.0	25.0	2.0
Stomp (2L),Gallery (250g),Affinity (60g)	27.0	2.0	31.0	2.0
Stomp (2L),Gallery (250g),Linuron (200g)	33.0	2.0	25.5	2.0
Stomp (2L),Gallery (250g),Brodal (200ml)	20.0	2.0	14.0	3.0
Untreated	27.0	2.0	28.0	2.0

[a] DAT = Days after treatment
[b] Main plot treatments sprayed at cotyledon to 2 true leaf stage
[c] Sub plot treatments sprayed at 2 to 4 true leaf stage

Table 22. Clover count 61 DAT[a], per m^2 (trial 04-PY-013, Lehman's Farm 2004)

	Main Plot Trt[b](rate/ha)			
	Brodal (50ml)		Raptor (45g)	
Sub Trt[c] (rate/ha)	**Count**	**Stature**	**Count**	**Stature**
Stomp (2L),Brodal (200ml),Totril (200ml)	18.0	1.0	6.0	1.0
Stomp (2L),Brodal (200ml),Affinity (60g)	13.0	1.0	9.5	1.0
Stomp (2L),Brodal (200ml),Linuron (200g)	12.0	1.0	6.0	1.0
Stomp (2L),Gallery (250g),Totril (200ml)	36.0	1.0	22.5	1.0
Stomp (2L),Gallery (250g),Affinity (60g)	47.0	1.0	21.5	1.0
Stomp (2L),Gallery (250g),Linuron (200g)	25.0	1.0	12.0	1.0
Stomp (2L),Gallery (250g),Brodal (200ml)	28.0	1.5	18.0	1.0
Untreated	31.0	1.0	16.5	1.0

[a] DAT = Days after treatment
[b] Main plot treatments sprayed at cotyledon to 2 true leaf stage
[c] Sub plot treatments sprayed at 2 to 4 true leaf stage

5.2.4 DISCUSSION

Pre-emergent applications of Brodal at 100mL/ha, or above, offer excellent control of white clover in first year pyrethrum, when compared with post-emergent applications which act only to suppress white clover growth. Pyrethrum assessments show that sequential applications of Brodal at pre-emergence, cotyledon and 2-4 true leaf do not significantly effect pyrethrum counts where pre-emergent rates are 50 or 100 mls/ha. Higher pre-emergent applications, 150 or 200 mls/ha, reduced the density of the pyrethrum by the final assessment indicating that caution be used when applying these higher rates in commercial circumstances.

Applications of 100 mls/ha pre-emergent, 50 mls/ha at cotyledon to 2 true leaf and 200 mls/ha at 2-4 true leaf is possibly the most appropriate Brodal spray program for pre-emergent clover control in new crops. Applications at these rates can provide effective clover control while minimizing effects on pyrethrum density.

Variability in results when Brodal was applied to semi commercial areas indicates the limitations of this program for control of white clover when used commercially. This variability in results may be due to the variation in soil moisture in commercial sites in a dry spring compared with trial sites that received regular irrigation.

Replacing early post-emergent Brodal applications with Gallery leads to poor control of white clover and is not recommended.

6 IMPROVING CHEMICAL WEED CONTROL IN POST-HARVEST PYRETHRUM CROPS

6.1 SIMAZINE SAFETY WHEN APPLIED TO POST-HARVEST PYRETHRUM CROPS

6.1.1 INTRODUCTION

Simazine is a pre-emergent herbicide which demonstrates good residual control of various broadleaf weeds and grasses. Initially simazine was screened for the control of *Apiaceae* weeds and was found to be very effective at rates of 2-4L/ha. In addition to the control of *Apiaceae* weeds, simazine has also shown good control of a number of common escape weeds such as thistles and groundsel present in current commercial crops. Therefore, the use of simazine within the current herbicide program has the ability to reduce the reliance on costly spot spraying and reduce weed competition during late winter and early spring when herbicide applications are not safe.

However, crop safety trials conducted in the past project and early in this project have identified negative interactions between simazine and other herbicides such as Brodal. These results indicate the need for more extensive crop safety trials over several seasons and also different soil types, with further yield and efficacy data needing to be collected. If the safety of simazine is proven to be suspect and its use is therefore limited, other herbicides providing residual control of escape weeds will need to be identified to control such weeds during the winter and spring periods.

6.1.2 MATERIALS AND METHODS

6.1.2.1 Trial locations

Table 23. Trial location and details

Trial no.	Year	Title	Location	Growth stage	Herbicides	Target weeds	Period
03-PY-004	2003	Simazine safety	Latrobe - Craigie's farm	Post-harvest	Simazine Brodal Eclipse Command Affinity	N/A	Mar-Dec
03-PY-005	2003	Simazine safety	Forth - Werrin farm	Post-harvest	Simazine Brodal Eclipse Command Affinity	N/A	Mar-Dec

03-PY-006	2003	Simazine safety at different rates	Forth - Werrin farm	Post-harvest	Simazine Brodal	N/A	Mar-Dec
05-PY-009	2005	Simazine interaction trial	Forth - Werrin farm	Post-harvest	Simazine Various	N/A	Mar-Dec

6.1.2.2 Application methods

All trials had treatments applied using a gas powered PET sprayer with a boom width of 1.5 metres (2 metre swathe width), fitted with Hardi 4110-12 nozzles and a carrier volume of 250L/ha at 200kPa

Application timing varied throughout the trials conducted and is outline above in Table 23.

6.1.2.3 Assessment methods

Trials were assessed using randomised quadrat counts to determine pyrethrum and weed density. Pyrethrum and weed stature was assessed using the EWRC rating scheme outlined in Table 1. In trials conducted during 2003 assessments of pyrethrum health were made using the EWRC stature scores as well as the percentage ground cover for each plot occupied by the pyrethrum plants

Where applicable statistics have been carried out using the professional statistics package, Statgraphics Plus 2.1, for Windows. The use of statistical analysis is noted by the significance groupings to the right of tabulated figures and LSD calculated at the bottom of corresponding tables.

6.1.3 RESULTS

Trial 03-PY-006 was conducted into the safety of simazine when applied at various rates on a heavy Ferrosol soil. This was conducted as a randomised split plot design with untreated and Brodal comprising the main plots and Simazine rate the sub plots. Brodal was applied twice at 300mL/ha, 20 days apart, with simazine being applied to the sub plots at varying rates at 20 day intervals starting at the same time as the initial main plot Brodal application (Table 24). Where simazine and Brodal were applied on the same day the Brodal was applied first on the main plot and allowed to dry before the simazine was applied to the relevant sub plot. Prior to the commencement of the trial, Stomp 4-5L/ha and Goal 0.5-1L/ha was applied over the entire trial area, followed by treatment applications beginning in March.

Brodal applied in combination with simazine decreased pyrethrum ground cover when compared with those in the equivalent untreated area (Table 24). Where simazine was applied at 2L/ha pyrethrum percentage ground cover was the lowest within the Brodal treatments. Two applications of simazine at 2L/ha had the greatest impact reducing pyrethrum ground cover within the untreated main plots (Table 24).

Table 24. Percentage pyrethrum ground cover, per plot (trial 03-PY-006, Werrin Farm 2003)

Treatment[e]	25-Mar-03 + 0 DAIA[a]		06-May-03 + 40 DAIA[a]		11-Jun-03 + 40 DAFA[b]		04-Aug-03 + 120 DAFA[b]		22-Sep-03 +150 DAFA[b]	
	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]
Simazine 1 L/ha x 2 apps	52.5	57.5	48.8	56.3	30.0	57.5	22.5	47.5	26.3	48.8
Simazine 2 L/ha	51.3	53.8	46.3	50.0	36.3	52.5	28.8	52.5	30.0	55.0
Simazine 1 L/ha x 4 apps	52.5	57.5	47.5	53.8	28.8	48.8	22.5	41.3	26.3	42.5
Simazine 2 L/ha x 2 apps	45.0	55.0	43.8	52.5	27.5	52.5	21.3	48.8	18.8	45.0
Simazine 4 L/ha	62.5	51.3	50.0	51.3	35.0	53.8	26.3	47.5	30.0	48.8
Untreated control	52.5	56.3	47.5	60.0	47.5	66.3	38.8	60.0	38.8	65.0
Mean	52.7	55.2	47.3	54.0	34.2	55.2	26.7	49.6	28.4	50.9

[a] DAIA= days after initial application. Application occurred on 25th March, 2003
[b] DAFA= days after final application. Application occurred on 26th May, 2003
[c] Brodal was applied twice at 0.3L/ha. Applications were 20 days apart.
[d] UTC= untreated control

Both the untreated and Brodal treated main plots, treatments which received 2 applications of simazine at 2L/ha had the highest plant stature score (Table 25). Brodal treatments showed a higher stature score when compared with the equivalent untreated main plots (Table 25).

Table 25. Pyrethrum stature - EWRC (trial 03-PY-006, Werrin Farm 2003)

Treatment	25-Mar-03 + 0 DAIA[a]		06-May-03 + 40 DAIA[a]		11-Jun-03 + 40 DAFA[b]		04-Aug-03 + 120 DAFA[b]		22-Sep-03 +150 DAFA[b]	
	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]	Brodal[c]	UTC[d]
Simazine 1 L/ha x 2 apps	1.0	1.0	4.0	1.0	5.8	3.0	6.8	5.3	5.5	4.3
Simazine 2 L/ha	1.0	1.0	4.0	1.5	5.0	3.0	6.0	5.0	6.3	4.3
Simazine 1 L/ha x 4 apps	1.0	1.0	4.0	1.3	6.0	3.5	7.0	5.5	6.8	4.8
Simazine 2 L/ha x 2 apps	1.0	1.0	4.0	1.8	6.0	4.0	7.0	5.8	7.0	5.3
Simazine 4 L/ha	1.0	1.0	4.0	2.0	5.8	3.3	7.0	5.0	6.3	4.5
Untreated control	1.0	1.0	3.0	1.0	3.8	2.0	5.0	3.8	5.0	2.5

[a] DAIA= days after initial application. Application occurred on 25th March, 2003
[b] DAFA= days after final application. Application occurred on 26th May, 2003
[c] Brodal was applied twice at 0.3L/ha. Applications were 20 days apart.
[d] UTC= untreated control

Two trials were carried out to investigate the effect of simazine when applied in combination with other herbicides. The trial sites were on a light Ferrosol (03-PY-004) and a heavy Ferrosol (03-PY-005). Simazine treatments were applied at 2L/ha as outlined in Table 26, below. In both trials Stomp 4-5L/ha and Goal 0.5-1L/ha was applied over the entire trial area, followed by treatments in March.

All treatments which consisted of Brodal and simazine showed a much lower level of ground cover than all other treatments (Table 26). These treatments also had the highest stature scores implying possible negative impacts of Brodal and simazine mixes.

Table 26. Percentage pyrethrum ground cover and stature EWRC, per plot (trial 03-PY-004 light Ferrosol, Craigie's Farm 2003)

Treatment	25-Mar-03 -1 DAT[a] % cover	Stat	17-Apr-03 +22 DAT[a] % cover	Stat	07-May-03 +42 DAT[a] % cover	Stat	12-Jun-03 +78 DAT[a] % cover	Stat	01-Aug-03 +128 DAT[a] % cover	Stat	23-Sep-03 +181 DAT[a] % cover	Stat
Brodal x 2 20 days apart	38.8	1.0	47.5	3.0	46.3	3.0	38.8	3.3	33.8	4.3	38.8	3.3
Brodal/Simazine in combination, repeat (20 days)	38.8	1.0	43.8	4.0	41.3	4.0	15.0	6.0	10.0	6.8	12.5	6.8
Brodal/Simazine separately, repeat (20 days)	38.8	1.0	41.3	3.5	38.8	4.0	16.3	5.8	11.3	7.0	13.8	6.8
Brodal, Simazine (10 days), Brodal (20 days), Simazine (30 days)	37.5	1.0	42.5	3.3	42.5	3.5	20.0	5.3	13.8	6.3	15.0	6.0
Eclipse/Brodal, then Brodal (20 days)	35.0	1.0	41.3	2.0	42.5	3.0	33.8	3.5	32.5	4.5	33.8	3.5
Eclipse/Brodal, then Simazine separately, Brodal/Simazine separately (20 days)	36.3	1.0	38.8	1.8	35.0	4.0	17.5	5.0	12.5	7.0	13.8	6.5
Simazine, Simazine (20 days)	33.8	1.0	47.5	1.0	48.8	1.8	38.8	3.3	33.8	5.3	36.3	4.5
Untreated control	40.0	1.0	45.0	1.0	51.3	1.0	46.3	2.0	47.5	3.0	53.8	1.8

[a] DAT= days after treatment

As was seen in the results for the light Ferrosol (above), the four treatments which received simazine and Brodal had the lowest percentage pyrethrum ground cover. All herbicide treatments had lower ground cover percentages than the untreated control (Table 27). Brodal/simazine treatments had the highest stature scores in all but the first assessment; herbicide treatments had higher stature sores than the untreated control (Table 27).

Table 27. Percentage pyrethrum ground cover and stature EWRC, per plot (trial 03-PY-005 heavy Ferrosol, Werrin Farm 2003)

Treatment	25-Mar-03 -1 DAT[a] % cover	Stat	17-Apr-03 +22 DAT[a] % cover	Stat	07-May-03 +42 DAT[a] % cover	Stat	11-Jun-03 +77 DAT[a] % cover	Stat	04-Aug-03 +131 DAT[a] % cover	Stat	22-Sep-03 +180 DAT[a] % cover	Stat
Brodal x 2 20 days apart	53.8	1.0	63.8	3.3	58.8	3.0	46.3	3.8	41.3	5.3	47.5	3.0
Brodal/Simazine in combination, repeat (20 days)	55.0	1.0	62.5	3.8	55.0	4.0	23.8	6.3	22.5	7.0	32.5	5.5
Brodal/Simazine separately, repeat (20 days)	56.3	1.0	58.8	3.8	48.8	4.0	23.8	6.3	22.5	6.8	26.3	5.3
Brodal, Simazine (10 days), Brodal (20 days), Simazine (30 days)	55.0	1.0	65.0	3.0	52.5	3.8	26.3	6.0	22.5	6.8	28.8	5.3
Eclipse/Brodal, then Brodal (20 days)	56.3	1.0	60.0	1.8	53.8	3.0	47.5	3.5	42.5	5.0	50.0	3.3
Eclipse/Brodal, then Simazine separately, Brodal/Simazine separately (20 days)	57.5	1.0	65.0	3.0	55.0	4.0	28.8	5.5	26.3	7.0	32.5	5.5
Simazine, Simazine (20 days)	53.8	1.0	56.3	1.5	56.3	2.0	53.8	3.3	45.0	5.0	47.5	3.8
Untreated control	66.3	1.0	71.3	1.0	71.3	1.0	63.8	2.5	57.5	3.8	67.5	1.5

[a] DAT= days after treatment

Brodal and simazine applications had the lowest dry matter yield, on both soil types (Table 28). However in the heavy Ferrosol the untreated control did not have the highest dry weight. This was achieved by the two treatments, Brodal applications 20 days apart and Eclipse + two Brodal applications 20 days apart (Table 28).

Table 28. Dry pyrethrum yield for both trials (03-PY-004 and 03-PY-005)

Treatment	Light Ferrosol weight (g)	Heavy Ferrosol weight (g)
Brodal 2 apps 20 days apart	184.0	151.3
Brodal/Simazine separately, repeat (20 days)	128.8	129.4
Brodal/Simazine in combination, repeat (20 days)	123.9	113.0
Brodal, Simazine (10 days), Brodal (20 days), Simazine (30 days)	148.1	117.9
Eclipse/Brodal, then Brodal (20 days)	177.9	153.8
Eclipse/Brodal, then Simazine separately, Brodal/Simazine separately (20 days)	136.1	119.9
Simazine, Simazine (20 days)	166.5	133.9
Untreated control	194.8	142.6

Trial 05-PY-009 was conducted to determine the safety of simazine when applied in with other herbicides in the current commercial program. These trials involved the application of simazine as main plot treatment and the application of other chemicals within the program as sub treatments either tank mixed, or applied separately at differing times. Application mixtures are outlined in Table 29 below.

Flower yield data suggested that simazine had no impact on yield, when applied as a single application up to 4L/ha (Table 29). Applications of simazine in combination with Brodal resulted in lower yield weights than other treatments. This effect can be seen to become less as the interval between the applications of Brodal and simazine is increased (Table 29).

Table 29. Pyrethrum yield, with differing applications and timing (trial 05-PY-009, Werrin Farm)

Main Plot Treatment (rate/ha)	Sub Plot Treatment (rate/ha)	Flower Yield (grams/m^2) App time 1[a]	Flower Yield (grams/m^2) App time 2[b]	Flower Yield (grams/m^2) App time 3[c]
Simazine 2 L	Brodal	106	141	160
Simazine 2 L	Command	150	152	157
Simazine 2 L	Goal EC	135	149	184
Simazine 2 L	Goal WP	136	144	166
Simazine 2 L	Raptor	127	159	173
Simazine 2 L	Untreated	126	152	163
$LSD_{(5\%)}$		**N/S[1]**	**N/S[1]**	**N/S[1]**
Simazine 4 L	Brodal	134	137	157
Simazine 4 L	Command	141	150	166
Simazine 4 L	Goal EC	152	172	170
Simazine 4 L	Goal WP	138	161	150
Simazine 4 L	Raptor	158	169	182
Simazine 4 L	Untreated	158	158	177
$LSD_{(5\%)}$		**N/S[1]**	**N/S[1]**	**N/S[1]**

Untreated	Brodal	154	135	163
Untreated	Command	144	152	144
Untreated	Goal EC	139	145	160
Untreated	Goal WP	155	140	172
Untreated	Raptor	145	147	138
Untreated	Untreated	164	150	145
$LSD_{(5\%)}$		**N/S[1]**	**N/S[1]**	**N/S[1]**

[1]N/S = not significant
[a] application treatments tank mixed
[b] main treatments applied 28 days before sub plot treatments
[c] main treatments applied 56 days before sub plot treatments

6.1.4 DISCUSSION

Two simazine applications at 2 L/ha had the largest effect on reducing pyrethrum growth. Increasing the number of simazine applications to four but spraying at 1L/ha or reducing simazine applications to one but spraying at 4 L/ha both reduced the negative effect of simazine on plant growth when compared to two simazine applications at 2 L/ha. It therefore appears that both application rate and number affect simazine safety in post harvest pyrethrum. Results suggest two applications of simazine at 1L/ha or single applications up to 4L/ha, would be the best program for pyrethrum safety.

Brodal has a suppressive affect on pyrethrum growth, but trials have shown no long term effect on yield at moderate rates (eg 2 x 300mL/ha). Previous research has highlighted an interaction between Brodal and simazine. This interaction effect has been confirmed in this current project,

It appears that the negative effects of simazine are more prominent where simazine is applied more than once, especially in circumstances where other herbicides such as Brodal are also used.

These results indicate that it is difficult to use simazine with Brodal in a spray program since crop yields are reduced. There is some indication that applying Brodal and simazine separately with a long interval between applications is relatively safe, but further work needs to be done to confirm this. Some potential programs that need to be tested could include the following;

1. Stomp/Goal EC (or Baron WG) in February, followed by Brodal ± Eclipse in March followed by Brodal in April, followed by simazine in June/July.
2. Stomp/simazine in February followed by Brodal ± Eclipse in late March, followed by Brodal in late April, followed by Baron WG in June.

These programs may give the necessary residual control of Groundsel as part of a Brodal program, while also providing efficacy against *Apiaceae* weeds and not have the detrimental interaction effect observed between Brodal and simazine.

6.2 IMPROVED RESIDUAL WEED CONTROL IN POST-HARVEST PYRETHRUM CROPS

6.2.1 INTRODUCTION

The use of residual herbicides in post-harvest pyrethrum crops is important due to the inability to apply herbicides over the crop during the late winter and early spring because of crop safety concerns. Previous research conducted has shown that there is a negative effect of some currently used herbicides when applied as sequential applications or applied in close proximity to other herbicides being used, for example simazine and simazine/Brodal. This has created the need for two separate spraying programs in order to separate problem chemicals and control weeds.

These two programs are intensive in nature and there is a need to find better long term residual herbicides to complement or replace those currently in use. Due to problems experienced with simazine safety much research has centred on finding a possible alternative, with Baron WG showing the most promise as a substitute. Although positive results have been demonstrated for Baron WG there is still the need to further investigate this herbicide along with other selective residual herbicides such as Command and Gallery.

6.2.2 MATERIALS AND METHODS

6.2.2.1 Trial locations

Table 30. Trial location and details

Trial no.	Year	Title	Location	Growth stage	Herbicides	Target weeds	Period
04-PY-004	2004	Command program	Various - Across NW	Post-harvest	Command Affinity Raptor Pulse	Various	Mar-Dec
04-PY-005	2004	Command interaction	Forth - Werrin farm	Post-harvest	Command Various	Various	Mar-May
04-PY-006	2004	Alternative command program	Forth - Phil Jarman's	Post-harvest	Command Various	Various	Mar-May
05-PY-010	2005	White Clover control with Command and Eclipse	Kindred - 814 Kindred Rd	Post-harvest	Command Brodal Eclipse	White Clover	Mar-Oct
05-PY-007	2005	Residual control of groundsel	Forth - Werrin farm	Post-harvest	Simazine Gallery Goal WP Command	Groundsel	Mar-Oct

05-PY-008	2005	Residual control of groundsel	Sassafras - Craigie Bro's	Post-harvest	Command Baron WP Simazine Gallery	Groundsel	Mar-Oct

6.2.2.2 Application methods

All trials had treatments applied using a gas powered PET sprayer with a boom width of 1.5 metres (2 metre swathe width), fitted with Hardi 4110-12 nozzles and a carrier volume of 250L/ha at 200kPa

Application timing varied throughout the trials conducted and is outline above in Table 30.

6.2.2.3 Assessment methods

Trials were assessed using randomised quadrat counts to determine pyrethrum and weed density. Pyrethrum and weed stature was assessed using the EWRC rating scheme outlined in Table 1. In trials conducted during 2003 assessments of pyrethrum health were made using the EWRC stature scores as well as the percentage ground cover for each plot occupied by the pyrethrum plants

Where applicable statistics have been carried out using the professional statistics package, Statgraphics Plus 2.1, for Windows. The use of statistical analysis is noted by the significance groupings to the right of tabulated figures and LSD calculated at the bottom of corresponding tables.

6.2.3 RESULTS

Trials conducted during 2004 investigated the possible use of the residual herbicide Command in a program containing Affinity and Raptor. With the possibility of Command replacing Brodal, which has been shown to interact with simazine.

Trial 04-PY-004 was conducted to evaluate a herbicide program based on Command rather than Brodal to control escaped weeds. Trials were conducted at numerous locations from Table Cape to Sassafras. Treatments consisted of Command 250mL/ha and Affinity 60g/ha applied in either early March or early April. There was also a treatment of Raptor 45g/ha and Pulse 100mL/100L applied in June. These treatments were applied after the initial commercial application of Stomp +/- Goal.

Weed control observations showed that the Command program provided better groundsel control than the current commercial program based on Brodal. Although groundsel levels were reduced under the Command program, 100% control was not achieved and, under high groundsel pressure, control was poor. Applications of Raptor in late July did improve control however at some sites it appeared to slow development of pyrethrum at the beginning of spring (data not presented).

Yield results compared samples taken from commercial areas outside the trial with areas in the trial. Results were variable between sites with some areas yielding higher under the Command spray program while others yielded higher under commercial applications (Table 31).

Table 31. Dry weight yield, g/m^2 (trial 04-PY-004, Various 2004)

	Spray Program		
Trial Locations	**Commercial**	**Command**	**Command inc. Raptor**
Site 1: Table Cape	118.2	104.4	142.7
Site 2: Burnie	86.3	48.8	61.6
Site 3: Kindred	69.6	63.6	61.3
Site 4: Kindred	129.3	126.1	144.4
Site 5: Forth	123.7	145.9	152.7
Site 6: Don	91.7	108.8	105.3
Site 7: Moriarty	134.7	116.5	141.4
Site 8: Sassafras	70.7	68.0	62.5
Site 9: Wesley Vale	82.6	44.2	40.0
Site 10: Wesley Vale	101.2	95.6	105.9

Note: The Command program included a Command 250ml/ha/Affinity 60g/ha application in March and April followed by a Stomp 5L/ha with or without Raptor 45g/ha in July.

Command was also examined in trials containing herbicides currently used in the commercial program (trial 04-PY-005). Command was applied as a tank-mix, 7 days apart and 28 apart with the following herbicides; Brodal, Eclipse, Goal EC, Raptor, Pledge, Stomp and Frontier P.

Applications of Stomp tank mixed with Command showed a slight reduction in yield compared to Command applied alone. No other treatments applied with or shortly after Command appeared to interact and reduce crop yield (Table 32). At spray separation time of 28 days Command/Eclipse and Command/Pledge reduced dry yield dramatically (Table 32). Low yields experienced in the Command/Eclipse and Command/Pledge treatments at 28 days is most likely due to the individual effects of Eclipse and Pledge alone as they are known to have a negative impact on pyrethrum, if applied late in autumn when mean temperatures are colder.

Table 32. Dry weight yield, g/m^2 (trial 04-PY-005, Werrin Farm 2004)

	Timing Between Product Applications		
Product	**tank-mix**	**7 Days**	**28 Days**
Command (250ml), Brodal (300ml)	106.4	93.2	108.6
Command (250ml), Eclipse (6g)	94.1	106.3	69.6
Command (250ml), Goal EC (400ml)	103.4	110.0	101.6
Command (250ml), Raptor (45g)	95.1	92.5	138.5
Command (250ml), Pledge (200g)	101.5	86.9	74.8
Command (250ml), Stomp (3L)	79.2	88.3	115.7
Command (250ml), Frontier P (2L)	112.2	86.5	117.5
Command (250ml)	95.5	90.0	117.7

Trial 04PY006 was conducted to investigate a number of possible spray programs incorporating the herbicide Command into the post harvest spray program. Treatments are outlined in Table 28 below.

The hand weeded untreated control yielded higher than all other treatments including the non hand weeded untreated plot (Table 33). Pledge treatments had the lowest yield, with the Brodal/Eclipse followed by the

Command treatment also yielding lower than most other treatments. The remaining alternative program treatments had similar yields to the commercial control and untreated control (Table 33).

Table 33. Dry weight, g/m^2 (trial 04-PY-006, Phil Jarman's 2004)

Product[a]	grams
Goal EC + Brodal/Eclipse + Brodal	104.51
Goal EC + Brodal/Eclipse + Command	68.88
Goal EC + Command/Eclipse + Brodal	110.95
Goal EC + Command/Eclipse + Command	93.01
Goal EC + Command/Affinity + Command/Affinity	88.55
Goal EC + Command/Frontier P + Command/Frontier P	98.83
Pledge + Command/Affinity + Command/Affinity	36.86
Goal WP + Command/Affinity + Command/Affinity	99.26
Simazine + Command/Affinity + Command/Affinity	73.94
Untreated + Command/Affinity + Command/Affinity	83.12
Untreated Control + Hand Weeded	156.71
Untreated Control	92.51

[a] Treatments applied at the following times March + 2 weeks + 3 weeks + June

The major weed encountered in this trial was groundsel. Effective control was achieved by the Pledge treatment (Table 34) which also significantly reduced flower yield (Table 33). Command/Frontier P or Command/Affinity had the next best level of control but still averaged 8 plants/m^2 (Table 34). Subterranean Clover was another weed found throughout the trial. Results showed treatments receiving Brodal applications during a spray program had no Sub Clover present at September assessments while most treatments not receiving Brodal had between 0.3 and 1.7 plants/m^2 (Table 35).

Table 34. Groundsel count and stature, per m^2 (trial 04-PY-006, Phil Jarman's 2004)

	6-May-04		6-Sep-04	
Product[a]	Count	Stat	Count	Stat
Goal EC + Brodal/Eclipse + Brodal	3.3	1.0	12.3	1.0
Goal EC + Brodal/Eclipse + Command	20.3	2.0	32.7	1.0
Goal EC + Command/Eclipse + Brodal	0.3	1.0	10.3	1.0
Goal EC + Command/Eclipse + Command	2.7	1.0	15.7	1.0
Goal EC + Command/Affinity + Command/Affinity	2.7	1.0	8.3	1.0
Goal EC + Command/Frontier P + Command/Frontier P	1.3	1.0	8.0	1.0
Pledge + Command/Affinity + Command/Affinity	4.7	1.0	0.0	0.0
Goal WP + Command/Affinity + Command/Affinity	1.0	1.0	11.0	1.0
Simazine + Command/Affinity + Command/Affinity	0.7	1.0	8.7	1.0
Untreated + Command/Affinity + Command/Affinity	1.7	1.0	14.3	1.0
Untreated Control + Hand Weeded	2.0	1.0	13.0	1.0
Untreated Control	15.7	1.0	30.3	1.0

[a] Treatments applied at the following times March + 2 weeks + 3 weeks + June

Table 35. Subterranean Clover count and stature per m^2 (trial 04-PY-006, Phil Jarman's 2004)

Product[a]	6-May-04 Count	Stat	6-Sep-04 Count	Stat
Goal EC + Brodal/Eclipse + Brodal	2.3	2.0	0.0	-
Goal EC + Brodal/Eclipse + Command	0.0	-	0.0	-
Goal EC + Command/Eclipse + Brodal	0.0	-	0.0	-
Goal EC + Command/Eclipse + Command	1.0	2.0	0.3	1.0
Goal EC + Command/Affinity + Command/Affinity	0.3	1.0	0.0	-
Goal EC + Command/Frontier P + Command/Frontier P	6.0	4.0	5.3	1.0
Pledge + Command/Affinity + Command/Affinity	0.0	-	0.3	1.0
Goal WP + Command/Affinity + Command/Affinity	0.0	-	0.3	1.0
Simazine + Command/Affinity + Command/Affinity	0.0	-	1.3	1.0
Untreated + Command/Affinity + Command/Affinity	0.0	-	0.7	1.0
Untreated Control + Hand Weeded	0.3	1.0	1.7	1.0
Untreated Control	0.3	1.0	1.3	1.0

[a] Treatments applied at the following times March + 2 weeks + 3 weeks + June

During 2005 trials were conducted into the use of Command and Eclipse for control of white clover. Two treatment applications were applied, the first, applied in early March, contained Brodal, Eclipse, and Command combinations. Different combinations of the same herbicides were applied at the 2nd application in mid April. Command at 250mL/ha had similar statures to the untreated control however Command at 350mL/ha and Brodal at 300mL/ha both showed effects of herbicide application with leaves of pyrethrum plants showing chlorosis (Table 36). Brodal/Eclipse followed by Brodal had the greatest visual impact on the pyrethrum plants. All other treatments also had some yellowing and leaf burning giving them a higher stature score than the untreated control. The assessment at 166 DAT showed that all herbicide treatments were having a visual impact on the pyrethrum stature. The treatment receiving Brodal followed by Brodal/Eclipse had the greatest visual impact on the crop however differences in stature were relatively small between this and the other treatments (Table 36).

Table 36. Pyrethrum stature (trial 05-PY-010, 814 Kindred Rd 2005)

Application 1[a]	Application 2[a]	Pyrethrum Stature 23-Mar	27-Apr	18-May	17-Aug	26-Sep
Brodal (300 ml)	Brodal (300 ml) Eclipse (6 g)	1.0	3.3	3.3	4.0	3.8
Brodal (300 ml) Eclipse (6 g)	Brodal (300 ml)	1.0	3.3	3.6	3.5	3.5
Command (250 ml)	Command (250 ml) Eclipse (6 g)	1.0	1.8	2.0	3.5	3.0
Command (250 ml) Eclipse (6 g)	Command (250 ml)	1.0	2.0	3.0	3.0	2.8
Command (350 ml)	Command (350 ml) Eclipse (6g)	1.0	2.8	3.0	3.8	3.5
Command (350 ml) Eclipse (6g)	Command (350 ml)	1.0	2.8	2.8	3.8	3.0
Untreated	Untreated	1.0	1.8	1.5	2.3	1.5

[a] Application 1 was applied on March 09, 2005 Application 2 was applied on April 13, 2005

All herbicide treatments had a visual impact on clover growth (Table 37). Treatments receiving Eclipse in the second herbicide application had a greater impact on clover than treatments receiving it in the first application. None of the herbicides however offered adequate control of established weeds in the trial and by the September assessments clover under all treatments had initiated new growth (visual observations, data not presented).

Table 37. Clover stature (trial 05-PY-010, 814 Kindred Rd 2005)

Application 1[a]	Application 2[a]	Clover Stature 23-Mar	27-Apr	18-May	17-Aug	26-Sep
Brodal (300 ml)	Brodal (300 ml) Eclipse (6 g)	3.0	3.0	3.6	3.8	3.3
Brodal (300 ml) Eclipse (6 g)	Brodal (300 ml)	2.8	3.4	3.1	2.5	2.3
Command (250 ml)	Command (250 ml) Eclipse (6 g)	3.0	2.7	2.7	3.0	3.0
Command (250 ml) Eclipse (6 g)	Command (250 ml)	3.0	3.0	3.1	2.3	2.0
Command (350 ml)	Command (350 ml) Eclipse (6g)	3.0	3.0	3.8	4.3	3.3
Command (350 ml) Eclipse (6g)	Command (350 ml)	3.0	3.3	3.4	2.0	2.5
Untreated	Untreated	3.0	2.3	2.6	2.3	1.0

[a] Application 1 was applied on March 09, 2005 Application 2 was applied on April 13, 2005

Trials were conducted in 2005 to evaluate possible herbicides for the residual control of emerging groundsel. These trials were focused on the chemicals Baron WP, Gallery, Command and simazine. Each herbicide was applied at two different rates as stated in Table 38. Trials 05-PY-007a/b were conducted at the same sites and were identical except for that 05-PY-007b was started a month later after the autumn rain break to test weather efficacy was increased by applications to moist soil when compared to dry soil applications.

In trial 05-PY-007a, all treatments offered significantly better control of emerging groundsel over the untreated at 44 days. At 120 days only simazine at 4L/ha and Baron WP at 1 and 2kg/ha demonstrated significantly better control. After this point there was no difference in the level of control gained for any of the treatments, indicating that the residual activity of these herbicides had ceased (Table 38).

Table 38. Emerging groundsel count m^2, (trial 05-PY-007a, Werrin Farm 2005)

Treatment	Rate /ha	44 DAT[a]		120 DAT[a]		182 DAT[a]	214 DAT[a]
Command	250 ml	0.3	a	3.7	ab	1.8	0.0
Command	350 ml	1.3	a	2.7	ab	6.3	1.7
Gallery	125 g	6.3	a	3.7	ab	4.4	6.3
Gallery	250 g	2.0	a	2.3	ab	2.2	1.3
Baron WP	1 kg	0.7	a	0.3	a	4.0	1.3
Baron WP	2 kg	0.0	a	0.3	a	2.7	1.7
Simazine	2 L	0.0	a	3.7	ab	5.7	0.3
Simazine	4 L	0.0	a	0.3	a	7.6	3.7
Untreated	-	23.0	b	6.0	b	6.7	0.3
LSD		11.7		3.8		N/S[1]	N/S[1]

[a] DAT = Days after treatment
N/S[1] = Not significant to (P = 0.05)

In trial 05-PY-007b all chemical treatments gave much improved control of emerging groundsel at 37 days, compared to the untreated control (Table 39). At 172 DAT Baron WP at 1 and 2kg/ha appeared to offer improved control of emerging groundsel when compared with other treatments; however this difference was not significant.

Applications of the residual herbicides did not appear the have their activity improved or reduced to a large extent by the presence of soil moisture, as highlighted in trial 05-PY007a/b.

Table 39. Emerging groundsel count m^2, (trial 05-PY-007b, Werrin Farm 2005)

Treatment	Rate /ha	37 DAT[a]	114 DAT[a]	172 DAT[a]	187 DAT[a]
Command	250 ml	0.0	2.0	4.7	0.3
Command	350 ml	0.0	1.0	3.3	0.0
Gallery	125 g	4.7	1.7	7.7	0.0
Gallery	250 g	1.3	1.3	7.0	0.0
Baron WP	1 kg	0.3	0.0	1.3	1.3
Baron WP	2 kg	0.0	0.0	0.3	0.3
Simazine	2 L	0.0	1.3	10.0	1.3
Simazine	4 L	0.0	0.7	9.3	0.3
Untreated	-	13.0	0.3	7.0	1.7
LSD		N/S[1]	N/S[1]	N/S[1]	N/S[1]

[a] DAT = Days after treatment
N/S[1] = Not significant to (P = 0.05)

Trial 05-PY-008 also evaluated the control of groundsel achieved using the residual herbicides Baron WP, Command, Gallery and simazine. Each herbicide was applied at two different rates as shown in Table 40.

All treatments showed significantly better control of groundsel than the untreated control at both 119 and 213 DAT. However at 213 DAT Baron WP at 2kg/ha and simazine at 4L/ha and Command at 350mL/ha gave significantly better control than other treatments (Table 40).

Table 40. Total groundsel per m^2, (trial 05-PY-008, Craigie Bro's 2005)

Treatment	Rate /ha	44 DAT[a]	119 DAT[a]		198 DAT[a]	213 DAT[a]	
Command	250 ml	0.0	0.8	a	50.0	24.3	b
Command	350 ml	0.0	0.0	a	12.0	13.0	a
Gallery	125 g	16.7	3.3	a	18.3	17.0	b
Gallery	250 g	14.7	8.0	a	31.3	27.0	b
Baron WP	1 kg	2.7	3.0	a	19.0	14.7	b
Baron WP	2 kg	0.0	0.0	a	1.3	0.7	a
Simazine	2 L	0.0	0.5	a	32.3	18.7	b
Simazine	4 L	0.0	0.0	a	23.7	13.0	a
Untreated	-	52.7	18.0	b	41.3	31.0	c
LSD		N/S[1]	11.0		N/S[1]	14.4	

[a] DAT = Days after treatment
N/S[1] = Not significant to (P = 0.05)

6.2.4 DISCUSSION

The ability to replace Brodal with Command in the post-harvest program is limited due to its potential impact on yield. Late applications of Eclipse should be avoided as they appear to have a large impact on the recovery of plants during spring however no yield results were taken to confirm these observations. Command (350 ml/ha) showed good efficacy against groundsel and may offer another alternative for groundsel control. The efficacy of this product against other weeds such a cleavers may mean that this is worth considering as an alternative to simazine. Gallery also offered short term residual control of groundsel. Gallery (250g/ha) did not have significantly lower groundsel levels at final assessments. The lower rate of Gallery (125g/ha) did have a lower level of groundsel compared to the untreated control in final assessments. However the use of these products solely for groundsel control is unlikely since the period of control was not adequate.

Baron WP offered the best overall control of groundsel at 1-2kg/ha reducing total groundsel levels compared to the untreated control up to 182 DAT. Simazine appeared to offer good residual control up to 163 DAT when applied at 4L/ha however the period of control was reduced when it was applied at 2L/ha. Due to interaction and crop safety concerns with Simazine an alternative product such as Baron WP is favourable. Further trials involving Baron WP to help establish ideal rates and the possibility of using split herbicide applications are recommended. Safety trials to establish that Baron WP does not reduce yield are also required. For future trials an increase in the number of replicates is recommended to reduce variation within treatments and obtain more statistically significant results especially if data is to be submitted for product registration.

FINAL REPORT

Survey of ryegrass resistance in pyrethrum crops

NW Tasmania, 2003

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Report Number: BRA03134#6

Report Date: 2nd September 2005

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7 Summary

Over past seasons it has been observed that ryegrass is not being controlled in commercial pyrethrum crops, with group A herbicides (fops and dims). The ryegrass is building up in density with successive harvests and is affecting pyrethrum yield and it is also difficult to manage in subsequent crops in the rotation.

The poor control is thought to be due to herbicide resistance developing in these ryegrass populations. Ryegrass populations resistant to group A herbicides have been widely observed in other regions of Australia.

This survey/trial was conducted to identify what species of ryegrass were present in pyrethrum crops and also what levels of herbicide resistance were present in these populations.

Ryegrass samples collected from pyrethrum paddocks, just prior to harvest in 2004, were identified by the Tasmanian Herbarium. The results show that both L. *multiflorum* and L. *perenne* and a range of hybrids between *L. rigidum, L. multiflorum* and *L. perenne* occur in pyrethrum crops.

Seed from these collected plants was grown in pots to test for herbicide resistance. A total of 10 plants per pot (x 4 replicates) was used for each treatment. Commercial rates and double commercial rates were tested for both Verdict 520 EC (250 and 500 mL/ha) and Select 240 EC (400 and 800 mL/ha). Uptake oil was applied with all herbicide treatments. Sprayed pots were compared to an untreated control. Susceptible varieties of ryegrass, which were not resistant to group A herbicides were also included for comparison.

7 out of 8 populations tested showed some resistance to Verdict (fop), the level of resistant individuals in each population ranged from 7 to 92% at commercial use rates of 250 mL/ha.

6 out of 8 populations tested showed some resistance to Select (dim) at the commercial use rate of 400 mL/ha, ranging from 30-80% of plants in the population being resistant.

The pyrethrum industry needs to develop a strategy for management of grass weeds which does not rely solely on group A herbicides.

8 Introduction

8.1 Background

Over past seasons it has been observed that ryegrass is becoming more difficult to control in some commercial pyrethrum crops, with group A herbicides (fops and dims). The ryegrass is building up in density with successive harvests and is affecting pyrethrum yield and also difficult to manage in subsequent crops in the rotation.

The poor control is thought to be due to resistance developing in these ryegrass populations. Ryegrass populations resistant to group A herbicides have been widely observed in other regions of Australia.

This survey/trial was conducted to identify what species of ryegrass were present in pyrethrum crops and also what levels of herbicide resistance were present in these populations.

8.2 Aims

- To identify species of ryegrass present in pyrethrum crops across NW Tasmania
- To quantify the levels of resistance top fop and dim herbicides in these populations.

8.3 Target Weed

Ryegrass (*Lollium* spp.)

9 Materials and Methods

9.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Verdict	haloxyfop	520 g/L	Emulsifiable Concentrate
Select	clethodim	240 g/L	Emulsifiable Concentrate
BS1000	alcohol alkoxylate	1000 g/L	Liquid
Uptake	paraffinic oil non ionic surfactants	582 g/L 240 g/L	Liquid

9.2 Treatment List

No.	Product	Rate		Application Schedule
		Product (L/ha) or (kg/ha)	Active Ingredient (g ai/ha)	
1	Verdict + Uptake	250 mL + 0.5 %		Single application at 2-4 Tiller stage of ryegrass plants
2	Verdict + Uptake	500 mL + 0.5 %		
3	Select + Uptake	400 mL + 0.5 %		
4	Select + Uptake	800 mL + 0.5 %		
5	Untreated Control	nil	Nil	nil

9.3 Product List

Paddock ID	Ryegrass species	Location	Ryegrass Distribution
60802	*L. rigidum x L. perenne*	Don	Scattered plants
56802	*L. multiflorum x L. rigidum*	Sassafras	Large clumps
70401	*L. multiflorum*	Stowport	Scattered plants
71401	*L. perenne*	Kindred	Large clumps
70017	*L. rigidum x L. perenne*	Table Cape	Large clumps
72401	*L. perenne*	Barrington	Scattered plants
72502	*L. multiflorum*	Kindred	Scattered plants
52604	*L. multiflorum x L. rigidum*	Abbotsham	Large clumps

9.4 Chronology of Events

Date	Days After Application (DAA)	Crop Stage	Event
19/12/03	NA	NA	Collected samples of ryegrass seed from ryegrass plants in various pyrethrum crops
26/07/04	NA	seed	Planted ryegrass seed into pots for resistance tests.
20/09/04	0	2-4 tillers	Applied herbicide treatments to pots
26/10/04	36	flowering	Assessed ryegrass plants for mortality

10 Results

10.1 Table 1 - Mean % Ryegrass Survival 36DAA

No	Treatment	Rate (amount/ha)	% Ryegrass Survival			
			susceptible *L. perenne*	susceptible *L.multiflorum*	71401 *L.perenne*	70017 *L. perenne x L. rigidum*
1	Verdict + Uptake	250 mL + 0.5 %	0.0	0.0	7.5	70.0
2	Verdict + Uptake	500 mL + 0.5 %	0.0	0.0	2.5	55.0
3	Select + Uptake	400 mL + 0.5 %	0.0	0.0	0.0	30.0
4	Select + Uptake	800 mL + 0.5 %	0.0	0.0	0.0	5.0
5	Untreated control	nil	100.0	100.0	100.0	100.0

10.2 Table 2 - Mean % Ryegrass Survival 36DAA

No	Treatment	Rate (amount/ha)	% Ryegrass Survival			
			72502 *L.multiflorum*	72401 *L. perenne*	70401 *L.multiflorum*	60802 *L. perenne x L. rigidum*
1	Verdict + Uptake	250 mls + 0.5 %	0.0	0.0	42.5	82.5
2	Verdict + Uptake	500 mls + 0.5 %	0.0	7.5	30.0	72.5
3	Select + Uptake	400 mls + 0.5 %	0.0	30.8	35.0	72.5
4	Select + Uptake	800 mls + 0.5 %	0.0	12.5	7.5	40.0
5	Untreated control	nil	100.0	0.0	100.0	100.0

10.3 Table 3 - Mean % Ryegrass Survival 36DAA

No	Treatment	Rate (amount/ha)	% Ryegrass Survival	
			56802 *L. multiflorum x L. rigidum*	52604 *L. multiflorum x L. rigidum*
1	Verdict + Uptake	250 mls + 0.5 %	82.5	92.5
2	Verdict + Uptake	500 mls + 0.5 %	72.5	90.0
3	Select + Uptake	400 mls + 0.5 %	65.0	80.0
4	Select + Uptake	800 mls + 0.5 %	37.5	45.0
5	Untreated control	nil	100.0	100.0

11 Results and Discussion

Ryegrass samples collected from pyrethrum paddocks were identified by the Tasmanian Herbarium. The results show that both *L. multiflorum* and *L. perenne* and a range of hybrids between *L. rigidum, L. multiflorum* and *L. perenne* occur in pyrethrum crops.

Seed from these collected plants was grown in pots to test for herbicide resistance. A total of 10 plants per pot (x 4 replicates) was used for each treatment. Commercial rates and double commercial rates were tested for both Verdict 520 EC (250 and 500 mls/ha) and Select 240 EC (400 and 800 mls/ha). Uptake oil was applied with all herbicide treatments. Sprayed pots were compared to an untreated control. Susceptible varieties of ryegrass, which were not resistant to group A herbicides were also included for comparison.

7 out of 8 populations tested showed some resistance to Verdict (fop), the level of resistant individuals in each population ranged from 7 to 92% at commercial use rates of 250 mls/ha.

6 out of 8 populations tested showed some resistance to Select (dim) at the commercial use rate of 400 mls/ha, ranging from 30-80% of plants in the population being resistant.

12 Appendices

12.1 Appendix i - Trial Details

12.1.1 Site Details

Location	Devonport
Soil Type	Potting mix
Trial Design	Randomised complete block
Replications	4
Plot Size	1 pot with 10 ryegrass plants per pot
Sowing Date	26/07/04

12.1.2 Trial Plan

1	3	5	4	2	**Block 4**
3	5	1	2	4	**Block 3**
4	2	3	5	1	**Block 2**
5	1	2	3	4	**Block 1**

↖N

12.1.3 Application Details

Application Equipment	
Equipment	CO2 pressurised knapsack sprayer fitted with a boom
Nozzles	Spraying Systems 8002 fan jets (x4)
Volume	230 L/ha
Pressure	280 KPa
Method	Walked at 1metre per second
Treatment Applications	
Application Number	1
Date	20/09/04
Time	8.30 am
Treatments Applied	1-4
Temperature (^{O}C)	7.9
Relative Humidity (%)	90
Cloud Cover (%)	30
Wind Direction	-
Wind Speed (km/h)	calm
Soil Moisture or Leaf Wetness	Soil moist, light dew on leaves
Ryegrass Growth Stage	2-4 tillers

12.1.4 Assessments

1. Ryegrass Survival Assessment	
Date	26/10/04
Days After Application	36 DAA
Sample Size	Whole Pot (10 Plants)
Method	Counted number of dead an number of alive ryegrass per pot

12.2 Appendix ii - Raw Data

12.2.1.1 Assessment 1 [26/10/04 36DAA]

No.	Product	Rep	72502 No Plants / pot Pre	72502 No Plants / pot Post	% survival	72401 No Plants / pot Pre	72401 No Plants / pot Post	% survival	71401 No Plants / pot Pre	71401 No Plants / pot Post	% survival
1	Verdict 250 mls + 0.5% Uptake	1	10	0	0	10	0	0	10	0	0
		2	10	0	0	10	0	0	10	0	0
		3	10	0	0	10	0	0	10	0	0
		4	10	0	0	10	0	0	10	3	30
		Mean	10.0	0.0	0.0	10.0	0.0	0.0	10.0	0.8	7.5
2	Verdict 500 mls + 0.5% Uptake	1	10	0	0	10	0	0	10	1	10
		2	10	0	0	10	0	0	10	0	0
		3	10	0	0	10	3	30	10	0	0
		4	10	0	0	10	0	0	10	0	0
		Mean	10.0	0.0	0.0	10.0	0.8	7.5	10.0	0.3	2.5
3	Select 400 mls + 0.5% Uptake	1	10	0	0	9	3	33	10	0	0
		2	10	0	0	10	3	30	10	0	0
		3	10	0	0	10	4	40	10	0	0
		4	10	0	0	10	2	20	8	0	0
		Mean	10.0	0.0	0.0	9.8	3.0	30.8	9.5	0.0	0.0
4	Select 800 mls + 0.5% Uptake	1	10	0	0	10	2	20	10	0	0
		2	10	0	0	10	0	0	10	0	0
		3	10	0	0	10	3	30	10	0	0
		4	10	0	0	10	0	0	10	0	0
		Mean	10.0	0.0	0.0	10.0	1.3	12.5	10.0	0.0	0.0
5	Untreated control	1	10	10	100	10	0	0	10	10	100
		2	10	10	100	10	0	0	10	10	100
		3	10	10	100	10	0	0	10	10	100
		4	10	10	100	10	0	0	10	10	100
		Mean	10.0	10.0	100.0	10.0	0.0	0.0	10.0	10.0	100.0

No.	Product	Rep	70017 No Plants / pot Pre	70017 No Plants / pot Post	70017 % survival	70401 No Plants / pot Pre	70401 No Plants / pot Post	70401 % survival	60802 No Plants / pot Pre	60802 No Plants / pot Post	60802 % survival
1	Verdict 250 mls + 0.5% Uptake	1	10	5	50	10	5	50	10	7	70
		2	10	6	60	10	5	50	10	8	80
		3	10	7	70	10	4	40	10	10	100
		4	10	10	100	10	3	30	10	8	80
		Mean	10.0	7.0	70.0	10.0	4.3	42.5	10.0	8.3	82.5
2	Verdict 500 mls + 0.5% Uptake	1	10	5	50	10	4	40	10	8	80
		2	10	7	70	10	3	30	10	8	80
		3	10	5	50	10	1	10	10	7	70
		4	10	5	50	10	4	40	10	6	60
		Mean	10.0	5.5	55.0	10.0	3.0	30.0	10.0	7.3	72.5
3	Select 400 mls + 0.5% Uptake	1	10	3	30	10	3	30	10	8	80
		2	10	2	20	10	5	50	10	7	70
		3	10	2	20	10	3	30	10	7	70
		4	10	5	50	10	3	30	10	7	70
		Mean	10.0	3.0	30.0	10.0	3.5	35.0	10.0	7.3	72.5
4	Select 800 mls + 0.5% Uptake	1	10	0	0	10	1	10	10	4	40
		2	10	0	0	10	1	10	10	5	50
		3	10	1	10	10	0	0	10	4	40
		4	10	1	10	10	1	10	10	3	30
		Mean	10.0	0.5	5.0	10.0	0.8	7.5	10.0	4.0	40.0
5	Untreated Control	1	10	10	100	10	10	100	10	10	100
		2	10	10	100	10	10	100	10	10	100
		3	10	10	100	10	10	100	10	10	100
		4	10	10	100	10	10	100	10	10	100
		Mean	10.0	10.0	100.0	10.0	10.0	100.0	10.0	10.0	100.0

No.	Product	Rep	56802 No Plants / pot Pre	56802 No Plants / pot Post	56802 % survival	Susceptible L. No Plants / pot Pre	Susceptible L. No Plants / pot Post	Susceptible L. % survival	Susceptible L. No Plants / pot Pre	Susceptible L. No Plants / pot Post	Susceptible L. % survival
1	Verdict 250 mls + 0.5% Uptake	1	10	10	100	10	0	0	10	0	0
		2	10	7	70	10	0	0	10	0	0
		3	10	8	80	10	0	0	10	0	0
		4	10	8	80	10	0	0	10	0	0
		Mean	10.0	8.3	82.5	10.0	0.0	0.0	10.0	0.0	0.0
2	Verdict 500 mls + 0.5% Uptake	1	10	8	80	10	0	0	10	0	0
		2	10	6	60	10	0	0	10	0	0
		3	10	8	80	10	0	0	10	0	0
		4	10	7	70	10	0	0	10	0	0
		Mean	10.0	7.3	72.5	10.0	0.0	0.0	10.0	0.0	0.0
3	Select 400 mls + 0.5% Uptake	1	10	6	60	10	0	0	10	0	0
		2	10	7	70	10	0	0	10	0	0
		3	10	5	50	10	0	0	10	0	0
		4	10	8	80	10	0	0	10	0	0
		Mean	10.0	6.5	65.0	10.0	0.0	0.0	10.0	0.0	0.0
4	Select 800 mls + 0.5% Uptake	1	10	7	70	10	0	0	10	0	0
		2	10	2	20	10	0	0	10	0	0
		3	10	3	30	10	0	0	10	0	0
		4	10	3	30	10	0	0	10	0	0
		Mean	10.0	3.8	37.5	10.0	0.0	0.0	10.0	0.0	0.0
5	Untreated Control	1	10	10	100	10	10	100	10	10	100
		2	10	10	100	10	10	100	10	10	100
		3	10	10	100	10	10	100	10	10	100
		4	10	10	100	10	10	100	10	10	100
		Mean	10.0	10.0	100.0	10.0	10.0	100.0	10.0	10.0	100.0

12.3

12.4

No.	Product	Rep	52604 No Plants / pot Pre spray	52604 No Plants / pot Post Spray	% survival
1	Verdict 250 mls + 0.5% Uptake	1	10	10	100
		2	10	9	90
		3	10	9	90
		4	10	9	90
		Mean	10.0	9.3	92.5
2	Verdict 500 mls + 0.5% Uptake	1	10	10	100
		2	10	8	80
		3	10	9	90
		4	10	9	90
		Mean	10.0	9.0	90.0
3	Select 400 mls + 0.5% Uptake	1	10	10	100
		2	10	7	70
		3	10	5	50
		4	10	10	100
		Mean	10.0	8.0	80.0
4	Select 800 mls + 0.5% Uptake	1	10	3	30
		2	10	5	50
		3	10	5	50
		4	10	5	50
		Mean	10.0	4.5	45.0
5	Untreated Control	1	10	10	100
		2	10	10	100
		3	10	10	100
		4	10	10	100
		Mean	10.0	10.0	100.0

12.4.1.1

FINAL REPORT

Evaluation of post-harvest herbicides for control of ryegrass in pyrethrum

Don, Tasmania, 2004

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13 Summary

A trial was conducted at Don in an ex pyrethrum paddock which had group A resistant ryegrass (L. rigidum x L. perenne). The paddock had been lightly cultivated following the pyrethrum so there was still pyrethrum trash on the soil surface. Pre emergence herbicide treatments were applied just prior to the autumn rains before the ryegrass had emerged. Frontier-P, Dual Gold, Exporsan, Goal WP and tank mixes of Frontier-P with Command or Simazine were evaluated pre emergence while Raptor and the commercial standard Verdict + Select were trialed post ryegrass emergence.

Efficacy was assessed using the EWRS scale. Most treatments provided very little control of ryegrass including the commercial standards Select + Verdict. The only treatment to provide effective control was Frontier-P 720 EC at 2 L/ha followed post emergence by Raptor 700 WG at 45 g/ha + BS1000 200 mL/100 L. Other trials have shown both these herbicide to be safe in pyrethrum and not affect yield.

14 Introduction

14.1 Background

Over past seasons it has been observed that ryegrass is becoming more difficult to control in some commercial pyrethrum crops, with group A herbicides (fops and dims). The ryegrass is building up in density with successive harvests and is affecting pyrethrum yield and is also difficult to manage in subsequent crops in the rotation.

The poor control is thought to be due to resistance developing in these ryegrass populations. Ryegrass populations resistant to group A herbicides have been widely observed in other regions of Australia.

14.2 Aims

- To evaluate various herbicides for control of group A herbicide resistant ryegrass.

14.3 Target Weed

Ryegrass (*Lolium* spp.)

15 Materials and Methods

15.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Command	clomazone	480 g/L	Emulsifiable Concentrate
Frontier-P	dimethenamid-p	720 g/L	Emulsifiable Concentrate
Goal WP	oxyflurofen	400 g/kg	Wettable Powder
Dual Gold	s-metolachlor	960 g/L	Emulsifiable Concentrate
Exporsan	bensulide	500 g/L	Emulsifiable Concentrate
Gallery	isoxaben	750 g/kg	Wettable Granule
Gesatop	simazine	500 g/L	Suspension Concentrate
Raptor	imazamox	700 g/kg	Wettable Granule
Verdict	haloxyfop	520 g/L	Emulsifiable Concentrate
Select	clethodim	240 g/L	Emulsifiable Concentrate
BS1000	alcohol alkoxylate	1000 g/L	Liquid
Uptake	paraffinic oil non ionic surfactants	582 g/L 240 g/L	Liquid
Liase	ammonium sulphate	417 g/L	Liquid

15.2 Treatment List

No.	Treatment (Product Amount/ha)	
	Pre Weed Emergence	**Post Weed Emergence**
1	Frontier-p 2 L	
2	Frontier-p 4 L	
3	Dual Gold 2 L	
4	Dual Gold 4 L	
5	Exporsan 10 L	
6	Gallery 250 g	
7	Goal WP 1 kg	
8	Frontier-p 2 L + Gesatop 2 L	
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L
10	Command 300 mls + Frontier -p 2 L	
11		Raptor 45 g + BS1000 200 mL/100 L
12	-	Raptor 45 g + BS1000 200 mL/100 L + Liase 2 L/100 L
13	-	Verdict 250 mls + Select 400 mls + Uptake 500 mL/100L
14	Untreated control	-

16 Results

16.1 Table 1 - Mean EWRS ratings for ryegrass control

No.	Treatment (product rate, mls or g/ha)		Mean EWRS Rating for ryegrass control		
	Pre Weed Emergence	Post Weed Emergence	07/05/04 37DAAT1 0DAAT2	25/05/04 55DAAT1 18DAAT2	17/06/04 78DAAT1 41DAAT2
1	Frontier-p 2 L	-	5.7	6.3	6.5
2	Frontier-p 4 L	-	5.5	6.0	5.5
3	Dual Gold 2 L	-	8.0	8.0	8.0
4	Dual Gold 4 L	-	7.0	7.0	7.7
5	Exporsan 10 L	-	8.7	8.3	8.7
6	Gallery 250 g	-	7.0	7.5	8.5
7	Goal WP 1 kg	-	7.0	8.3	8.7
8	Frontier-p 2 L + Gesatop 2 L	-	4.0	7.0	6.5
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	6.5	3.7	2.7
10	Command 300 mls + Frontier -p 2 L	-	4.3	6.0	6.0
11	-	Raptor 45 g or 90 g + BS1000 200 mL/100 L (split plot)	-	7.0	5.7
12	-	Raptor 45 g + BS1000 200 mL/100 L + Liase 2 L/100 L	-	8.0	6.0
13	-	Verdict 250 mls + Select 400 mls + Uptake 500 mL/100L	-	8.3	8.3
14	Untreated control		9.0	9.0	9.0

DAA = Days after application

Results and Discussion

This trial was conducted at Don in an ex pyrethrum paddock which had group a resistant ryegrass (L. rigidum x L. perenne). The paddock had been lightly cultivated following the pyrethrum so there was still pyrethrum trash on the soil surface. Pre emergence herbicide treatments were applied just prior to the autumn rains before the ryegrass had emerged. Frontier-p, Dual Gold, Exporsan, Goal WP and tank mixes of Frontier-p with Command or Simazine were evaluated pre emergence while Raptor and the commercial standard Verdict + Select were trialed post ryegrass emergence.

Efficacy was assessed using the EWRS scale (Table 1). Most treatments provided very little control of ryegrass including the commercial standards Select + Verdict. The only treatment to provide effective control was Frontier-p 720 EC at 2 L/ha followed post emergence by Raptor 700 WG at 45 g/ha + BS1000 200 mL/100 L. Other trials have shown both these herbicide to be safe in pyrethrum and not affect yield.

17 Appendices

17.1 Appendix i - Trial Details

17.1.1 Site Details

Grower	Tony Parker
Location	Don
Soil Type	Ferrosol
Crop	Fallow ground following pyrethrum crop
Trial Design	Randomised complete block
Replications	3
Plot Size	2m x 8m

17.1.2 Trial Plan

8	9	5	14	1	3	6	REP 3
13	2	4	11	12	7	10	
11	14	13	3	5	4	7	REP 2
12	6	8	10	2	9	1	
8	10	12	9	14	5	4	REP 1
2	3	7	6	11	1	13	

↖N

17.1.3 Application Details

Application Equipment		
Equipment	CO_2 pressurised precision knapsack sprayer	
Nozzles	4 X Spraying Systems DG8002 fan jets	
Volume	240 L/ha	
Pressure	280 kPa	
Method	Walked at 1 m/sec	
Treatment Applications		
Application Number	1	2
Date	31/03/04	07/05/04
Time	11.30 am	9.15 am
Treatments Applied	Pre emergent	Post emergent
Temperature (^{O}C)	22	11
Relative Humidity (%)	40	72
Cloud Cover (%)	40	0
Wind Direction	W	NW
Wind Speed (km/h)	10	1-5
Soil Moisture	Surface Dry	Moist
Weed Growth Stage	Pre emergence	1-3 Leaf

Meteorological data from Forthside Vegetable Research Station for the months of April, May and June are included as Appendix iv to this report. The trial site was situated 2km from Forthside Vegetable Research Station.

17.1.4 Assessments

1. Weed Assessment	
Dates	07/05/04, 25/05/04 and 17/06/04
Days After Application	37 DAAT1 and 0DAA2, 55 DAAT1 and 18 DAAT2, 78 DAAT1 and 41 DAAT2
Sample Size	Whole plot
Method	EWRS Rating

17.2 Appendix ii - Raw Data

17.2.1.1 Weed Efficacy Assessments

Treatment				EWRS RATING for weed control		
No	**Pre Weed Emergence**	**Post Weed Emergence**	**Rep**	07/05/04	25/05/04	17/06/04
1	Frontier-p 2 L		1	4	5	5
			2	9	7	8
			3	4	7	
			Mean	5.7	6.3	6.5
2	Frontier-p 4 L		1			
			2	6	7	6
			3	5	5	5
			Mean	5.5	6.0	5.5
3	Dual Gold 2 L		1			
			2	8	8	8
			3			
			Mean	8.0	8.0	8.0
4	Dual Gold 4 L		1	8	8	8
			2	5	7	8
			3	8	6	7
			Mean	7.0	7.0	7.7
5	Exporsan 10 L		1	8	8	8
			2	9	8	9
			3	9	9	9
			Mean	8.7	8.3	8.7
6	Gallery 250 g		1	6	7	8
			2	8	8	9
			3			
			Mean	7.0	7.5	8.5
7	Goal WP 1 kg		1		8	8
			2	6	8	9
			3	8	9	9
			Mean	7.0	8.3	8.7
8	Frontier-p 2 L + Gesatop 2 L		1	4		
			2	4	8	7
			3	4	6	6
			Mean	4.0	7.0	6.5
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	1	5	4	3
			2	8	4	2
			3		3	3
			Mean	6.5	3.7	2.7
10	Command 300 mls + Frontier -p 2 L		1	4		
			2	5	7	7
			3	4	5	5
			Mean	4.3	6.0	6.0
11		Raptor 45 g or 90 g + BS1000 200 mL/100 L (split plot)	1		5	5
			2		8	6
			3		8	6
			Mean		7.0	5.7
12		Raptor 45 g + BS1000 200 mL/100 L + Liase 2 L/100 L	1		8	
			2		8	6
			3		8	6
			Mean		8.0	6.0
13		Verdict 250 mls + Select 400 mls + Uptake 500 mL/100L	1		8	8
			2		9	9
			3		8	8
			Mean		8.3	8.3
14	Untreated Control		1	9	9	9
			2	9	9	9
			3	9	9	9
			Mean	9.0	9.0	9.0

17.3

17.4 Appendix iii - Rating Scales

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

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	Heavy damage to total kill
7	30.1 - 45	
8	45.1 - 70	
9	70.1 - 100	

The EWRS (European Weed Research System) scale is based on comparison of the treated plots with the untreated control plot. The aim is to assess as accurately as possible the decrease in the natural number of plants per weed species (still visible in the untreated plot). This decrease in the weed population corresponds to the action of the product. The EWRS scale is logarithmic, the intervals decreasing as the action increases. This enables detailed assessment in the range of effective herbicide action.

Reference: Puntener W. 1981. Manual for Field Trials in Plant Protection. Second Edition. Ciba-Geigy Limited, Basle, Switzerland.

17.5 Appendix v - Meteorological Details

Recordings (Min,Max,Aver & Total) To 9:00 Hrs

Date	Time	Max. Dry B. Deg.C	Min. Dry B. Deg.C	Aver. Dry B. Deg.C	Max. Grass Deg.C	Min. Grass Deg.C	Aver. Grass Deg.C	Max. 10 cm Deg.C	Min. 10 cm Deg.C	Aver. 10 cm Deg.C	Max. 20 cm Deg.C	Min. 20 cm Deg.C	Aver. 20 cm Deg.C	Evap. MM	Total Wind K	Aver. Wind KPH	Total Solar mj/m2	Total Rain MM	Relative Humidity Max.	Min.	Aver.
1/04/2004	9:00:00	16.8	9	13.2	22.6	6.6	15	18.5	13.1	15.9	17.4	16.2	16.9	2.1	40	1.7	10.2	3.4	95%	52%	71%
2/04/2004	9:00:00	16.5	8.8	11.6	28.3	5.7	11.9	16.3	11.5	13.8	16.2	14.9	15.8	2.4	41	1.74	10.5	1.6	95%	43%	65%
3/04/2004	9:00:00	16.7	9	12.5	31.7	6	13.2	15.7	11.6	13.6	15.4	14.6	15	1.7	34	1.41	8.6	0	96%	55%	72%
4/04/2004	9:00:00	17.5	9.3	12.9	31	8.2	14.3	16.4	11.9	14	15.5	14.5	15	2	33	1.38	8.4	0	77%	55%	64%
5/04/2004	9:00:00	17.9	7.5	11.9	37.6	4.8	14.7	17.7	12.3	14.9	16	14.6	15.3	2.4	51	2.12	12.7	0.6	93%	51%	72%
6/04/2004	9:00:00	16.3	11.3	14.1	33.8	12.1	15.9	15.8	12.3	14.6	15.5	14.8	15.2	1.2	34	1.42	8.6	6.2	98%	53%	77%
7/04/2004	9:00:00	21.1	7.4	12.8	32.7	4.9	14	18.9	11.3	15.3	16.5	15.1	15.8	2.8	48	2.02	12.1	0	96%	36%	66%
8/04/2004	9:00:00	18.2	6.3	11	34.5	4.4	13.4	17.3	11.2	14	16	14.6	15.2	2.6	58	2.44	14.5	0	95%	40%	75%
9/04/2004	9:00:00	17.7	8.2	12.4	33.3	7	15.4	18	11.2	14.8	16	14.4	15.2	2.6	53	2.22	13.2	0	100%	64%	85%
10/04/2004	9:00:00	18.7	5.4	11.4	35.8	3.3	13.4	18.4	11.4	14.9	16.3	15	15.6	2.6	56	2.33	13.8	0	95%	48%	70%
11/04/2004	9:00:00	17.3	11	13.2	37.2	11.1	15.1	15.9	11.4	14.3	15.3	14.5	14.9	1.1	31	1.3	7.9	11.2	97%	54%	77%
12/04/2004	9:00:00	15.1	9	12.7	19	8.3	12.8	14.6	12.9	13.9	15	14.6	14.8	0.7	10	0.45	3	1.4	100%	79%	91%
13/04/2004	9:00:00	19.3	8.8	13.3	31.2	7.5	15.1	16.9	12.9	14.7	15.5	14.4	14.9	1.8	35	1.46	8.8	0.6	99%	63%	85%
14/04/2004	9:00:00	16.9	12.6	14.3	24.3	11.7	14.8	15.5	13.4	14.5	15.1	14.7	14.9	0.9	21	0.9	5.6	0.2	97%	69%	84%
15/04/2004	9:00:00	20.2	14.9	16.2	31.7	13.8	17	17.1	14.5	15.7	15.7	14.8	15.3	2.3	44	1.83	11.4	0.8	95%	77%	89%
16/04/2004	9:00:00	18.7	7	12.4	21.8	5.3	12	16.7	12	14.6	15.9	14.6	15.4	2.7	68	2.86	17.5	0.6	99%	63%	89%
17/04/2004	9:00:00	16.1	6	10.6	22.7	5	10.7	14.9	10.8	12.7	14.7	13.5	14.3	3	78	3.26	19.8	18.4	100%	62%	87%
18/04/2004	9:00:00	19.3	8.6	11.4	26.2	5.4	11.4	15.1	10.1	12.3	14.2	13.2	13.6	3.5	71	2.97	18.1	0.4	93%	50%	75%
19/04/2004	9:00:00	17.4	3.5	9.9	31.1	1.6	11.2	15.2	9.1	12.2	14.1	12.9	13.4	2.6	66	2.75	16.9	0	96%	41%	73%
20/04/2004	9:00:00	15.8	5.8	9.6	32.2	4	12.7	15.1	9.1	12	13.8	12.5	13.2	1.2	52	2.19	13.6	0	96%	52%	82%
21/04/2004	9:00:00	14.9	8.2	11.1	23.6	6.2	12.3	14.1	10.8	12.6	13.6	12.8	13.2	1	30	1.25	8.1	0	93%	64%	83%
22/04/2004	9:00:00	18.4	9.9	13.5	33	7.8	15.7	16.4	11.3	14	14.6	13	13.9	1.8	50	2.08	12.9	0	98%	59%	85%
23/04/2004	9:00:00	17.8	11.3	14.5	24.7	10.3	15.2	15.6	12.6	14.4	14.6	13.8	14.3	1.8	50	2.1	13.1	4.6	98%	78%	91%
24/04/2004	9:00:00	11.8	8.9	10	14.3	5.4	8.6	13.6	9.5	11.9	14.4	12.8	13.8		118	4.93	29.4	1.2	91%	49%	65%
25/04/2004	9:00:00	12.3	6	9.1	16	4.9	8.8	11.3	9.5	10.2	12.8	12	12.3		46	1.93	12	2	94%	52%	81%
26/04/2004	9:00:00	16.8	6.5	10.9	28.6	3.6	11.4	14.7	9.6	12	13.3	11.9	12.6	4.2	55	2.33	14.4	0	98%	60%	82%
27/04/2004	9:00:00	16.2	4	10.1	28.2	1.4	10.1	14	8.6	11.3	13.1	12.1	12.5	1.2	84	3.51	21.2	0	93%	46%	75%
28/04/2004	9:00:00	19.1	5.9	10.6	31.1	3.2	12.4	14	8.5	11.1	12.9	11.7	12.3	1.6	49	2.04	12.7	0	98%	46%	80%
29/04/2004	9:00:00	14.9	10.4	12	22.7	10.6	13.2	13.1	9.8	12	12.7	11.9	12.3	1.4	37	1.57	10	7	98%	68%	87%
30/04/2004	9:00:00	16.9	10.5	13	30.6	9.2	14.1	15.3	11.9	13.5	13.7	12.6	13.2	1.4	51	2.13	13.2	9.2	98%	73%	91%
	Totals	512.6	251	362.2	851.5	199.3	395.8	472.1	336.1	405.7	445.8	413	430.1	56.6	1494	62.62	382.2	69.4			
	Average	17.1	8.4	12.1	28.4	6.6	13.2	15.7	11.2	13.5	14.9	13.8	14.3	2.0			12.7	2.3	96%	57%	79%

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Recordings (Min,Max,Aver & Total) To 9:00 Hrs

Date	Time	Max. Dry B. Deg.C	Min. Dry B. Deg.C	Aver. Dry B. Deg.C	Max. Grass Deg.C	Min. Grass Deg.C	Aver. Grass Deg.C	Max. 10 cm Deg.C	Min. 10 cm Deg.C	Aver. 10 cm Deg.C	Max. 20 cm Deg.C	Min. 20 cm Deg.C	Aver. 20 cm Deg.C	Evap. MM	Total Wind K	Aver. Wind KPH	Total Solar mj/m2	Total Rain MM	Relative Humidity Max.	Min.	Aver.
1/05/2004	9:00:00	16.3	3.1	9.5	29	1.9	10.2	15.8	8.8	12.4	14	12.4	13.3				19.4	0	96%	58%	77%
2/05/2004	9:00:00	13.6	2.6	7.4	26.7	0.8	8.3	12.7	7.8	9.8	12.5	11.2	12				27	0.2	88%	45%	68%
3/05/2004	9:00:00	12.6	4.7	7.6	19.5	1.6	6.9	11	7.1	8.8	11.5	10.3	11	5.8	732.3		41.4	4.2	93%	58%	73%
4/05/2004	9:00:00	13.9	8.4	11.4	20.5	6.3	11.1	10.7	7.7	10	11.2	10.2	10.7	1	423.5		45.5	0.6	93%	58%	77%
5/05/2004	9:00:00	10.4	4.2	6.4	17.5	1.6	5.7	11.3	6.4	9	11.4	10	10.9	2	320.1		36.2	7	88%	59%	75%
6/05/2004	9:00:00	12.9	6.8	9.8	23.5	4.1	9.5	11.1	6.4	9	10.7	9.7	10.2	1.4	271.6		31.4	0	91%	56%	73%
7/05/2004	9:00:00	15.2	2.2	8.1	24.1	-0.3	8	12.1	6.3	9.2	11.1	10	10.5	1.6	154		20.6	0	99%	51%	77%
8/05/2004	9:00:00	16.1	2.3	9	28.4	0	9.5	12.2	6.2	9.1	10.9	9.6	10.3				16	0	95%	56%	76%
9/05/2004	9:00:00	16.4	5.6	10.1	26.4	1.8	10.6	12.2	6.7	9.5	11	9.7	10.4				17.2	0	95%	54%	76%
10/05/2004	9:00:00	17.5	3	9	28.9	0.6	10.2	12.5	7.2	9.7	11.2	10.1	10.6	4	357.7		15.7	0	94%	48%	74%
11/05/2004	9:00:00	15.7	0.9	6.7	27.4	-1.1	7.7	11.9	5.9	8.7	10.9	9.8	10.3	1	104.2		14.1	0	97%	46%	75%
12/05/2004	9:00:00	18	2.6	9.2	29.1	-0.2	9.8	11.5	5.9	8.6	10.6	9.4	10	2.4	121.6		15.5	0	97%	48%	76%
13/05/2004	9:00:00	14.5	4.2	8.4	27.2	0.9	8.6	11.5	6.8	9	10.6	9.5	10	0.2	93		12.4	0	100%	52%	82%
14/05/2004	9:00:00	16.3	2.1	8.2	29.1	-0.3	8.8	12.4	6.7	9.4	10.9	9.7	10.3	0.8	95.1		13.6	0	100%	54%	84%
15/05/2004	9:00:00	16.2	3.9	8	27.6	1.9	9.6	11.9	6.6	9.1	10.7	9.6	10.2				13	0	100%	53%	86%
16/05/2004	9:00:00	12.6	6	10.4	20.2	5	10.3	10.4	7.7	9.6	10.5	9.8	10.2				16.3	13	97%	80%	89%
17/05/2004	9:00:00	15.4	5.2	9.8	25.4	1.2	9.4	12.6	7.6	10.2	11.2	10.3	10.7	3.4	388.7		18	0.8	99%	64%	84%
18/05/2004	9:00:00	16	8.3	11.4	25.8	7.5	12.5	11.8	7.5	10.2	10.9	10	10.5				20.2	12	96%	64%	86%
19/05/2004	9:00:00	13.4	5	9.8	15.6	2.2	8.1	11.8	7.6	10.2	11.3	10.3	10.9	3	417		28.3	8.6	98%	64%	83%
20/05/2004	9:00:00	14.4	6	10.6	20.9	2.8	10.1	11.3	7.6	9.3	10.7	10	10.3	1.2	276.2		31.6	2.2	98%	52%	81%
21/05/2004	9:00:00	14.9	4.5	9.9	18.1	1.9	8.1	11.4	6.9	9.4	10.8	9.9	10.4	1.6	312		34.1	0.4	92%	51%	69%
22/05/2004	9:00:00	15.7	3.2	9.1	25.7	1.3	8	11.2	6.8	8.8	10.4	9.5	9.9				12.3	0	100%	68%	86%
23/05/2004	9:00:00	13.9	6.5	11.5	19	7.2	11.3	10.5	6.7	9.6	10.4	9.3	9.9				11.5	0	99%	77%	88%
24/05/2004	9:00:00	16.9	11.7	13.7	24.7	10.6	13.7	12.4	9.8	11.6	11.4	10.4	10.9	1.6	335.2		16.2	12.4	98%	75%	90%
25/05/2004	9:00:00	15	8.8	11.6	20.2	6.2	11.3	13.6	10.3	12.1	12.1	11.4	11.7	0.8	115		12.4	1	100%	91%	96%
26/05/2004	9:00:00	15.3	2.8	9	22.7	0.8	8.8	13.3	7.7	10.7	12	10.8	11.5	1	145.9		18.2	0.4	98%	64%	82%
27/05/2004	9:00:00	12.4	0	5.6	22.3	-1.8	5.6	11	5.8	8.5	10.9	9.6	10.4	0.6	129.1		16	0	100%	63%	79%
28/05/2004	9:00:00	11.8	4.1	7.9	19.3	1.3	7.5	9.4	5.6	7.5	9.7	9.1	9.4	0.6	130.8		17.1	0.4	100%	60%	84%
29/05/2004	9:00:00	10	5.8	7.5	17.5	2	6.6	9.2	5.7	7.2	9.5	8.6	9.1				47.1	1	82%	56%	66%
30/05/2004	9:00:00	12.6	8.8	10.4	22	5.4	9.7	9.4	5.7	8	9.3	8.4	8.9				28.3	0.2	94%	62%	80%
31/05/2004	9:00:00	15.6	10.3	12.5	24	6.9	12.4	11.1	7.9	9.9	10.1	9.1	9.7	3.4	970.2		36.7	6.2	97%	69%	85%
	Totals	451.5	153.6	289.5	728.3	80.1	287.9	361.2	219.4	294.1	340.4	307.7	325.1	37.4	5893			70.6			
	Average	14.6	5	9.3	23.5	2.6	9.3	11.7	7.1	9.5	11	9.9	10.5	1.9	294.7			2.3	96%	60%	80%

Recordings (Min,Max,Aver & Total) To 9:00 Hrs

Date	Time	Max. Dry B. Deg.C	Min. Dry B. Deg.C	Aver. Dry B. Deg.C	Max. Grass Deg.C	Min. Grass Deg.C	Aver. Grass Deg.C	Max. 10 cm Deg.C	Min. 10 cm Deg.C	Aver. 10 cm Deg.C	Max. 20 cm Deg.C	Min. 20 cm Deg.C	Aver. 20 cm Deg.C	Evap. MM	Total Wind K	Aver. Wind KPH	Total Solar mj/m2	Total Rain MM	Relative Max.	Humidity Min.	Aver.
1/06/2004	9:00:00	13.8	12.4	12.9	17.8	9.9	12	11.9	10.4	10.9	10.9	10.1	10.6	1.2	493			0	89%	63%	77%
2/06/2004	9:00:00	13	4.2	7.6	19.4	1.9	6.8	11.2	7.4	9.2	10.8	9.6	10.4	1.4	131			0.8	99%	59%	85%
3/06/2004	9:00:00	12.4	8.7	10.2	18.1	5.7	9.3	10.2	7.5	8.8	10	9.5	9.7	0.8	318.3			0.6	96%	65%	82%
4/06/2004	9:00:00	11.3	3.4	6.8	16.5	0.1	5.3	10	5.5	7.9	10	8.7	9.5	1.4	309.5			2.4	92%	57%	75%
5/06/2004	9:00:00	11.6	-0.1	6.1	19.8	-1.7	5.1	9	4.8	6.7	9	8.1	8.6					0	100%	56%	78%
6/06/2004	9:00:00	13.9	1.1	5.7	24.5	-1.3	6	9.2	4.6	6.4	8.7	7.7	8.2					0	99%	62%	85%
7/06/2004	9:00:00	9	1.4	5.5	11.7	-0.5	4.3	7.1	4.8	5.9	7.9	7.6	7.7	1.6	362.5			0	100%	84%	92%
8/06/2004	9:00:00	14.2	5.1	11.1	24.6	5.6	11.5	9.4	4.9	8.2	9	7.4	8.1	0.6	91.9			5.6	100%	80%	93%
9/06/2004	9:00:00	13.9	11	12.3	18.5	9.8	12.3	11.6	9.4	10.8	10.3	9	9.7	0.4	153.3			1.6	100%	93%	96%
10/06/2004	9:00:00	12.8	6.1	10.8	13.1	3.5	10.1	11.4	9.3	10.8	10.7	10.2	10.5	1.2	168.1			10.6	100%	76%	96%
11/06/2004	9:00:00	14.9	1.3	7.4	22.3	-0.4	6.9	11.9	5.7	9	10.6	9.3	10.2	1.4	158.7			0	93%	60%	76%
12/06/2004	9:00:00	13.7	2.4	6.7	21.1	-0.3	6.7	9.2	5.6	7	9.3	8.5	8.9					0	90%	62%	78%
13/06/2004	9:00:00	9.8	6.1	7.5	15.7	5.4	7.8	8	5.6	7.4	8.6	8.2	8.4					10.8	100%	66%	90%
14/06/2004	9:00:00	12.8	9.2	11.2	18.9	6.8	10.3	10.1	8	9.4	9.6	8.6	9.2					18.6	98%	77%	89%
15/06/2004	9:00:00	12.1	7.9	9.1	12.1	5.3	7.8	9.7	7.7	8.9	9.7	9.2	9.4	7.2	1004			17	97%	72%	87%
16/06/2004	9:00:00	14.1	3.6	8.5	19.7	0	6.7	10.1	5.7	8.1	9.5	8.7	9.1	1	157			0	89%	63%	77%
17/06/2004	9:00:00	14.1	1.7	4.4	20.8	-0.1	4.9	9.8	5.8	5.3	9.1	8.3	6.2	0.8	119.4			0	94%	61%	73%
18/06/2004	9:00:00	10.7	4.6	8.6	19.7	5.1	8.7	8.8	5.8	7.9	8.8	8.1	8.5	2.4	267			21.4	98%	68%	86%
19/06/2004	9:00:00	10.9	2.2	7	15.7	-0.2	6.1	9.3	5.5	7.7	9	8.3	8.7					1.8	90%	61%	79%
20/06/2004	9:00:00	9.3	2.6	5.3	17.2	-0.6	4.3	8.6	4.2	6.1	8.4	7.4	8					0	89%	57%	73%
21/06/2004	9:00:00	13.4	5.4	9.9	17.3	2.8	7.7	7.8	4.1	6.5	7.9	7.1	7.5	2.8	689.9			0	90%	62%	71%
22/06/2004	9:00:00	13.9	4	8.2	19.9	0.7	6.9	9.3	5.1	7	8.3	7.5	7.9	1	126.4			0	99%	59%	81%
23/06/2004	9:00:00	12.5	7.6	10.5	17.9	6.4	10	8.7	5.1	7.9	8.6	7.4	7.9	0.6	203.6			0.6	98%	83%	91%
24/06/2004	9:00:00	11.4	9	10.7	11.3	8.8	10	9.4	8.6	9.1	9.2	8.5	8.8	1.6	530.2			18	97%	80%	87%
25/06/2004	9:00:00	14	7.4	9.9	23.1	5.5	10.2	12	8.7	10	10.1	9.1	9.6	1.8	285			20.8	97%	64%	85%
26/06/2004	9:00:00	10.4	2.5	6.3	19.6	-0.1	5.6	10.2	5.5	8.2	9.6	8.6	9.2					4.4	99%	75%	88%
27/06/2004	9:00:00	12.5	6.6	8.8	20.6	2.8	7.1	8.5	5.4	7.1	8.6	8.1	8.3					0	99%	61%	80%
28/06/2004	9:00:00	13.5	9	11.1	21.3	6.4	11	9.6	5.8	8.7	9.1	7.9	8.5	2.2	870.9			1.8	97%	63%	84%
29/06/2004	9:00:00	11.3	6.2	8.7	10.9	3.1	6.8	9.8	6.5	8.4	9.4	8.5	9.1	2.6	457.1			14.4	98%	69%	82%
30/06/2004	9:00:00	13.2	8.7	11	18.6	6.8	10.6	9.6	6.6	8.8	9.2	8.3	8.7	1	461.1			8.4	97%	60%	83%
	Totals	374.4	161.3	259.8	547.7	97.2	238.8	291.4	189.6	244.1	279.9	253.5	265.1	35	7358			159.6			
	Average	12.5	5.4	8.7	18.3	3.2	8.0	9.7	6.3	8.1	9.3	8.5	8.8	1.7	350.4			5.3	96%	67%	83%

19

20 Photographs

20.1.1.1 Photograph 1: (17/06/04) - Treatment 9, Frontier-p followed by Raptor + BS1000

20.1.1.2 Photograph 2: (17/06/04) - Treatment 13, Verdict + Select + Uptake

20.1.1.3 Photograph 3: (17/06/04) - Treatment 1, untreated control

FINAL REPORT

Evaluation of post-harvest grass herbicides for crop safety in pyrethrum

Forth, Tasmania, 2004

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21 Summary

At Werrin farm, NW Tasmania, in 2004 grass herbicides were applied at 2 application timings to a weed free site to determine crop safety; a mix of Brodal 300 mls/ha + Eclipse 6 g/ha was applied prior to the entire trial to control broadleaf weeds at the site. The treatments applied at the first application timing included: Frontier-p at 2 L/ha, with and without Gesatop at 2L/ha or Command at 300 mls/ha, Frontier-p at 4 L/ha, Dual Gold at 2 and 4 L/ha, Gallery at 250 g/ha, Exporsan at 10 L/ha and Goal WP at 1 kg/ha. Frontier-p at 2 L/ha was also applied prior to the second application timing of Raptor 45 g/ha + BS1000. Raptor was further trialed at the second application timing at 45 and 90 g/ha with the wetters BS1000 and Liase.

All treatments were safe to the crop throughout the assessment period although the combination of Frontier-p + Gesatop caused some mild crop damage by 88 days after the second herbicide application timing (88DAAT2).

Pyrethrum was harvested from selected treatments; there was no significant treatment effect on yield.

22 Introduction

22.1

22.2 Aims

- To investigate the crop tolerance of grass herbicides on pyrethrum.

22.3 Target

Crop safety

23 Materials and Methods

23.1 Product List

Product name	Active ingredient	Concentration of active ingredient	Formulation
Command	clomazone	480 g/L	Emulsifiable Concentrate
Frontier-P	dimethenamid-p	720 g/L	Emulsifiable Concentrate
Goal	oxyflurofen	240 g/L	Wettable Powder
Dual Gold	s-metolachlor	960 g/L	Emulsifiable Concentrate
Exporsan	bensulide	500 g/L	Emulsifiable Concentrate
Gallery	isoxaben	750 g/kg	Wettable Granule
Gesatop	simazine	500 g/L	Suspension Concentrate
Raptor	imazamox	700 g/kg	Wettable Granule
BS1000	alcohol alkoxylate	1000 g/L	Liquid
Liase	ammonium sulphate	417 g/L	Liquid

23.2 Treatment List

No.	Treatment (Product rate per hectare)	
	Application Timing 1 (15/03/04)	Application Timing 2 (23/03/04)
1	Frontier-p 2 L	-
2	Frontier-p 4 L	-
3	Dual Gold 2 L	-
4	Dual Gold 4 L	-
5	Exporsan 10 L	-
6	Gallery 250 g	-
7	Goal WP 1 kg	-
8	Frontier-p 2 L + Gesatop 2 L	-
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L
10	Command 300 mls + Frontier -p 2 L	-
11	-	Raptor 45 g + BS1000 200 mL/100 L
12	-	Raptor 45 g + BS1000 200 mL/100 L + Liase 2 L/100 L
13	-	Raptor 90 g + BS1000 200 mL/100 L
14	Untreated Control	-

23.3 Chronology of Events

Date	Days after 1st herbicide application timing (DAAT1)	Days after 2nd herbicide application timing (DAAT2)	Event
01/03/04	-14	-22	Brodal 300 mls/ha + Eclipse 6 g/ha applied to all plots in trial to control broadleaf weeds.
15/03/04	0	-8	Applied application timing 1 herbicide treatments.
23/03/04	8	0	Applied application timing 2 herbicide treatments.
26/03/04	11	3	Crop safety assessed using EWRS ratings.
06/04/04	22	14	Applied Brodal 300 mls/ha to all plots in trial to control broadleaf weeds.
26/04/04	42	34	Visual crop safety assessment.
05/05/04	51	43	Visual crop safety assessment.
19/06/04	96	88	Crop safety assessed using EWRS ratings.
07/07/04	114	106	Visual crop safety assessment.
27/09/04	196	188	Visual crop safety assessment.
29/12/04	289	281	Treatments 2, 4, 9, 10, 13 and 14 harvested.

24 Results and Discussion

The pyrethrum crop was checked at 34, 43, 106 and 188 days after the second herbicide application timing (DAAT2); there were no visual treatment differences for crop tolerance at any of these assessment dates. However, at 34 and 43DAAT2 yellowing caused by application of Brodal 300 mls/ha + Eclipse 6 g/ha, to control broadleaf weeds, was noted across all plots in the trial.

The crop was assessed using the EWRS rating system at 3 and 88DAAT2.

24.1 Table 1 - Crop safety at 3DAAT2 and 88DAAT2 (26/03/04 & 19/06/04).

No.	Treatments and product rate per hectare		Mean EWRS rating	
	Application Timing 1 (15/03/04)	**Application Timing 2 (23/03/04)**	**3DAAT2**	**88DAAT2**
1	Frontier-p 2 L	-	1.0	1.0
2	Frontier-p 4 L	-	1.0	1.0
3	Dual Gold 2 L	-	1.0	1.0
4	Dual Gold 4 L	-	1.0	1.0
5	Exporsan 10 L	-	1.0	1.0
6	Gallery 250 g	-	1.0	1.0
7	Goal WP 1 kg	-	1.0	1.0
8	Frontier-p 2 L + Gesatop 2 L	-	1.0	4.3
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	1.0	1.0
10	Command 300 mls + Frontier - p 2 L	-	1.0	1.0
11	-	Raptor 45 g + BS1000 200 mL/100 L	1.0	1.0
12	-	Raptor 45 g + BS1000 200 mL/100 L + Liase 2 L/100 L	1.0	1.0
13	-	Raptor 90 g + BS1000 200 mL/100 L	1.0	1.0
14	Untreated Control		1.0	1.0

DAAT2 = Days after second herbicide application.

At 3DAAT2 there was no significant treatment effect on crop safety; all treatments were safe to the crop.

At 88DAAT2 crop tolerance was marginal for a commercial crop where Frontier-p at 2 L/ha + Gesatop 2 L/ha had been applied; all other treatments were completely safe to the crop at 88DAAT2.

24.2 Table 2 - Yield at 281DAAT2 (29/12/04).

No.	Treatments (product rate per hectare)		Flower Dry weight (g /m^2)
	Application Timing 1 (15/03/04)	Application Timing 2 (23/03/04)	
2	Frontier-p 4 L	-	207.0
4	Dual Gold 4 L	-	215.5
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	222.6
10	Command 300 mls + Frontier -p 2 L	-	207.3
13	-	Raptor 90 g + BS1000 200 mL/100 L	261.9
14	Untreated Control		222.5
p-value			0.4729
LSD (5% level)			N/A*

*Fischer's least significant difference (LSD) test was not conducted, as an analysis of variance (ANOVA) indicated no significant treatment effect at the 5% level.

There was no significant treatment effect on yield (dry weight), between the treatments listed in Table 2, at 281DAAT2.

25 Conclusions

- All treatments were safe to the crop at all assessment dates.
- The only treatment which caused crop damage was Frontier-p at 2 L/ha + Gesatop 2 L/ha applied at the first application timing. This treatment caused recognizable symptoms of crop damage however these symptoms were mild and were acceptable for a commercial crop.
- There was no significant treatment effect on yield between pyrethrum treated at the first application timing with Frontier- p or Dual Gold at 4 L/ha, Command 300 mls/ha + Frontier–p 2 L/ha, Frontier-p at 2 L/ha followed by Raptor 45 g/ha + BS1000 or at the second application timing of Raptor 90 g/ha + BS1000.

26 Appendices

26.1 Appendix i - Trial Details

26.1.1 Site Details

Grower	Botanical Resources Australia Pty Ltd
Location	Forth, Tasmania
Soil Type	Ferrosol
Crop	Pyrethrum
Trial Design	Randomised complete block
Replications	4
Plot Size	2 m x 7 m
Harvest Date	29/12/04 (crop cut)

26.1.2 Trial Plan

3	11	4	2	7	13	14	8	9	1	5	10	6	12	**Block 4**
10	8	3	1	5	11	10	13	2	9	12	7	14	4	**Block 3**
2	4	13	9	8	12	1	14	11	3	10	5	7	6	**Block 2**
5	9	14	12	10	7	6	4	3	2	11	13	8	1	**Block 1**

↖N

26.1.3 Application Details

Application Equipment		
Equipment	CO2 pressurised precision knapsack sprayer	
Nozzles	4 X Spraying Systems DG8002 fan jets	
Volume	230 L/ha	
Pressure	280 kPa	
Method	Walked at 1 m/sec	
Treatment Applications		
Application Number	1	2
Date	15/03/04	23/03/04
Time	10am	9am
Treatments Applied	1 - 10 (Application Timing 1)	9, 11 - 13 (Application Timing 2)
Temperature (^{O}C)	15.3	10.3
Relative Humidity (%)	71	67
Cloud Cover (%)	30	0
Wind Direction	NW	SW
Wind Speed (km/h)	0 - 8	0 – 3
Soil Moisture	Dry	Dry
Crop Stage	30 cm rosette	30 cm rosette

Meteorological data from Forthside Vegetable Research Station for the months of March to December 2004 is included as Appendix iv to this report. The trial site was situated 3 km from the station.

26.1.4 Assessments

1. Crop safety						
Dates	26/03/04	26/04/04	05/05/04	19/06/04	07/07/04	27/09/04
Days after second application	3	34	43	88	106	188
Sample Size	Whole plot (2 x 7 m)					
Method	Visual assessment					
Rating Scale	EWRS for crop tolerance - Appendix iii					

3. Yield Assessment	
Date	29/12/04
Days After Application	281DAAT2
Sample Size	2 x 1 m quadrats.
Method	Pyrethrum in 2 randomly placed quadrats per 2 m x 7m plot were cut.
Statistical Analysis	An analysis of variance (ANOVA) test was conducted using Statgraphics Plus

26.2 Appendix ii - Raw Data

26.2.1.1 Crop safety assessment 26/03/04

Treatment				EWRS Rating for crop tolerance
No.	**Application Timing 1 15/03/04**	**Application Timing 2 23/03/04**	**Rep**	**26/03/04**
1	Frontier-p 2 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
2	Frontier-p 4 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
3	Dual Gold 2 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
4	Dual Gold 4 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
5	Exporsan 10 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
6	Gallery		1	1
			2	1
			3	1
			4	1
			Mean	1.0
7	Goal WP 1 kg		1	1
			2	1
			3	1
			4	1
			Mean	1.0
8	Frontier-p 2 L + Gesatop 2 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	1	1
			2	1
			3	1
			4	1
			Mean	1.0
10	Command (Solvesso) 300 mls + Frontier-p 2 L		1	1
			2	1
			3	1
			4	1
			Mean	1.0
14	Untreated control		1	1
			2	1
			3	1
			4	1
			Mean	1.0

Appendix ii - Raw Data (Cont.)

26.2.1.2 Yield assessment (Samples harvested 29/12/04)

Treatment				Fresh Net Weights			Dry Net Weights		
No.	**Application Timing 1 15/03/04**	**Application Timing 2 23/03/04**	**Rep**	**Total sample (g)**	**FMI Sub-sample (g)**	**Assay Sub-sample (g)**	**Assay Sub-sample (g)**	**FMI Sub-sample (g)**	**Dry Weight (g/m^2)**
2	Frontier-p 4 L		1	559.9	119.6	216.1	82	597	212
			2	660.6	116.4	229.8	81.5	591	234
			3	394.3	115.6	231.6	87.5	564	149
			4	620.5	141	246.7	92.3	604	232
			Mean	558.8	123.2	231.1	85.8	589.0	207
4	Dual Gold 4 L		1	614.2	131.2	241.6	89.5	575	228
			2	515.6	146.8	238	82.4	584	179
			3	785	146.5	230.6	77.5	592	264
			4	533	138.4	204.1	73.5	587	192
			Mean	612.0	140.7	228.6	80.7	584.5	215
9	Frontier-p 2 L	Raptor 45 g + BS1000 200 mL/100 L	1	730.3	103.3	251	91.3	601	266
			2	537.2	117.6	232.7	87.3	596	202
			3	451.4	128.8	217.7	74.2	565	154
			4	727.9	127.7	225.8	83.6	599	269
			Mean	611.7	119.4	231.8	84.1	590.3	223
10	Command (Solvesso) 300 mls + Frontier-p 2 L		1						
			2	492.8	130.5	239.4	86.9	589	179
			3	527.7	121.6	242.3	85	558	185
			4	681.3	137	235.4	89.1	587	258
			Mean	567.3	129.7	239.0	87.0	578.0	207
13		Raptor 90 g + BS1000 200 mL/100 L	1	780.7	138.4	239.9	82.3	586	268
			2	603	141.6	235.6	83.4	595	213
			3	815.2	147.8	243.4	86.4	533	289
			4	819.7	128.3	246.1	83.2	584	277
			Mean	754.7	139.0	241.3	83.8	574.5	262
14	Untreated Control		1	567.2	116	221.2	77	580	197
			2	726.9	145.6	238.3	84.1	589	257
			3	581.2	107.4	249.6	88.1	594	205
			4	621.2	122.2	236.1	87.7	596	231
			Mean	624.1	122.8	236.3	84.2	589.8	222

26.3 Appendix iii - Rating Scales

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	Heavy damage to total kill
7	30.1 - 45	
8	45.1 - 70	
9	70.1 - 100	

The EWRS (European Weed Research System) scale is based on comparison of the treated plots with the untreated control plot. The aim is to assess as accurately as possible the decrease in the natural number of plants per weed species (still visible in the untreated plot). This decrease in the weed population corresponds to the action of the product. The EWRS scale is logarithmic, the intervals decreasing as the action increases. This enables detailed assessment in the range of effective herbicide action.

Reference: Puntener W. 1981. Manual for Field Trials in Plant Protection. Second Edition. Ciba-Geigy Limited, Basle, Switzerland.

26.4 Appendix iv - Statistical Analysis

Analysis of Variance for dry wt - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	7783.56	5	1556.71	0.96	0.4729
B:rep	5129.27	3	1709.76	1.06	0.3984
RESIDUAL	22642.0	14	1617.29		
TOTAL (CORRECTED)	35829.7	22			

All F-ratios are based on the residual mean square error.

26.5 Appendix v - Meteorological Details

FORTHSIDE RESARCH STATION WEATHER REPORT MARCH																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/03/2004	9:00:00	12.9	11.6	10.5	17.4	14.2	13.2							4.2	89	3.7	22	0	74%	61%	66%
2/03/2004	9:00:00	16.3	7.3	11.8	37	8.3	18.5							4.1	86	3.6	21.2	0	94%	56%	76%
3/03/2004	9:00:00	21.4	13.9	16.5	42.8	14.4	22.6							3.7	69	2.9	17	0	94%	57%	78%
4/03/2004	9:00:00	24.4	12.2	17.8	44.8	12.8	22.9							3.4	64	2.7	16.1	0	98%	57%	81%
5/03/2004	9:00:00	25.4	8.8	18.1	46	9.6	22.9							4.4	79	3.3	19.4	0	84%	45%	64%
6/03/2004	9:00:00	22.7	13.2	15.8	42.2	14.7	22.4							3.1	79	3.3	19.4	2	96%	37%	69%
7/03/2004	9:00:00	17.5	9.5	13.2	20.9	10.1	14.3							0.7	8	0.4	2.6	4.2	97%	79%	90%
8/03/2004	9:00:00	19.9	14.4	16.2	27.7	16.1	19.2							1.6	41	1.7	10.5	0.6	100%	70%	88%
9/03/2004	9:00:00	19.3	12.7	15.1	30	13.8	17.5							1.5	25	1.1	6.6	0.4	100%	72%	92%
10/03/2004	9:00:00	19.9	5	11.4	33	5.5	14.2							3.1	56	2.4	14.1	0.2	87%	43%	66%
11/03/2004	9:00:00	17.4	5.5	10.8	35.7	3.8	15.2	20.8		16.5	18.3		17.1	3.5	81	3.4	19.9	0	97%	44%	73%
12/03/2004	9:00:00	18.9	7.9	12.3	38.4	5.9	16.1	20.4	13.7	16.9	18	16.7	17.3	3.2	58	2.5	14.6	0	94%	45%	75%
13/03/2004	9:00:00	22.2	8.1	14.4	33.5	4.9	16.9	22	14.8	18.2	18.7	16.9	17.8	4	79	3.3	19.5	0	87%	38%	66%
14/03/2004	9:00:00	22.7	8.7	14.7	42.6	6.6	18.1	22.3	14.9	18.4	18.8	17.2	18	3.9	70	2.9	17.4	0	88%	37%	63%
15/03/2004	9:00:00	20.1	5.7	13.6	37.1	3.1	16.6	22.5	14.8	18.6	19.1	17.5	18.3	3.9	73	3.1	18.3	0	96%	46%	71%
16/03/2004	9:00:00	19.8	6.7	13.1	36.9	4.1	15.2	20.1	14.6	17.3	18.3	17.3	17.8	2.9	51	2.1	12.8	0	97%	49%	74%
17/03/2004	9:00:00	19.2	6.9	12.5	37.9	4.5	16	21.7	14.6	17.8	18.6	17	17.8	3.5	74	3.1	18.4	0	94%	39%	72%
18/03/2004	9:00:00	19.3	5.6	12.5	39	3.7	16.2	21.3	14.4	17.5	18.4	17	17.7	3.3	71	3.0	17.7	0	95%	40%	63%
19/03/2004	9:00:00	20.8	12	15.3	35.4	8.2	16.2	18.4	14.4	16.3	17.4	16.8	17.1	1.9	33	1.4	8.5	0	79%	44%	63%
20/03/2004	9:00:00	21.4	7.9	14.8	34.7	4.3	15.5	19	14.3	16.8	17.5	16.6	17	2.4	37	1.6	9.4	0	93%	51%	70%
21/03/2004	9:00:00	21.7	8.3	13.6	38	5.9	17.2	21	14.3	17.3	18	16.4	17.2	3.9	74	3.1	18.3	0	71%	35%	54%
22/03/2004	9:00:00	18.9	7.4	12.9	36.4	5.1	16.1	21.3	14.5	17.6	18.2	16.6	17.4	3.6	71	3.0	17.5	0	91%	52%	74%
23/03/2004	9:00:00	19	7.3	13.4	38.4	3.5	16	21.3	14.2	17.6	18.3	16.7	17.5	4.2	72	3.0	17.9	0	96%	52%	71%
24/03/2004	9:00:00	23.9	9.7	15.4	41.7	7.2	19.4	21.2	14.2	18	18.2	16.7	17.5	2.9	63	2.6	15.5	0	87%	35%	65%
25/03/2004	9:00:00	19.7	9.6	13.9	36.5	6.7	17.4	21.1	15.7	18	18.4	17.2	17.7	2.4	52	2.2	13.1	0	100%	51%	83%
26/03/2004	9:00:00	22.6	9.2	14.7	36.7	5.4	16.8	21.1	14.8	17.8	18.4	17.2	17.8	3.4	60	2.5	15	0	84%	40%	65%
27/03/2004	9:00:00	19.8	6.4	13.2	34.3	2.5	14.2	19.6	13.5	16.6	17.8	16.7	17.3	3.1	51	2.2	12.9	0	94%	47%	67%
28/03/2004	9:00:00	20.3	11	14.8	41.2	8.4	18.8	20.1	13.5	17.1	17.7	16.3	17	3.3	65	2.7	16.1	0	88%	40%	70%
29/03/2004	9:00:00	20.4	16.2	18	36.7	16	20.7	19.6	15.7	18	17.7	16.8	17.3	2.2	39	1.6	9.7	0	86%	59%	75%
30/03/2004	9:00:00	22.2	10.9	13.7	38.3	10.1	14.4	18.4	14.3	16.3	17.6	16.4	17.2	1.2	14	0.6	4	17.4	96%	64%	90%
31/03/2004	9:00:00	22.3	11.5	16.4	33.7	9.4	18.9	20.6	14.4	17.5	17.9	16.2	17.1	3.2	64	2.7	15.8	0	91%	60%	74%
	Totals	632.3	291.1	440.4	1125	248.8	539.6	433.8	289.6	366.1	381.3	336.2	366.9	95.7	1848	77.5	461.2	24.8			
	Average	20.4	9.4	14.2	36.3	8.0	17.4	20.7	14.5	17.4	18.2	16.8	17.5	3.1	59.6	2.5	14.9	0.8	91%	50%	73%
39 year average		19.9	10.4	14.1	33.2	7.5	16.6	21.8	13.6	17.6	18.7	16.5	17.7	3.8	193.6	7.8	15.0	1.8	93%	53%	75%
Percent of average		102%	90%	100%	109%	107%	105%	95%	106%	99%	97%	102%	99%	81%	31%	32%	99%	44%	98%	95%	97%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT APRIL																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/04/2004	9:00:00	16.8	9	13.2	22.6	6.6	15	18.5	13.1	15.9	17.4	16.2	16.9	2.1	40	1.7	10.2	3.4	95%	52%	71%
2/04/2004	9:00:00	16.5	8.8	11.6	28.3	5.7	11.9	16.3	11.5	13.8	16.2	14.9	15.8	2.4	41	1.74	10.5	1.6	95%	43%	65%
3/04/2004	9:00:00	16.7	9	12.5	31.7	6	13.2	15.7	11.6	13.6	15.4	14.6	15	1.7	34	1.41	8.6	0	96%	55%	72%
4/04/2004	9:00:00	17.5	9.3	12.9	31	8.2	14.3	16.4	11.9	14	15.5	14.5	15	2	33	1.38	8.4	0	77%	55%	64%
5/04/2004	9:00:00	17.9	7.5	11.9	37.6	4.8	14.7	17.7	12.3	14.9	16	14.6	15.3	2.4	51	2.12	12.7	0.6	93%	51%	72%
6/04/2004	9:00:00	16.3	11.3	14.1	33.8	12.1	15.9	15.8	12.3	14.6	15.5	14.8	15.2	1.2	34	1.42	8.6	6.2	98%	53%	77%
7/04/2004	9:00:00	21.1	7.4	12.8	32.7	4.9	14	18.9	11.3	15.3	16.5	15.1	15.8	2.8	48	2.02	12.1	0	96%	36%	66%
8/04/2004	9:00:00	18.2	6.3	11	34.5	4.4	13.4	17.3	11.2	14	16	14.6	15.2	2.6	58	2.44	14.5	0	95%	40%	75%
9/04/2004	9:00:00	17.7	8.2	12.4	33.3	7	15.4	18	11.2	14.8	16	14.4	15.2	2.6	53	2.22	13.2	0	100%	64%	85%
10/04/2004	9:00:00	18.7	5.4	11.4	35.8	3.3	13.4	18.4	11.4	14.9	16.3	15	15.6	2.6	56	2.33	13.8	0	95%	48%	70%
11/04/2004	9:00:00	17.3	11	13.2	37.2	11.1	15.1	15.9	11.4	14.3	15.3	14.5	14.9	1.1	31	1.3	7.9	11.2	97%	54%	77%
12/04/2004	9:00:00	15.1	9	12.7	19	8.3	12.8	14.6	12.9	13.9	15	14.6	14.8	0.7	10	0.45	3	1.4	100%	79%	91%
13/04/2004	9:00:00	19.3	8.8	13.3	31.2	7.5	15.1	16.9	12.9	14.7	15.5	14.4	14.9	1.8	35	1.46	8.8	0.6	99%	63%	85%
14/04/2004	9:00:00	16.9	12.6	14.3	24.3	11.7	14.8	15.5	13.4	14.5	15.1	14.7	14.9	0.9	21	0.9	5.6	0.2	97%	69%	84%
15/04/2004	9:00:00	20.2	14.9	16.2	31.7	13.8	17	17.1	14.5	15.7	15.7	14.8	15.3	2.3	44	1.83	11.4	0.8	95%	77%	89%
16/04/2004	9:00:00	18.7	7	12.4	21.8	5.3	12	16.7	12	14.6	15.9	14.6	15.4	2.7	68	2.86	17.5	0.6	99%	63%	89%
17/04/2004	9:00:00	16.1	6	10.6	22.7	5	10.7	14.9	10.8	12.7	14.7	13.5	14.3	3	78	3.26	19.8	18.4	100%	62%	87%
18/04/2004	9:00:00	19.3	8.6	11.4	26.2	5.4	11.4	15.1	10.1	12.3	14.2	13.2	13.6	3.5	71	2.97	18.1	0.4	93%	50%	75%
19/04/2004	9:00:00	17.4	3.5	9.9	31.1	1.6	11.2	15.2	9.1	12.2	14.1	12.9	13.4	2.6	66	2.75	16.9	0	96%	41%	73%
20/04/2004	9:00:00	15.8	5.8	9.6	32.2	4	12.7	15.1	9.1	12	13.8	12.5	13.2	1.2	52	2.19	13.6	0	96%	52%	82%
21/04/2004	9:00:00	14.9	8.2	11.1	23.6	6.2	12.3	14.1	10.8	12.6	13.6	12.8	13.2	1	30	1.25	8.1	0	93%	64%	83%
22/04/2004	9:00:00	18.4	9.9	13.5	33	7.8	15.7	16.4	11.3	14	14.6	13	13.9	1.8	50	2.08	12.9	0	98%	59%	85%
23/04/2004	9:00:00	17.8	11.3	14.5	24.7	10.3	15.2	15.6	12.6	14.4	14.6	13.8	14.3	1.8	50	2.1	13.1	4.6	98%	78%	91%
24/04/2004	9:00:00	11.8	8.9	10	14.3	5.4	8.6	13.6	9.5	11.9	14.4	12.8	13.8		118	4.93	29.4	1.2	91%	49%	65%
25/04/2004	9:00:00	12.3	6	9.1	16	4.9	8.8	11.3	9.5	10.2	12.8	12	12.3		46	1.93	12	2	94%	52%	81%
26/04/2004	9:00:00	16.8	6.5	10.9	28.6	3.6	11.4	14.7	9.6	12	13.3	11.9	12.6	4.2	55	2.33	14.4	0	98%	60%	82%
27/04/2004	9:00:00	16.2	4	10.1	28.2	1.4	10.1	14	8.6	11.3	13.1	12.1	12.5	1.2	84	3.51	21.2	0	93%	46%	75%
28/04/2004	9:00:00	19.1	5.9	10.6	31.1	3.2	12.4	14	8.5	11.1	12.9	11.7	12.3	1.6	49	2.04	12.7	0	98%	46%	80%
29/04/2004	9:00:00	14.9	10.4	12	22.7	10.6	13.2	13.1	9.8	12	12.7	11.9	12.3	1.4	37	1.57	10	7	98%	68%	87%
30/04/2004	9:00:00	16.9	10.5	13	30.6	9.2	14.1	15.3	11.9	13.5	13.7	12.6	13.2	1.4	51	2.13	13.2	9.2	98%	73%	91%
	Totals	512.6	251	362.2	851.5	199.3	395.8	472.1	336.1	405.7	445.8	413	430.1	56.6	1494	62.62	382.2	69.4			
	Average	17.1	8.4	12.1	28.4	6.6	13.2	15.7	11.2	13.5	14.9	13.8	14.3	2.0			12.7	2.3	96%	57%	79%
39 year average		15.3	6.6	11.4	26.9	4.7	12.5	15.7	9.5	12.6	14.1	12.5	13.4	2.3	191.6	7.4	10.5	2.5	96%	63%	81%
Percent of average		112%	127%	106%	105%	142%	106%	100%	118%	108%	106%	110%	107%	88%	0%	0%	121%	93%	100%	90%	97%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT MAY																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/05/2004	9:00:00	16.3	3.1	9.5	29	1.9	10.2	15.8	8.8	12.4	14	12.4	13.3				19.4	0	96%	58%	77%
2/05/2004	9:00:00	13.6	2.6	7.4	26.7	0.8	8.3	12.7	7.8	9.8	12.5	11.2	12				27	0.2	88%	45%	68%
3/05/2004	9:00:00	12.6	4.7	7.6	19.5	1.6	6.9	11	7.1	8.8	11.5	10.3	11	5.8	732		41.4	4.2	93%	58%	73%
4/05/2004	9:00:00	13.9	8.4	11.4	20.5	6.3	11.1	10.7	7.7	10	11.2	10.2	10.7	1	424		45.5	0.6	93%	58%	77%
5/05/2004	9:00:00	10.4	4.2	6.4	17.5	1.6	5.7	11.3	6.4	9	11.4	10	10.9	2	320		36.2	7	88%	59%	75%
6/05/2004	9:00:00	12.9	6.8	9.8	23.5	4.1	9.5	11.1	6.4	9	10.7	9.7	10.2	1.4	272		31.4	0	91%	56%	73%
7/05/2004	9:00:00	15.2	2.2	8.1	24.1	-0.3	8	12.1	6.3	9.2	11.1	10	10.5	1.6	154		20.6	0	99%	51%	77%
8/05/2004	9:00:00	16.1	2.3	9	28.4	0	9.5	12.2	6.2	9.1	10.9	9.6	10.3				16	0	95%	56%	76%
9/05/2004	9:00:00	16.4	5.6	10.1	26.4	1.8	10.6	12.2	6.7	9.5	11	9.7	10.4				17.2	0	95%	54%	76%
10/05/2004	9:00:00	17.5	3	9	28.9	0.6	10.2	12.5	7.2	9.7	11.2	10.1	10.6	4	358		15.7	0	94%	48%	74%
11/05/2004	9:00:00	15.7	0.9	6.7	27.4	-1.1	7.7	11.9	5.9	8.7	10.9	9.8	10.3	1	104		14.1	0	97%	46%	75%
12/05/2004	9:00:00	18	2.6	9.2	29.1	-0.2	9.8	11.5	5.9	8.6	10.6	9.4	10	2.4	122		15.5	0	97%	48%	76%
13/05/2004	9:00:00	14.5	4.2	8.4	27.2	0.9	8.6	11.5	6.8	9	10.6	9.5	10	0.2	93		12.4	0	100%	52%	82%
14/05/2004	9:00:00	16.3	2.1	8.2	29.1	-0.3	8.8	12.4	6.7	9.4	10.9	9.7	10.3	0.8	95.1		13.6	0	100%	54%	84%
15/05/2004	9:00:00	16.2	3.9	8	27.6	1.9	9.6	11.9	6.6	9.1	10.7	9.6	10.2				13	0	100%	53%	86%
16/05/2004	9:00:00	12.6	6	10.4	20.2	5	10.3	10.4	7.7	9.6	10.5	9.8	10.2				16.3	13	97%	80%	89%
17/05/2004	9:00:00	15.4	5.2	9.8	25.4	1.2	9.4	12.6	7.6	10.2	11.2	10.3	10.7	3.4	389		18	0.8	99%	64%	84%
18/05/2004	9:00:00	16	8.3	11.4	25.8	7.5	12.5	11.8	7.5	10.2	10.9	10	10.5				20.2	12	96%	64%	86%
19/05/2004	9:00:00	13.4	5	9.8	15.6	2.2	8.1	11.8	7.6	10.2	11.3	10.3	10.9	3	417		28.3	8.6	98%	64%	83%
20/05/2004	9:00:00	14.4	6	10.6	20.9	2.8	10.1	11.3	7.6	9.3	10.7	10	10.3	1.2	276		31.6	2.2	98%	52%	81%
21/05/2004	9:00:00	14.9	4.5	9.9	18.1	1.9	8.1	11.4	6.9	9.4	10.8	9.9	10.4	1.6	312		34.1	0.4	92%	51%	69%
22/05/2004	9:00:00	15.7	3.2	9.1	25.7	1.3	8	11.2	6.8	8.8	10.4	9.5	9.9				12.3	0	100%	68%	86%
23/05/2004	9:00:00	13.9	6.5	11.5	19	7.2	11.3	10.5	6.7	9.6	10.4	9.3	9.9				11.5	0	99%	77%	88%
24/05/2004	9:00:00	16.9	11.7	13.7	24.7	10.6	13.7	12.4	9.8	11.6	11.4	10.4	10.9	1.6	335		16.2	12.4	98%	75%	90%
25/05/2004	9:00:00	15	8.8	11.6	20.2	6.2	11.3	13.6	10.3	12.1	12.1	11.4	11.7	0.8	115		12.4	1	100%	91%	96%
26/05/2004	9:00:00	15.3	2.8	9	22.7	0.8	8.8	13.3	7.7	10.7	12	10.8	11.5	1	146		18.2	0.4	98%	64%	82%
27/05/2004	9:00:00	12.4	0	5.6	22.3	-1.8	5.6	11	5.8	8.5	10.9	9.6	10.4	0.6	129		16	0	100%	63%	79%
28/05/2004	9:00:00	11.8	4.1	7.9	19.3	1.3	7.5	9.4	5.6	7.5	9.7	9.1	9.4	0.6	131		17.1	0.4	100%	60%	84%
29/05/2004	9:00:00	10	5.8	7.5	17.5	2	6.6	9.2	5.7	7.2	9.5	8.6	9.1				47.1	1	82%	56%	66%
30/05/2004	9:00:00	12.6	8.8	10.4	22	5.4	9.7	9.4	5.7	8	9.3	8.4	8.9				28.3	0.2	94%	62%	80%
31/05/2004	9:00:00	15.6	10.3	12.5	24	6.9	12.4	11.1	7.9	9.9	10.1	9.1	9.7	3.4	970		36.7	6.2	97%	69%	85%
	Totals	451.5	153.6	289.5	728.3	80.1	287.9	361.2	219.4	294.1	340.4	307.7	325.1	37.4	5893			70.6			
	Average	14.6	5	9.3	23.5	2.6	9.3	11.7	7.1	9.5	11	9.9	10.5	1.9	295			2.3	96%	60%	80%
39 year average		14.2	6.4	9.9	22.5	3.3	9.9	12	7.2	9.6	11.3	10	10.6	1.5	159	6.5	7	3	98%	69%	86%
Percent of average		103%	77%	94%	104%	78%	94%	97%	98%	99%	97%	99%	99%	126%	185%	0%	0%	76%	98%	87%	93%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT JUNE																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/06/2004	9:00:00	13.8	12.4	12.9	17.8	9.9	12	11.9	10.4	10.9	10.9	10.1	10.6	1.2	493			0	89%	63%	77%
2/06/2004	9:00:00	13	4.2	7.6	19.4	1.9	6.8	11.2	7.4	9.2	10.8	9.6	10.4	1.4	131			0.8	99%	59%	85%
3/06/2004	9:00:00	12.4	8.7	10.2	18.1	5.7	9.3	10.2	7.5	8.8	10	9.5	9.7	0.8	318			0.6	96%	65%	82%
4/06/2004	9:00:00	11.3	3.4	6.8	16.5	0.1	5.3	10	5.5	7.9	10	8.7	9.5	1.4	310			2.4	92%	57%	75%
5/06/2004	9:00:00	11.6	-0.1	6.1	19.8	-1.7	5.1	9	4.8	6.7	9	8.1	8.6					0	100%	56%	78%
6/06/2004	9:00:00	13.9	1.1	5.7	24.5	-1.3	6	9.2	4.6	6.4	8.7	7.7	8.2					0	99%	62%	85%
7/06/2004	9:00:00	9	1.4	5.5	11.7	-0.5	4.3	7.1	4.8	5.9	7.9	7.6	7.7	1.6	363			0	100%	84%	92%
8/06/2004	9:00:00	14.2	5.1	11.1	24.6	5.6	11.5	9.4	4.9	8.2	9	7.4	8.1	0.6	91.9			5.6	100%	80%	93%
9/06/2004	9:00:00	13.9	11	12.3	18.5	9.8	12.3	11.6	9.4	10.8	10.3	9	9.7	0.4	153			1.6	100%	93%	96%
10/06/2004	9:00:00	12.8	6.1	10.8	13.1	3.5	10.1	11.4	9.3	10.8	10.7	10.2	10.5	1.2	168			10.6	100%	76%	96%
11/06/2004	9:00:00	14.9	1.3	7.4	22.3	-0.4	6.9	11.9	5.7	9	10.6	9.3	10.2	1.4	159			0	93%	60%	76%
12/06/2004	9:00:00	13.7	2.4	6.7	21.1	-0.3	6.7	9.2	5.6	7	9.3	8.5	8.9					0	90%	62%	78%
13/06/2004	9:00:00	9.8	6.1	7.5	15.7	5.4	7.8	8	5.6	7.4	8.6	8.2	8.4					10.8	100%	66%	90%
14/06/2004	9:00:00	12.8	9.2	11.2	18.9	6.8	10.3	10.1	8	9.4	9.6	8.6	9.2					18.6	98%	77%	89%
15/06/2004	9:00:00	12.1	7.9	9.1	12.1	5.3	7.8	9.7	7.7	8.9	9.7	9.2	9.4	7.2	1004			17	97%	72%	87%
16/06/2004	9:00:00	14.1	3.6	8.5	19.7	0	6.7	10.1	5.7	8.1	9.5	8.7	9.1	1	157			0	89%	63%	77%
17/06/2004	9:00:00	14.1	1.7	4.4	20.8	-0.1	4.9	9.8	5.8	5.3	9.1	8.3	6.2	0.8	119			0	94%	61%	73%
18/06/2004	9:00:00	10.7	4.6	8.6	19.7	5.1	8.7	8.8	5.8	7.9	8.8	8.1	8.5	2.4	267			21.4	98%	68%	86%
19/06/2004	9:00:00	10.9	2.2	7	15.7	-0.2	6.1	9.3	5.5	7.7	9	8.3	8.7					1.8	90%	61%	79%
20/06/2004	9:00:00	9.3	2.6	5.3	17.2	-0.6	4.3	8.6	4.2	6.1	8.4	7.4	8					0	89%	57%	73%
21/06/2004	9:00:00	13.4	5.4	9.9	17.3	2.8	7.7	7.8	4.1	6.5	7.9	7.1	7.5	2.8	690			0	90%	62%	71%
22/06/2004	9:00:00	13.9	4	8.2	19.9	0.7	6.9	9.3	5.1	7	8.3	7.5	7.9	1	126			0	99%	59%	81%
23/06/2004	9:00:00	12.5	7.6	10.5	17.9	6.4	10	8.7	5.1	7.9	8.6	7.4	7.9	0.6	204			0.6	98%	83%	91%
24/06/2004	9:00:00	11.4	9	10.7	11.3	8.8	10	9.4	8.6	9.1	9.2	8.5	8.8	1.6	530			18	97%	80%	87%
25/06/2004	9:00:00	14	7.4	9.9	23.1	5.5	10.2	12	8.7	10	10.1	9.1	9.6	1.8	285			20.8	97%	64%	85%
26/06/2004	9:00:00	10.4	2.5	6.3	19.6	-0.1	5.6	10.2	5.5	8.2	9.6	8.6	9.2					4.4	99%	75%	88%
27/06/2004	9:00:00	12.5	6.6	8.8	20.6	2.8	7.1	8.5	5.4	7.1	8.6	8.1	8.3					0	99%	61%	80%
28/06/2004	9:00:00	13.5	9	11.1	21.3	6.4	11	9.6	5.8	8.7	9.1	7.9	8.5	2.2	871			1.8	97%	63%	84%
29/06/2004	9:00:00	11.3	6.2	8.7	10.9	3.1	6.8	9.8	6.5	8.4	9.4	8.5	9.1	2.6	457			14.4	98%	69%	82%
30/06/2004	9:00:00	13.2	8.7	11	18.6	6.8	10.6	9.6	6.6	8.8	9.2	8.3	8.7	1	461			8.4	97%	60%	83%
	Totals	374.4	161.3	259.8	547.7	97.2	238.8	291.4	189.6	244.1	279.9	253.5	265.1	35	7358			159.6			
	Average	12.5	5.4	8.7	18.3	3.2	8.0	9.7	6.3	8.1	9.3	8.5	8.8	1.7	350.4			5.3	96%	67%	83%
39 year average		12.4	4.5	8.1	18.3	1.9	7.5	9.4	5.5	7.3	9.1	8.0	8.3	1.1	160.3	6.5	5.3	3.4	98%	68%	86%
Percent of average		101%	119%	107%	100%	174%	106%	103%	115%	111%	102%	106%	106%	151%	219%	0%	0%	155%	98%	99%	97%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT JULY																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/07/2004	9:00:00	10.3	3.6	6.7	10.7	0.3	4.7	9.2	4.9	7.6	9.3	8.1	8.9	1.4	326.9			3	89%	60%	74%
2/07/2004	9:00:00	10.1	4.9	8.1	16.9	2.8	7	8	4.8	6.9	8.2	7.6	7.9	1.2	468			11.2	97%	65%	79%
3/07/2004	9:00:00	11.6	2	6	17.4	0.9	6.6	9.2	5.6	6.9	8.4	7.6	8					15.2	100%	56%	83%
4/07/2004	9:00:00	11.8	5.8	10.3	13.3	5.3	9	8.5	5.8	7.8	8.4	7.4	7.9					7.2	100%	69%	86%
5/07/2004	9:00:00	12.2	5.5	8.5	18.2	2.5	8.4	9.8	6.9	8.4	8.8	8.3	8.5	6.6	818.4			18	100%	59%	78%
6/07/2004	9:00:00	8.9	2.2	5.3	14	-0.6	4.4	8.5	4.2	6.5	8.5	7.3	8	1.2	359.2			2.4	86%	58%	73%
7/07/2004	9:00:00	9.5	3.2	6.3	17.8	0.9	6.1	7.6	4.1	5.9	7.5	6.9	7.2	1.2	230.2			2	91%	60%	77%
8/07/2004	9:00:00	10.1	-0.6	4.9	14.7	-1.4	3.9	7.5	3.5	5.3	7.4	6.4	6.9	1.2	225.1			0	100%	55%	71%
9/07/2004	9:00:00	12.9	3	8.2	19	1.1	8.2	7.4	3.4	6	7.1	6.1	6.7	1	110.3			0	94%	55%	81%
10/07/2004	9:00:00	12.3	6.3	9.5	17.8	4.9	9	9	6.3	8	8.1	7	7.6					0	100%	88%	93%
11/07/2004	9:00:00	14.4	5	9.1	21.4	3.3	9	10.1	7.1	8.3	8.7	7.9	8.2					0.4	100%	72%	87%
12/07/2004	9:00:00	11.4	9.1	10.2	13.6	8.4	9.9	9.1	7.1	8.7	8.8	8	8.4	1.4	414.6			7.6	100%	90%	95%
13/07/2004	9:00:00	12	1.5	7.2	16.2	-0.6	6	11	5.2	8.7	9.5	8.3	9	0.6	83.7			1.2	100%	77%	92%
14/07/2004	9:00:00	11.9	5.2	8.5	19.4	1.8	8.1	8.7	5	7	8.3	7.7	8	0.6	292.1			0	92%	58%	74%
15/07/2004	9:00:00	11.4	3.3	6.9	19.7	-0.3	6	9.2	4.6	6.9	8.4	7.4	7.9	1	212			0	99%	58%	80%
16/07/2004	9:00:00	13.1	7	9.8	22.2	4.8	10.1	9.1	4.6	7.7	8.2	7.1	7.8	1.6	318.5			2.8	98%	61%	87%
17/07/2004	9:00:00	10.2	1.6	6.6	10.4	-0.9	5.1	8.8	4.8	7.4	8.5	7.7	8.2					9.4	98%	58%	78%
18/07/2004	9:00:00	11.1	-2.3	3.7	16.4	-2.2	3.5	7.7	3.6	5.3	7.7	6.6	7.2					0	100%	48%	74%
19/07/2004	9:00:00	11.7	-2	3.4	19.2	-2.2	3.9	7.1	3.4	4.7	6.9	6.2	6.5	3	497.9			0	100%	55%	83%
20/07/2004	9:00:00	12.4	1.3	5.8	19.9	-1	4.9	7	3.2	4.8	6.7	5.9	6.3	0.6	76.3			0.2	100%	61%	86%
21/07/2004	9:00:00	13.2	3.9	7.9	24.3	-0.7	6.6	7.7	3.4	5.6	6.9	5.8	6.4	0.8	157.6			0	100%	58%	81%
22/07/2004	9:00:00	14.7	2.9	7.4	23.5	-0.2	7.5	8.3	3.9	6	7.3	6.1	6.7	1	103.6			0	94%	54%	80%
23/07/2004	9:00:00	13.6	4.8	8.9	25.1	4	9.6	8.8	5	7.2	7.6	6.5	7.1	1.2	108.5			12.8	98%	67%	89%
24/07/2004	9:00:00	12.1	7.1	8.7	21.3	6.9	9.4	9.8	7.3	8.5	8.4	7.4	8					22.2	98%	72%	89%
25/07/2004	9:00:00	10.8	7.7	9.2	12.1	7.8	9.4	9.1	7.8	8.7	8.6	8.1	8.3					5.6	99%	93%	96%
26/07/2004	9:00:00	11.9	5.7	9.3	15	1.9	8	10.9	6.6	9.1	9.4	8.5	8.9	2.6	524.3			1.6	100%	66%	90%
27/07/2004	9:00:00	9.8	-0.5	4.6	20.1	-0.8	5.3	9.8	4.6	6.9	8.8	7.4	8.2	1.4	158.4			0.2	100%	58%	79%
28/07/2004	9:00:00	10.6	0.2	6.1	17.5	-0.9	5.2	8.4	4.2	6.3	7.9	7	7.4	0.6	275.9			0	99%	67%	82%
29/07/2004	9:00:00	11.3	-1.7	3.6	22	-1.8	4.6	8.5	3.8	5.7	7.6	6.6	7.1	1	91.4			0	100%	53%	84%
30/07/2004	9:00:00	10.1	1.3	5.7	21.9	0.3	6.6	8	3.6	5.8	7.3	6.3	6.8	1.2	100.1			0.2	100%	51%	88%
31/07/2004	9:00:00	12.8	2.2	7.9	22.4	0.9	8	9.5	5	7.3	7.9	6.6	7.3					0	100%	64%	89%
	Totals	360.2	99.2	224.3	563.4	45.2	214	271.3	153.3	215.9	251.1	221.8	237.3	32.4	5953	0	0	123			
	Average	11.6	3.2	7.2	18.2	1.5	6.9	8.8	4.9	7	8.1	7.2	7.7	1.5	270.6			4	98%	63%	83%
39 year average		11.3	3.7	7.4	17.7	1.5	7	8.5	4.5	6.4	7.8	6.7	7.2	1.1	171.8	6.4	5.8	4.2	98%	68%	86%
Percent of average		103%	87%	97%	103%	99%	99%	103%	110%	109%	104%	107%	106%	133%	157%			95%	100%	93%	97%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT AUGUST																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/08/2004	9:00:00	12.8	4.2	7.4	22.7	3.7	8.4	9.3	5.5	7.5	8.1	7.2	7.7					0	90%	60%	73%
2/08/2004	9:00:00	9	3.3	5.7	18.1	2.5	6.5	8.5	6.2	7	7.9	7.4	7.6	3.2	435			0	94%	62%	82%
3/08/2004	9:00:00	9.9	5.3	7.7	9	1.4	7.4	7.7	6.2	7.1	7.7	7.3	7.4	1.2	166			14.6	100%	90%	95%
4/08/2004	9:00:00	10	4.8	7.3	13.5	2.3	7	9.3	5.8	7.8	8.3	7.6	7.9	0.6	116			1	98%	79%	89%
5/08/2004	9:00:00	14.6	4.1	8.4	24.3	0.7	8.5	10.9	4.9	7.7	8.7	7.4	8	1.4	187			0	84%	58%	70%
6/08/2004	9:00:00	11.8	2.8	6.5	22.5	-0.5	6.3	9.7	4.1	6.5	8.3	7.1	7.7	1.8	154			0	92%	50%	74%
7/08/2004	9:00:00	12.3	4.1	7.7	22.5	0.4	7.4	9.3	4.1	6.6	8	6.8	7.4					0	100%	45%	78%
8/08/2004	9:00:00	13.8	4	7.9	24.9	-0.2	7.7	10.3	4.6	7	8.3	6.9	7.6					0	99%	55%	77%
9/08/2004	9:00:00	11.2	3.1	7	16.5	0.2	6.2	8.7	4.2	6.6	7.9	6.9	7.4	2.4	671			5.8	98%	55%	76%
10/08/2004	9:00:00	10.4	5.5	7.7	20	2.7	7.8	8.6	4.2	6.8	7.7	6.7	7.2	1.8	358			2.6	92%	64%	76%
11/08/2004	9:00:00	12	8.3	9.6	22.3	6.1	9.8	9.6	5.5	7.9	8.2	7.1	7.7					0.2	90%	54%	73%
12/08/2004	9:00:00	12.9	8.8	10.3	23.3	6.1	9.9	9.9	7.1	8.4	8.6	7.8	8.2	3.2	834			0.2	82%	54%	68%
13/08/2004	9:00:00	13.7	8	10	19.6	6.3	9.2	9.9	7.8	8.6	8.8	8.1	8.4	1.2	314			3.2	98%	57%	79%
14/08/2004	9:00:00	10.1	6.4	8.2	9.9	5.1	7.6	8.9	7.3	8.2	8.6	8.3	8.4					23.6	100%	63%	89%
15/08/2004	9:00:00	12.1	-0.6	4.9	18.7	-1.6	4.1	9.5	4.1	6.8	8.6	7.2	8					0.2	100%	44%	70%
16/08/2004	9:00:00	11.7	-0.5	4	22.3	-1.7	5.4	9.3	3.9	6	8	6.8	7.3	4.2	574			0	100%	48%	80%
17/08/2004	9:00:00	10.2	1.7	5.3	24.3	0.5	7.7	9.3	3.8	6.4	7.8	6.5	7.2	1.2	106			0	97%	62%	84%
18/08/2004	9:00:00	12.7	1.6	5.8	26.6	-0.8	7.2	10	4.5	7	8.3	6.9	7.5	1.4	85.9			0	99%	50%	81%
19/08/2004	9:00:00	12.7	2	6.4	25.5	0.2	8	9.5	4.5	7.3	8.1	6.9	7.6	0.8	80			0.2	100%	64%	88%
20/08/2004	9:00:00	11.9	5.1	8.9	25	2.9	10.5	10.7	5.6	8.7	8.6	7.3	8.1	1.6	177			4.8	100%	74%	87%
21/08/2004	9:00:00	12	9.3	10.5	23.1	6.8	11.1	11.2	7.3	9.7	9.3	8.2	8.9					9	97%	60%	86%
22/08/2004	9:00:00	13.5	2.3	8.1	23.8	-0.6	7.3	11.6	5.3	8.7	9.8	8.3	9.2					0	92%	48%	70%
23/08/2004	9:00:00	12.8	0.9	6.3	27.8	-0.5	8	11.6	5.2	7.9	9.3	7.9	8.6	4.6	774			0	95%	47%	79%
24/08/2004	9:00:00	11.3	5.5	8.8	26	4.5	11.2	11	5.3	9	9.2	7.7	8.6	1.2	116			1.6	100%	77%	92%
25/08/2004	9:00:00	15.3	5.7	10.5	27.1	4.1	11.8	13.1	8.1	10.5	10.3	8.8	9.6	0.6	116			0.2	99%	66%	89%
26/08/2004	9:00:00	16.1	6.2	10.2	25.4	4.1	10.7	12.7	7.8	10.1	10.4	9.4	9.9	1.4	134			0	97%	68%	86%
27/08/2004	9:00:00	16.9	4.3	10.2	23.3	3.2	10.5	11.8	7.8	9.9	10.2	9.3	9.8	1.2	98.2			1.2	100%	53%	85%
28/08/2004	9:00:00	13.3	3.1	7.8	24.8	1.6	9.5	13	6.9	9.8	10.6	9.3	9.9					0	100%	63%	88%
29/08/2004	9:00:00	14.4	4.3	9.5	29.2	3.2	11.7	12.6	6.9	10.1	10.4	9	9.8					0	100%	73%	90%
30/08/2004	9:00:00	15.6	7.1	11.7	28.3	5.1	12.7	13.5	8.8	11.4	11	9.6	10.4	4.4	367			0	93%	70%	83%
31/08/2004	9:00:00	13.6	0.7	6.3	19.4	-1.8	5.7	11.1	5	8.4	10.5	8.7	9.9	1.2	160			0	86%	37%	65%
	Totals	390.6	131.4	246.6	689.7	66	262.8	322.1	178.3	251.4	275.5	240.4	258.9	40.6	6022	0	0	68.4			
	Average	12.6	4.2	8	22.2	2.1	8.5	10.4	5.8	8.1	8.9	7.8	8.4	1.9	287			2.2	96%	60%	81%
39 year average		11.9	4.1	8	20.5	2	8.3	10.3	5.1	7.6	8.8	7.4	8.1	1.6	185	8.2	8.1	3.6	98%	65%	84%
Percent of average		106%	103%	100%	108%	108%	103%	101%	114%	106%	101%	104%	103%	120%	155%	0%	0%	61%	98%	92%	96%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT SEPTEMBER																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/09/2004	9:00:00	10.9	0.8	6.2	21	-0.6	6.2	8.9	4.9	6.8	8.9	7.9	8.5	1.4	158			0	99%	44%	74%
2/09/2004	9:00:00	14.6	1.7	8.6	32.5	-0.6	10.2	12.4	5.1	8.9	9.7	7.7	8.9	1.4	172			0	97%	55%	74%
3/09/2004	9:00:00	14.2	2.2	7.6	30	-0.9	10	13.7	6	9.6	10.4	8.4	9.5	1.6	107			0.2	99%	54%	82%
4/09/2004	9:00:00	12.3	3.1	7.5	31.5	0.9	9.8	13.2	6	9.6	10.4	8.7	9.6					0	100%	70%	85%
5/09/2004	9:00:00	14	4.1	9.2	30.9	2.3	12.6	14.5	6.6	10.8	11	8.9	10.1					0	99%	51%	80%
6/09/2004	9:00:00	14	3.9	8.2	32.4	1.7	11.5	15.1	7.9	11.2	11.6	9.8	10.6	5.6	411			0	99%	56%	84%
7/09/2004	9:00:00	15.8	8.3	11.3	33.3	6.9	15	15.6	7.9	12.2	11.8	9.8	11	2.4	136			0.4	93%	51%	79%
8/09/2004	9:00:00	13.7	10.2	11.5	25.1	9.8	12.5	13.5	10.8	12	11.7	11	11.3	2.2	188			10.4	97%	71%	85%
9/09/2004	9:00:00	12.2	9.4	10.8	18.7	9.1	11.5	12.9	10.6	11.6	11.5	11	11.2	1.2	86			3.8	99%	81%	93%
10/09/2004	9:00:00	19	10.1	12.3	29	9.5	14.2	15.6	10.6	12.8	12.4	11	11.7	1.2	172			0	97%	56%	81%
11/09/2004	9:00:00	13.7	4	8.3	22.2	3	8.5	12.8	8.2	10.9	11.8	10.5	11.4					0.6	96%	70%	85%
12/09/2004	9:00:00	13.3	0.3	6.1	26.9	-1.6	7.8	14	5.8	9.7	11.5	9.6	10.6					0.2	94%	47%	64%
13/09/2004	9:00:00	13.1	6.9	9.1	26.3	4.8	10.7	11.8	5.8	9.3	10.5	9.1	9.9	4.4	698			0.2	95%	50%	76%
14/09/2004	9:00:00	15.3	6.5	10.4	24.8	3.4	11.2	13.3	8.3	10.5	11.1	9.7	10.4	2	238			0	95%	52%	76%
15/09/2004	9:00:00	14.8	6.6	10.4	30	4.7	11.9	13.8	8.6	11.1	11.4	9.9	10.7	2.6	429			2.6	92%	52%	70%
16/09/2004	9:00:00	11.4	3.5	6.8	21.7	0.6	8.6	13	6.8	9.8	11.3	9.7	10.6	2.6	258			0	89%	38%	67%
17/09/2004	9:00:00	13.2	6.9	9.9	23.4	3.6	10.7	12.3	7	9.9	10.7	9.5	10.1	1.8	327			0	92%	59%	76%
18/09/2004	9:00:00	14.8	3.9	9.6	28.1	0.8	10.9	13.7	7.5	10.6	11.2	9.8	10.5					0	94%	55%	75%
19/09/2004	9:00:00	16.2	4.3	9.5	35	2.3	12.5	15.7	7.6	11.5	12	9.8	11					0	88%	48%	72%
20/09/2004	9:00:00	15.1	2.9	9.1	31.8	3.1	13.9	16.8	8.2	12.4	12.6	10.3	11.5	6.2	517			0	100%	55%	84%
21/09/2004	9:00:00	14.7	2.3	8.9	34.8	1.9	13.6	17.6	9.2	13.1	13.2	11	12.1	1.8	107			0	100%	66%	88%
22/09/2004	9:00:00	17	10	12.2	32.6	9.8	16.7	17.2	9.3	14	13.3	11.2	12.4	2.4	123			0.6	98%	64%	88%
23/09/2004	9:00:00	14.4	5.9	10.2	20.4	3	9.6	13.9	8.5	11.7	12.7	11.2	12.2	1.2	222			2.8	97%	67%	81%
24/09/2004	9:00:00	14.9	5.1	9.7	27.8	2.5	10.9	14	8.3	11	12.1	10.8	11.4	1	196			0.6	98%	62%	80%
25/09/2004	9:00:00	15.5	7	11.2	31.3	4	13.5	15.8	8.8	12.5	12.7	10.6	11.7					0	99%	62%	83%
26/09/2004	9:00:00	16.4	7.6	11.3	30.3	5.8	14.3	17	9.8	13.3	13.2	11.2	12.3					0	94%	55%	81%
27/09/2004	9:00:00	12.9	6.8	10.4	19.1	4.7	11.5	13.1	10.1	11.9	12.3	11.6	12	3.8	534			9.6	100%	73%	95%
28/09/2004	9:00:00	17.7	2.5	9.9	30.7	0.6	12.5	17	8.3	12.7	13.4	11.5	12.4	3.8	189			0.2	94%	39%	73%
29/09/2004	9:00:00	12.8	3	8.9	25.5	1.1	10.7	13.3	8.4	10.9	12	11	11.5	1.8	190			0	99%	60%	81%
30/09/2004	9:00:00	16.4	2.4	9.5	32.2	0.1	12.3	16.3	8.1	12.1	12.9	10.8	11.9	1.4	182			0	90%	50%	73%
	Totals	434.3	152.2	284.6	839.3	96.3	345.8	427.8	239	334.4	351.3	303	329	53.8	5641			32.2			
	Average	14.5	5.1	9.5	28	3.2	11.5	14.3	8	11.1	11.7	10.1	11	2.4	256			1.1	96%	57%	80%
39 year average		14	5.2	9.4	24.2	3.6	10.7	13.3	7.3	10.3	11.1	9.5	10.4	2.4	227	8.5	11.4	3.2	97%	63%	82%
Percent of average		104%	97%	101%	115%	90%	108%	107%	110%	108%	105%	106%	105%	101%	113%	0%	0%	34%	99%	90%	96%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT OCTOBER																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/10/2004	9:00:00	15.3	4.9	9.4	35.8	2.8	12.3	15.2	8.3	12	12.6	10.9	11.8	2.2	164			0	91%	51%	77%
2/10/2004	9:00:00	15.5	9.3	11.5	29.1	8.7	15	16.9	9.2	13.4	13.2	11.1	12.3					0	84%	53%	71%
3/10/2004	9:00:00	13.9	2.8	9.8	22	0.8	10.4	13.6	8.9	11.8	12.4	11.5	12.1					0.2	100%	64%	89%
4/10/2004	9:00:00	13.9	5.8	9.4	28.6	2.2	11.3	15	8.4	11.7	12.5	11.2	11.8	6.8	766			2.2	95%	56%	71%
5/10/2004	9:00:00	14.6	8.2	10.8	32.4	6.5	15	17	8.7	13.2	13.1	10.9	12.2	2.8	266			0.2	93%	46%	70%
6/10/2004	9:00:00	16.4	4	10.3	33.5	2	14	18.8	9.9	14.2	14.1	11.9	13	3.2	216			0	98%	49%	73%
7/10/2004	9:00:00	16.1	7.1	10.9	34.9	6.8	16.7	19.8	10.2	15.2	14.6	12.1	13.5	3.4	161			0	95%	52%	79%
8/10/2004	9:00:00																				
9/10/2004	9:00:00	16.3	6.6		28.5	3.7		15.6	9.6		13.1	11.5		4.8	106	4.42	26.1	0.2	94%	54%	
10/10/2004	9:00:00	18.8	3.7	11.5	36.1	2.6	15.1	18.8	9.7	13.8	14	11.7	12.9	4.7	111	4.65	27.8	0	94%	50%	70%
11/10/2004	9:00:00	14.8	8.2	11.3	32.3	7.8	16.4	18.7	9.7	14.7	14.3	12.1	13.3	4.3	118	4.92	29.3	0	100%	62%	90%
12/10/2004	9:00:00	17.7	8	12.9	28.8	6.2	14.8	17.4	11.4	14.3	14.3	13.1	13.6	2.9	73	3.06	18.6	0	100%	46%	80%
13/10/2004	9:00:00	17.6	9.5	13.6	37.3	7.6	18.9	21.5	11.5	16.5	15.7	12.9	14.4	5	114	4.77	28.4	0	97%	68%	83%
14/10/2004	9:00:00	18.8	7.3	12.5	37.3	5.4	17.1	21.3	12.6	16.6	16	14	15	7.1	178	7.42	43.7	0	83%	30%	62%
15/10/2004	9:00:00	15.1	4.5	8.6	32.8	2.8	12.8	19.2	10.8	14.9	15.3	13.7	14.5	6.3	156	6.5	38.4	0.6	84%	34%	67%
16/10/2004	9:00:00	13.7	-0.3	6.9	29.7	-1.3	10.9	18.9	9	13.8	14.8	13	13.9	6.1	151	6.31	37.3	0	100%	38%	64%
17/10/2004	9:00:00	12.4	4.1	7.8	33.8	4.3	15.2	19.7	9.1	14.7	14.7	12.4	13.6	4.2	99	4.13	24.7	0	90%	37%	66%
18/10/2004	9:00:00	14.4	3.6	8.5	39.5	2.2	14.7	19.4	10.8	15	15	13	14	2.9	70	2.95	17.9	0	97%	49%	76%
19/10/2004	9:00:00	14.8	4.7	10.2	36.7	4	17.8	21.8	10.8	16.5	15.7	13	14.5	3.8	92	3.85	23.2	0	100%	67%	85%
20/10/2004	9:00:00	16.8	5.2	10.7	42.6	4.8	18.6	22.3	12.4	17.1	16.4	13.9	15.2	3.8	88	3.69	22.3	0	99%	59%	83%
21/10/2004	9:00:00	18.1	7.6	13.1	41.7	7.7	21.1	22.7	13.1	17.9	16.9	14.4	15.7	4.3	82	3.43	20.7	0	98%	59%	79%
22/10/2004	9:00:00	19.3	10	15	35	8.8	19.4	22.2	15.2	18.4	17.2	15.3	16.3	4.6	99	4.13	24.7	0	97%	59%	79%
23/10/2004	9:00:00	20.7	11.2	15.6	44.9	11.3	23.4	24.4	15.4	19.8	18.2	15.7	17	3.9	78	3.26	19.8	0	100%	61%	82%
24/10/2004	9:00:00	22.2	8.5	14	45.7	8.8	21	25.7	15.8	20.3	19	16.7	17.8	6.8	144	6.02	35.7	0	78%	41%	61%
25/10/2004	9:00:00	17.9	8.8	12.4	42.3	8.5	21.7	24.5	15.9	19.9	18.8	16.6	17.7	3.7	93	3.89	23.3	0.2	98%	50%	79%
26/10/2004	9:00:00	17.5	7.4	11.8	40.1	6.1	18.3	23.1	14.9	18.9	18.5	16.7	17.6	4.9	123	5.13	30.5	0	93%	47%	72%
27/10/2004	9:00:00	13.4	9.8	11.2	23.4	10	13.7	16.9	13.2	15.3	16.7	15.1	16	2.5	66	2.78	17	25.6	98%	77%	92%
28/10/2004	9:00:00	16.7	6	10.3	31.1	3.3	10.5	16.1	9.6	12.9	15.2	13.3	14.6	6	118	4.92	29.3	1.6	91%	50%	65%
29/10/2004	9:00:00	16	5.4	10.7	34.2	5.3	16.7	19.7	9.8	15.3	15.8	13	14.5	4.9	103	4.31	25.8	0	95%	51%	75%
30/10/2004	9:00:00	18.4	7.4	12.8	40.1	7.5	19.6	22.4	11.9	17.4	17	14	15.6	4	90	3.78	22.7	0	94%	47%	73%
31/10/2004	9:00:00	17.6	8.2	12.4	43.7	8.9	20.2	23.6	14.2	18.4	17.7	15.2	16.5	4.2	85	3.56	21.5	0	95%	55%	78%
	Totals	494.7	197.5	325.9	1054	166.1	472.6	592.2	340	453.9	462.8	399.9	420.9	124.1	4010	102	608.7	30.8			
	Average	16.5	6.6	11.2	35.1	5.5	16.3	19.7	11.3	15.7	15.4	13.3	14.5	4.4	143	4.4	26.5	1	94%	52%	76%
39 year average		15.4	6.4	10.6	29.8	4.4	13.3	17.3	10	13.4	13.6	11.5	12.5	3.5	207	8.7	17.3	2.6	95%	56%	78%
Percent of average		107%	104%	106%	118%	125%	123%	114%	113%	117%	113%	116%	116%	127%	69%	51%	153%	39%	99%	93%	97%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT NOVEMBER																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/11/2004	9:00:00	19.6	10.9	15.1	41.5	11.5	21.9	24.3	15	19.6	18.4	15.9	17.2	4.5			24.7	0	94%	56%	77%
2/11/2004	9:00:00	19.3	10.5	14.2	40.6	10	20.9	24.4	16.4	20	18.8	16.7	17.8	6.2			39.3	0	96%	67%	83%
3/11/2004	9:00:00	14.5	10.2	11.8	27.7	8.2	13.6	17.5	13	16	17.4	15.5	16.6	5.5			28	17.2	98%	60%	85%
4/11/2004	9:00:00	18.1	4.8	11.6	30.8	4.4	15.7	20.5	12.2	16.1	17	15.1	16	6.1			33.7	0	89%	45%	64%
5/11/2004	9:00:00	14.8	9.6	11.6	31.2	9.9	14.9	17.6	12.4	15	15.7	14.8	15.2	3.2			21.2	10.2	97%	62%	79%
6/11/2004	9:00:00	14.6	7.6	11.3	18.5	5.7	11.5	15.5	10.8	13.4	14.8	13.7	14.5	3.2			17.5	19.4	98%	76%	89%
7/11/2004	9:00:00	18.1	8.8	11.9	35	8.9	15	18	11.1	14.9	15.3	13.4	14.5	4			24.4	10.6	97%	67%	87%
8/11/2004	9:00:00	17.2	8.9	11.7	31.3	10	15.5	17.7	12.7	15.2	15.4	14.1	14.7	3.6			19	1.4	96%	59%	84%
9/11/2004	9:00:00	15.9	9	12.2	35.8	8.4	18	20.4	13.3	16.9	16.5	14.4	15.5	4			22.5	0.2	96%	69%	84%
10/11/2004	9:00:00	17	9.3	13	39.3	9.1	20.7	23.9	14	18.8	17.9	15.1	16.6	3.8			22.5	1.6	97%	60%	80%
11/11/2004	9:00:00	16.4	12.3	13.9	32.1	12.6	16.6	19	15.1	16.8	16.7	15.8	16.3	4.2			27.3	3.2	95%	58%	78%
12/11/2004	9:00:00	15.1	9.6	13.1	21.9	8.1	13.3	15.9	12.9	14.8	15.8	14.8	15.4	4.3			22	14.4	100%	70%	93%
13/11/2004	9:00:00	17.1	8.1	12	31.4	8.5	15.9	18.5	13.2	16	16.1	14.6	15.4	5.4			29.9	6.6	98%	66%	86%
14/11/2004	9:00:00	16.1	6.2	10.6	31.5	5.4	14	18.8	11.5	15.3	16.2	14.5	15.4	6.7			35.5	1.4	95%	48%	71%
15/11/2004	9:00:00	18.1	8.1	12.4	33.8	6.3	15.3	18.2	11.7	14.9	15.7	14.1	14.9	7.8			46.6	0.2	80%	53%	66%
16/11/2004	9:00:00	15.6	5.1	9.6	34.7	4.6	15.1	20.5	11.9	15.8	16.3	14.2	15.2	7.2			40.8	0	89%	46%	68%
17/11/2004	9:00:00	17.9	9.1	12.6	38.3	8.5	19.7	22.3	12.1	17.8	17	14.3	15.8	5.9			33.6	0	89%	48%	69%
18/11/2004	9:00:00	19.8	9.4	13.2	39.7	9.7	19.8	22.4	15	18.1	17.4	15.6	16.4	4.7			20.7	0	97%	62%	81%
19/11/2004	9:00:00	21.4	7.8	13.3	32	5.5	14.9	18.7	13	16.4	16.6	15.2	16.1	4.9			26.3	0.4	88%	59%	74%
20/11/2004	9:00:00	15.6	6	10.8	35.2	4.6	15.5	21	12.6	16.7	16.8	14.9	15.8	8.2			43.5	1	84%	48%	66%
21/11/2004	9:00:00	18.8	7.5	12.6	43.2	7.4	20.8	24.9	12.8	19.1	18.1	14.9	16.6	5.7			30.7	0	82%	43%	60%
22/11/2004	9:00:00	19.4	5.1	11.5	44.4	3.2	17.6	23.1	13.4	18.3	18.1	16.1	17	6.2			34	0	83%	46%	61%
23/11/2004	9:00:00	21.1	7.2	13.8	44.7	7.1	21.8	25	13.6	19.7	18.6	15.7	17.3	5.8			30.1	0	99%	34%	62%
24/11/2004	9:00:00	19.5	6.9	13.7	46.2	6.4	22.6	26.1	15.8	20.7	19.4	16.8	18.1	4.5			21.7	0	93%	48%	71%
25/11/2004	9:00:00	18.2	9.4	13.4	44.7	10.8	23.5	26.4	16.1	21.4	19.8	17.2	18.6	4.7			27.1	0	100%	65%	85%
26/11/2004	9:00:00	18.3	11.4	14.9	46.5	12.7	25.2	27.4	17.8	22.6	20.7	18	19.4	4.9			25	0	98%	66%	84%
27/11/2004	9:00:00	20.8	11.2	15.6	48.4	11.6	26	28.4	19	23.3	21.5	18.9	20.2	4.3			21.2	0	98%	57%	81%
28/11/2004	9:00:00	23.8	14.4	17.3	47.9	13.2	22.9	25.1	18.4	21.6	20.6	19.3	19.8	5.1			21.5	0	96%	49%	76%
29/11/2004	9:00:00	21.6	4.4	13.7	46.7	4.4	20	26.4	16	21.5	20.8	18.8	19.8	7.3			36.7	0	93%	44%	63%
30/11/2004	9:00:00	17.8	12.7	14.7	40.7	13.6	22.9	26	16.2	21.5	20.3	18.2	19.3	6.9			37.6	0	95%	55%	79%
	Totals	541.5	261.5	387.1	1116	250.3	551.1	653.9	419	538.2	529.7	470.6	501.4	158.8			864.6	87.8			
	Average	18.1	8.7	12.9	37.2	8.3	18.4	21.8	14.0	17.9	17.7	15.7	16.7	5.3			28.8	2.9	94%	56%	76%
39 year average		17.4	8.5	12.0	32.6	5.7	15.7	20.7	12.6	16.4	16.9	14.3	15.7	4.4	208.6	8.6	20.5	2.3	95%	53%	76%
Percent of average		104%	103%	107%	114%	147%	117%	105%	111%	110%	105%	110%	106%	120%	0%	0%	140%	126%	99%	106%	101%

Appendix v - Meteorological Details (Cont.)

FORTHSIDE RESARCH STATION WEATHER REPORT DECEMBER																					
Date	Time	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Evap.	Total	Aver.	Total	Total	Relative	Humidity	
		Dry B.	Dry B.	Dry B.	Grass	Grass	Grass	10 cm	10 cm	10 cm	20 cm	20 cm	20 cm		Wind	Wind	Solar	Rain	Max.	Min.	Aver.
		Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	Deg.C	MM	K	KPH	mj/m2	MM			
1/12/2004	9:00:00	20.1	9.7	13.1	34.9	10.1	16.8	21.7	16	19.2	19.3	17.9	18.9	4.6			26.2	6.2	97%	62%	87%
2/12/2004	9:00:00	17.3	7.7	11.9	37.7	6.3	17.3	23.9	14.4	19	19.4	17.4	18.4	8.4			44	0	82%	43%	64%
3/12/2004	9:00:00	18.1	5.7	11.9	40.5	5.3	17.7	23.2	14.4	18.7	18.9	16.9	17.9	5.7			28.3	0	91%	44%	67%
4/12/2004	9:00:00	19	11.3	14.5	44.7	11.6	24.5	27.2	14.7	21.7	20.2	16.8	18.7	5.5			28.8	0	90%	47%	71%
5/12/2004	9:00:00	20.1	9.3	15	46.9	8.9	23.3	26.3	17.5	21.9	20.6	18.4	19.5	4.9			21.7	0	100%	60%	78%
6/12/2004	9:00:00	21.3	11.4	16.3	49.6	11.7	26.4	29	17.8	23.6	21.6	18.6	20.2	5.6			27	0	92%	58%	76%
7/12/2004	9:00:00	19.8	9.8	14.7	51	9.5	25.5	29.6	18.8	24	22.3	19.6	21	5.5			23.6	0	97%	57%	81%
8/12/2004	9:00:00	25.8	13.3	18.3	48.9	12	26.2	29.1	18.9	23.9	22.4	19.8	21.1	9			40	0	78%	24%	57%
9/12/2004	9:00:00	26.2	12.9	18.4	47.2	12	24.6	28.2	19.3	23.4	22.3	20.1	21.2	8.4			38	0	84%	46%	64%
10/12/2004	9:00:00	23	10.9	16.9	45.9	10.8	25.5	29	19.7	24.1	22.9	20.1	21.5	5.8			26.2	0	98%	56%	78%
11/12/2004	9:00:00	23.8	16.6	18.7	46.9	17.2	25.9	27.9	20	24.1	22.6	20.5	21.7	4.3			21.9	0	94%	58%	80%
12/12/2004	9:00:00	23.4	16	18.5	42.8	16.2	24.6	26.3	20.9	23.2	22.2	20.9	21.5	3.7			17.1	1.2	94%	68%	83%
13/12/2004	9:00:00	22.6	14.2	17.5	42.2	14.3	22.2	25.3	18.8	21.9	21.7	20.2	21	2.8			14.5	23.2	100%	71%	91%
14/12/2004	9:00:00	21.3	13.9	17.3	35.5	15.7	20.9	24.1	18.9	21.1	21	19.8	20.4	3.2			14.4	8.2	98%	65%	90%
15/12/2004	9:00:00	21.2	7.1	14.6	33.2	6	17.7	23.2	14.6	19.3	20.7	18.4	19.8	7.6			37.5	0.2	84%	46%	59%
16/12/2004	9:00:00	21.1	7.8	14.5	43.8	7.7	21.4	27	14.9	21.1	21.1	17.9	19.6	6			31.9	0	91%	42%	63%
17/12/2004	9:00:00	20.9	9.2	15	43.2	9.4	21.6	26.1	16.4	21.1	21	18.6	19.8	7.1			32.5	0	93%	50%	67%
18/12/2004	9:00:00	21.8	12.4	16.7	45.2	12.8	26.1	29.6	17.3	24	22.5	19	20.9	5			25	0	97%	45%	78%
19/12/2004	9:00:00	23.1	13.8	17.7	50.2	14	26.7	30	19.9	24.8	23.2	20.5	21.9	5.1			23.1	2.4	94%	52%	72%
20/12/2004	9:00:00	18.8	6.6	12.3	37.2	6.3	17.1	26.2	15.9	21.3	22.1	19.6	21.2	6.5			36.1	0.8	88%	43%	66%
21/12/2004	9:00:00	20.1	8.9	13.8	42.2	9.3	20.4	26.3	16.1	21	21.3	19	20.1	6.2			35.1	0	89%	37%	64%
22/12/2004	9:00:00	22	9.7	15.8	43.8	8.5	22.7	28	17.4	22.5	22.1	19.2	20.7	7.5			35.4	0	93%	44%	65%
23/12/2004	9:00:00	21.9	13.3	16.8	46.1	13.8	26.3	29.9	18.1	24.4	22.9	19.8	21.5	5.5			30.5	0	95%	46%	74%
24/12/2004	9:00:00	21.3	15.2	17.7	47.2	15.5	27.1	29.7	20.2	24.7	23.1	20.8	22	5.5			26.9	0	89%	58%	76%
25/12/2004	9:00:00	25.3	8.2	17.3	48.4	7.9	24.4	30.4	19.2	24.6	23.8	21.4	22.5	7.8			36.7	0	85%	31%	55%
26/12/2004	9:00:00	21.1	7.2	14.4	44.8	7	21.9	28.4	18.4	23.2	23	20.9	21.9	6.6			35.3	0	82%	32%	55%
27/12/2004	9:00:00	22.2	8.4	14.9	50.6	7.2	23.8	28.4	18.4	23.1	22.5	20.3	21.4	7.6			38.7	0	85%	35%	58%
28/12/2004	9:00:00	16.1	5.6	10.9	38.1	5.2	16.6	23.7	16	20.3	21.1	19.2	20.4	7.6			39.2	0	79%	42%	56%
29/12/2004	9:00:00	18.9	7.7	13.1	43.1	7	20.3	24.8	16.2	20.5	20.4	18.8	19.6	6			30.1	0	93%	39%	64%
30/12/2004	9:00:00	19.3	9	14.4	46.3	8.4	24.6	27.8	17.4	22.8	21.9	19	20.6	6.1			30.1	0	98%	49%	76%
31/12/2004	9:00:00	20.2	9.3	14.9	46.5	8.6	24.4	28.9	18.9	23.7	22.6	19.9	21.4	4.9			26.8	0	98%	57%	81%
	Totals	657.1	322.1	477.8	1365	316	705	839	545	692	673	599	638	186			923	42.2			
	Average	21.2	10.4	15.4	44.0	10.2	22.7	27.1	17.6	22.3	21.7	19.3	20.6	6.0			29.8	1.4	91%	49%	71%
39 year average		19.1	9.7	14.0	37.0	8.1	19.0	24.5	15.6	19.7	19.8	16.9	18.5	5.1	209.6	8.6	23.4	2.1	93%	53%	74%
Percent of average		111%	107%	110%	119%	125%	119%	111%	112%	113%	110%	114%	112%	118%	0%	0%	127%	64%	98%	93%	95%

26.6 Appendix vi - Acknowledgements

The assistance of Botanical Resources Australia Pty Ltd who provided us with the trial site is gratefully acknowledged.

Serve-Ag Research staff who contributed to this project included Tim Hingston.

FINAL REPORT

Evaluation of post-harvest herbicides for control of groundsel (*Senecio vulgaris* L.) in pyrethrum

Forth, Tasmania, 2004

Client: Botanical Resources Australia Pty Ltd

Author: Phillip Frost B Agr Sc (Hons)
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27 Summary

At Forth, North West Tasmania, in 2004 a trial was conducted to evaluate various herbicide regimes for control of Groundsel (*Senecio vulgaris*) in a post-harvest established pyrethrum crop. Experimental herbicides identified from earlier work were evaluated with currently used herbicides in a range of tank mixes and regimes. All herbicide treatments (1 to 10) consisted of an application in March and April, and treatments 1 to 7 also received an herbicide application in May.

Command 250 mL/ha was tank-mixed with Affinity, Frontier-p or Brodal and applied in March. Command + Affinity and Command + Frontier-p were followed by Command + Affinity in April and Raptor in May. Command 250 + Brodal was followed by Brodal alone in April and Raptor in May. Command 250 + Affinity applied in March was also trialed in a regime with Command 250 applied alone in April and May. Command was also trialed at 350 mL/ha in a tank mix with Affinity and applied in March and April, followed by Raptor in May. Brodal + Affinity applied in March was followed by either Brodal + Command in April and Raptor in May, or a second application of Brodal + Affinity in April and Brodal in May. Goal WP and Pledge applied in March were also trialed in a regime with Command + Affinity applied in April, and Brodal was evaluated on it's own and applied in March and April as the current commercial standard.

Assessments for crop safety were conducted at 11 and 22 days after application 1 (DAA1), 14DAA2 and 21DAA3. Groundsel density was assessed at 123DAA3 by counting the number of plants per m^2. Two quadrats per plot were harvested for treatments 1 - 7, 10 and 11 for dry weight yield.

Herbicide regimes consisting of at least two applications of Command (250 or 350 mL/ha) applied in March and April, were safe to the crop and achieved good control of groundsel; Command 250 and 350 + Affinity applied in March and April followed by Raptor in May (treatments 1 and 2), Command 250 + Affinity applied in March followed by Command 250 in April and May (treatment 3), and Command 250 + Frontier-p followed by Command 250 + Affinity in April and Raptor in May (treatment 7) reduced the mean groundsel density to between 0.3 and 1.0 plant per m^2.

Brodal + Affinity applied in March and April, followed by Brodal in May (treatment 4) and Command + Brodal applied in March, followed by Brodal in April and Raptor in May (treatment 5) provided adequate control of groundsel, however were unsafe to the crop by 21DAA3.

Pledge applied in March followed by Command 250 + Affinity in April (treatment 9) did not reduce the mean number of groundsel per m^2 compared to the untreated control, and was unsafe to the crop at all assessment dates.

There was no significant treatment effect on dry weight yield.

28 Introduction

28.1 Aims

- To evaluate sequential applications of Command at 250 and 350 mL/ha applied alone and tank mixed with Affinity, Brodal or Frontier-p for crop safety and control of groundsel in post-harvest established pyrethrum crops.
- To evaluate sequential applications of Brodal tank-mixed with Affinity for crop safety and control of groundsel in post-harvest established pyrethrum crops.
- To evaluate the crop safety and efficacy of Goal and Pledge applied in a regime with Command + Affinity
- To evaluate the crop safety and efficacy of Raptor at the final application timing within various herbicide regimes.

28.2 Target Weed

Groundsel (*Senecio vulgaris* L.) SENVU

29 Materials and Methods

29.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Command	clomazone	480 g/L	Emulsifiable Concentrate
Affinity	carfentrazone-ethyl	400 g/kg	Wettable Granule
Brodal	diflufenican	500 g/L	Suspension Concentrate
Frontier-p	dimethenamid-p	720 g/L	Emulsifiable Concentrate
Goal WP	oxyflurofen	400 g/kg	Wettable Powder
Raptor WG	imazamox	700 g/kg	Wettable Granule
Pledge 500 WG	flumioxazin	500 g/L	Wettable Granule
BS 1000	alcohol alkoxylate	1000 g/L	Liquid

29.2 Treatment List

No.	Treatment (Product rate, mL or g/ha)		
	March	**April**	**May**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-
10	Brodal 300 mL	Brodal 300 mL	-
11	Handweed control	-	-
12	Untreated control	-	-

29.3 Chronology of Events

Date	Days After Application (DAA#)	Crop Stage	Event
01/03/04	0DAA1	10 - 20 cm rosette	**Applied March herbicide treatments 1-10**
12/03/04	11DAA1	10 - 20 cm rosette	Crop safety assessment 1
23/03/04	22DAA1	10 - 20 cm rosette	Crop safety assessment 2
12/04/04	42DAA1	20 - 30 cm rosette	**Applied April herbicide treatments 1-10**
26/04/04	14DAA2	20 - 30 cm rosette	Crop safety assessment 3
27/05/04	45DAA2	20 - 40 cm rosette	**Applied May herbicide treatments 1-7**
17/06/04	21DAA3	20 - 40 cm rosette	Crop safety assessment 4
27/09/04	123DAA3		Weed density assessment 1
29/12/04	216DAA3	Harvest	Harvested plots for yield assessment

30 Results and Discussion

30.1 Table 1 - Mean crop safety 11 days after application 1 (DAA1), 22DAA1, 14DAA2 and 21DAA3

No.	Treatment (product rate, mL or g/ha)			Mean EWRS Rating for crop tolerance			
	March	April	May	12/03/04 11DAA1	23/03/04 22DAA1	26/04/04 14DAA2	17/06/04 21DAA3
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	3.0	2.0	2.0	3.3
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.8	2.0	2.8	3.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	3.0	2.0	2.3	3.3
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	3.0	2.8	3.3	4.8
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	3.0	4.5	4.3	4.0
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.8	2.3	2.5	3.5
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.3	1.5	1.5	3.3
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-	2.0	2.0	2.0	3.5
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	5.5	5.0	5.3	4.8
10	Brodal 300 mL	Brodal 300 mL	-	2.3	3.3	3.8	3.8
11	Handweed control			1.0	1.0	1.0	1.0
12	Untreated control			1.0	1.0	1.0	1.0

Pledge applied in March followed by Command 250 + Affinity in April was unsafe to the crop at all assessment dates. Command + Brodal applied in March followed by Brodal in April and Raptor in May resulted in crop damage that was bordering on the limit of commercial acceptability (EWRS Scale for Crop Tolerance) at 22DAA1, 14DAA2 and 21DAA3. Brodal + Affinity applied in March and April, followed by Brodal in May, resulted in symptoms that were mild but clearly recognizable 11 and 22DAA1 and 14DAA2, and became commercially unacceptable by 21DAA3. The safest treatment to the crop at all assessment dates was Command 250 + Frontier-p applied in March, followed by Command 250 + Affinity in April and Raptor in May. All other treatments were safe to the crop at 11and 22DAA1, 14DAA2 and 21DAA3.

30.2 Table 2 - Weed density assessment at 123DAA3 (27/09/04)

No.	Treatment (product rate, mL or g/ha)			Mean number groundsel per m^2	
	March	April	May		
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	0.8	ab
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.0	ab
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	0.3	a
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	1.5	ab
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	1.0	ab
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.3	bc
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	0.5	a
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-	3.0	bc
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	3.8	cd
10	Brodal 300 mL	Brodal 300 mL	-	2.3	bc
12	Untreated control			5.0	d
p-value				0.0004	
LSD (5% level)				*	

Means within columns followed by the same letter are not significantly different at the 5% level according to Least Significant Difference (LSD) test.
*Data was analysed using x=sqrt(y+0.5), so the LSD is not applicable to the untransformed means.

Weed density at this site was relatively low, despite this all herbicide treatments, with the exception of Pledge applied in March followed by Command 250 + Affinity in April, significantly reduced the mean number of groundsel per m^2 by 123DAA3 compared to the untreated control.
Command 250 tank-mixed with Affinity and applied in March followed by Command 250 in April and May (treatment 3), and Command 250 + Frontier-p applied in March followed by Command 250 + Affinity in April and Raptor in May (treatment 7) reduced mean groundsel numbers to 0.3 and 0.5 plants per m^2 respectively, compared to 5.0 for the untreated control. Treatments 3 and 7 resulted in significantly lower weed densities than Brodal + Affinity followed by Command + Affinity and Raptor (treatment 6), and treatments 8, 9 and 10, which did not have any herbicides applied at the May timing.
Command at rates of 250 or 350 mL/ha, tank-mixed with Affinity and applied in March and April and followed by Raptor in May (treatments 1 and 2), resulted in 0.8 and 1.0 mean plants per m^2 respectively and there was no significant difference between these two treatments.

30.3 Table 3 - Yield assessment 216DAA3 (29/12/04)

No.	Treatment (product rate, mL or g/ha)			Flower dry weight (g/m^2)
	March	April	May	
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	221.1
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	219.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	202.7
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	181.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	190.6
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	189.9
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	222.8
10	Brodal 300 mL	Brodal 300 mL	-	187.2
11	Handweed control			194.0
p-value				0.6722
LSD (5% level)				-

There was no significant treatment effect on dry weight yield.

31 Conclusions

- Herbicide regimes consisting of at least two applications of Command (250 or 350 mL/ha) applied in March and April, were safe to the crop and achieved good control of groundsel; Command 250 and 350 + Affinity applied in March and April followed by Raptor in May (treatments 1 and 2), Command 250 + Affinity applied in March followed by Command 250 in April and May (treatment 3), and Command 250 + Frontier-p followed by Command 250 + Affinity in April and Raptor in May (treatment 7) reduced the mean groundsel density to between 0.3 and 1.0 plant per m^2.
- Brodal + Affinity applied in March and April, followed by Brodal in May (treatment 4) and Command + Brodal applied in March, followed by Brodal in April and Raptor in May (treatment 5) provided adequate control of groundsel, however were unsafe to the crop by 21DAA3.
- Herbicide regimes that did not have any sprays applied in May – Goal WP applied in March followed by Command 250 + Affinity in April (treatment 8) and Brodal applied in both March and April (treatment 10) – appeared to result in higher mean numbers of groundsel plants per m^2, however this trend was not statistically significant.
- Pledge applied in March followed by Command 250 + Affinity in April (treatment 9) did not reduce the mean number of groundsel per m^2 compared to the untreated control, and was unsafe to the crop at all assessment dates.

32 Appendices

32.1 Appendix i - Trial Details

32.1.1 Site Details

Grower	Botanical Resources Australia Pty Ltd
Location	Forth, Tasmania
Soil Type	Ferrosol
Crop	Pyrethrum
Trial Design	Randomised complete block
Replications	4
Plot Size	2 m x 7 m
Harvest Date	29/12/04

32.1.2 Trial Plan

6	3	8	4	7	2	11	1	9	12	5	10	**Block 4**
9	12	2	11	6	10	3	5	4	1	8	7	**Block 3**
11	4	9	5	8	1	6	2	3	7	10	12	**Block 2**
1	5	10	7	12	3	11	8	6	9	4	2	**Block 1**

↖N

32.1.3 Application Details

Application Equipment			
Equipment	CO2 pressurised precision knapsack sprayer		
Nozzles	4 X Spraying Systems DG8002 fan jets		
Volume	230 L/ha		
Pressure	280 kPa		
Method	Walked at 1 m/sec		
Treatment Applications			
Application Number	1	2	3
Date	01/03/04	12/04/04	27/05/04
Time	1:00 PM	9:45 AM	9:30 AM
Treatments Applied	1 - 10	1 - 10	1 - 7
Temperature (^{O}C)	16	16	5.8
Relative Humidity (%)	30	73	69
Cloud Cover (%)	0	0	20
Wind Direction	NE	-	-
Wind Speed (km/h)	5 - 8	Calm	Calm
Soil Moisture	Dry	Wet	Wet
Weed Growth Stage	No weeds emerged	SENVU 2 - 6 Leaf	SENVU 2 - 8 leaf
Crop Stage	10 - 20 cm rosette	20 - 30 cm rosette	20 - 40 cm rosette
Photographs	Yes	No	Yes

Meteorological data from Forthside Vegetable Research Station (FVRS) for the months of March to December 2004 is included as Appendix v to this report. The trial site was situated 5 km from FVRS.

32.1.4 Assessments

1. Crop Safety Assessment				
Dates	12/03/04	23/03/04	26/04/04	17/06/04
Days After Application	11DAA1	22DAA1	14DAA2	21DAA3
Sample Size	Whole plot			
Method	Visual assessment			
Rating Scale	EWRS for crop tolerance - Appendix iii			
2. Weed Density Assessment				
Date	27/09/04			
Days After Application	123DAA3			
Sample Size	Whole plot			
Method	Number of groundsel plants per m^2 were counted			
Statistical Analysis	Appendix iii			
3. Yield Assessment				
Date	29/12/04			
Days After Application	216DAA3			
Sample Size	2 x 0.5 m2 quadrats per plot (treatments 1 – 7, 10 and 11)			
Method	Fresh flowers were harvested and weighed for each plot. A sub-sample of the flowers was dried in an oven for dry weight. Total flowers' dry weights were then tabulated from the percentage dry matter of flowers in the sub-samples of flowers from each plot.			
Statistical Analysis	Appendix iii			

32.2 Appendix ii - Raw Data

32.2.1.1 Crop Safety Assessments

Treatment					EWRS Rating for crop tolerance			
No.	**March**	**April**	**May**	**Rep**	**12/03/04**	**23/03/04**	**26/04/04**	**17/06/04**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	3	2	2	4
				2	3	2	2	3
				3	3	2	2	3
				4	3	2	2	3
				Mean	3.0	2.0	2.0	3.3
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	2	2	3
				2	3	2	3	3
				3	3	2	4	4
				4	3	2	2	3
				Mean	2.8	2.0	2.8	3.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	3	2	1	3
				2	3	2	2	3
				3	3	2	2	3
				4	3	2	4	4
				Mean	3.0	2.0	2.3	3.3
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	Brodal 300 mL	1	3	3	2	5
				2	3	3	4	5
				3	3	3	3	4
				4	3	2	4	5
				Mean	3.0	2.8	3.3	4.8
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	3	5	4	5
				2	3	5	4	4
				3	3	4	4	4
				4	3	4	5	3
				Mean	3.0	4.5	4.3	4.0
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	3	2	3	3
				2	3	3	2	3
				3	3	2	3	4
				4	2	2	2	4
				Mean	2.8	2.3	2.5	3.5
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	2	2	4
				2	1	2	2	2
				3	1	1	1	3
				4	1	1	1	4
				Mean	1.3	1.5	1.5	3.3
8	Goal WP 500 g	Brodal 300 mL + Affinity 60 g		1	2	2	2	3
				2	2	2	1	4
				3	2	2	2	3
				4	2	2	3	4
				Mean	2.0	2.0	2.0	3.5
9	Pledge 200 g	Pledge 200 g + Command 250 mL		1	5	5	5	5
				2	6	5	5	5
				3	6	5	5	4
				4	5	5	6	5
				Mean	5.5	5.0	5.3	4.8
10	Brodal 300 mL	Brodal 300 mL		1	3	4	4	4
				2	2	3	3	4
				3	2	3	4	4
				4	2	3	4	3
				Mean	2.3	3.3	3.8	3.8
11	Handweed Control			1	1	1	1	1
				2	1	1	1	1
				3	1	1		1
				4	1	1	1	1
				Mean	1.0	1.0	1.0	1.0
12	Untreated Control			1	1	1	1	1
				2	1	1	1	1
				3	1	1	1	1
				4	1	1	1	1
				Mean	1.0	1.0	1.0	1.0

Appendix ii - Raw Data (Cont.)

32.2.1.2 Weed Count Assessment

Treatment					Estimate number **SENVU** per m2
No.	**March**	**April**	**May**	**Rep**	**27/09/04**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	0
				2	0
				3	1
				4	2
				Mean	0.8
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	0
				2	1
				3	1
				4	2
				Mean	1.0
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	0
				2	0
				3	1
				4	0
				Mean	0.3
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	1	1
				2	1
				3	3
				4	1
				Mean	1.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	0
				2	0
				3	1
				4	3
				Mean	1.0
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2
				2	1
				3	3
				4	3
				Mean	2.3
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	0
				2	0
				3	0
				4	2
				Mean	0.5
8	Goal WP 500 g	Command 250 mL + Affinity 60 g		1	0
				2	0
				3	2
				4	10
				Mean	3.0
9	Pledge 200 g	Command (solvesso) 250 mL + Affinity 60 g		1	2
				2	4
				3	5
				4	4
				Mean	3.8
10	Brodal 300 mL	Brodal 300 mL		1	2
				2	4
				3	2
				4	1
				Mean	2.3
12	Untreated Control			1	3
				2	5
				3	6
				4	6
				Mean	5.0

32.3

Appendix ii - Raw Data (Cont.)

32.3.1.1 Yield Assessment 29/12/04

Treatment					Fresh Net Weights			Dry Net Weights		
No.	March	April	May	Rep	Total sample (g)	FMI Sub-sample (g)	Assay Sub-sample (g)	Assay Sub-sample (g)	FMI Sub-sample (g)	Dry Weight (g/m^2)
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	515.6	126.7	236.1	96.8	574	211
				2	531.6	108.4	231.7	87.6	554	201
				3	538.4	136.8	217.9	87.5	586	216
				4	628.8	145.6	241.3	98.2	546	256
				Mean	553.6	129.4	231.8	92.5	565.0	221
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	606	132.2	234.4	94.2	529	244
				2	509.2	121	226.6	89.9	567	202
				3	391.5	147.9	243.9	88.9	532	143
				4	729.1	134.9	231.3	91.7	584	289
				Mean	559.0	134.0	234.1	91.2	553.0	219
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	568.8	104.2	216.8	88.4	595	232
				2	504.8	126.4	250.8	98.6	588	198
				3	472.8	122	230.3	92.4	580	190
				4	499.2	125.7	245.2	93.7	547	191
				Mean	511.4	119.6	235.8	93.3	577.5	203
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	1	591.2	115.4	240.8	96.5	584	237
				2	453.2	127.3	241.6	90.4	523	170
				3	438.4	113.8	228.3	89.2	589	171
				4	386.9	145.7	241.2	92.4	527	148
				Mean	467.4	125.6	238.0	92.1	555.8	182
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	518.7	108	227.3	87.4	575	199
				2	515.6	129.1	234.5	90.2	581	198
				3	473.4	107	241.2	88.4	571	174
				4	448.4	146.6	210.1	89.6	571	191
				Mean	489.0	122.7	228.3	88.9	574.5	191
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	540	131.4	229.3	93.3	529	220
				2	494.9	140.6	243.2	98.5	559	200
				3	428.4	123.5	230.1	94.6	571	176
				4	401.6	134	225.7	91.8	586	163
				Mean	466.2	132.4	232.1	94.6	561.3	190
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	508.7	133.6	220	89.4	550	207
				2	545	130.5	220.7	93.2	555	230
				3	552.5	142.3	232.5	95.1	536	226
				4	577.3	140.8	220.6	87.3	555	228
				Mean	545.9	136.8	223.5	91.3	549.0	223
10	Brodal 300 mL	Brodal 300 mL		1	309.2	115.2	193	82.1	586	132
				2	494.4	124.9	241.4	96	586	197
				3	631	119.4	221.7	92.2	581	262
				4	384.3	111.2	234.1	96.4	536	158
				Mean	454.7	117.7	222.6	91.7	572.3	187
11	Handweed Control			1	358.8	116.1	242.9	105.9	595	156
				2	524.4	126.3	226.9	92.4	575	214
				3	640.7	125.8	241.9	86.6	551	229
				4	430.9	116.9	230.9	94.6	588	177
				Mean	488.7	121.3	235.7	94.9	577.3	194

32.4 Appendix iii - Rating Scales

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	Heavy damage to total kill
7	30.1 - 45	
8	45.1 - 70	
9	70.1 - 100	

The EWRS (European Weed Research System) scale is based on comparison of the treated plots with the untreated control plot. The aim is to assess as accurately as possible the decrease in the natural number of plants per weed species (still visible in the untreated plot). This decrease in the weed population corresponds to the action of the product. The EWRS scale is logarithmic, the intervals decreasing as the action increases. This enables detailed assessment in the range of effective herbicide action.

Reference: Puntener W. 1981. Manual for Field Trials in Plant Protection. Second Edition. Ciba-Geigy Limited, Basle, Switzerland.

32.5 Appendix iv - Statistical Analysis

Analysis of Variance for sqrt(groundsel+0.5) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	8.72736	10	0.872736	4.85	0.0004
B:rep	3.13292	3	1.04431	5.80	0.0030
RESIDUAL	5.40176	30	0.180059		
TOTAL (CORRECTED)	17.262	43			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for sqrt(groundsel+0.5) by treatment

Method: 95.0 percent LSD

treatment	Count	LS Mean	Homogeneous Groups
3	4	0.836516	X
7	4	0.925615	X
1	4	1.05502	XX
5	4	1.12745	XX
2	4	1.18443	XX
4	4	1.38627	XX
8	4	1.55893	XX
10	4	1.62709	XX
6	4	1.63689	XX
9	4	2.04225	XX
12	4	2.32876	X

Appendix iv - Statistical Analysis (Cont.)

Analysis of Variance for dry weight - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	8288.37	8	1036.05	0.72	0.6722
B:rep	147.823	3	49.2744	0.03	0.9913
RESIDUAL	34533.9	24	1438.91		
TOTAL (CORRECTED)	42970.1	35			

All F-ratios are based on the residual mean square error.

FINAL REPORT

Evaluation of post-harvest herbicides for control of groundsel (*Senecio vulgaris* L.) and cleavers (*Galium aparine*) in pyrethrum

Kindred, Tasmania, 2004

Client: Botanical Resources Australia Pty Ltd

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33 Summary

At Kindred, North West Tasmania, in 2004 a trial was conducted to evaluate various herbicide regimes for control of Groundsel *(Senecio vulgaris)* and Cleavers *(Galium aparine)* in a post-harvest established pyrethrum crop. Experimental herbicides identified from earlier work were evaluated with currently used herbicides in a range of tank mixes and regimes. All herbicide treatments (1 to 10) consisted of an application in March and April, and treatments 1 to 7 also received an herbicide application in May.

Assessments for crop safety were conducted at 11 and 22 days after application timing 1 (DAAT1), 14 and 43DAAT2 and 22DAAT3. Assessments for weed efficacy were conducted at 14 and 43DAAT2, and 22, 117 and 179DAAT3. Groundsel and cleaver plant densities were assessed at 25DAAT2, and 35 and 117DAAT3.

Plots treated with Command 250 mL/ha + Brodal 300 mL/ha in March, Brodal 300 mL/ha in April and Raptor 45 g/ha in May showed severe crop damage symptoms at 22DAAT1, but recovered by 22DAAT3.
Command 250 mL/ha + Affinity 60 g/ha applied in March, followed by Command 250 mL/ha in April and May was safe to the crop at all assessments until 22DAAT3, when commercially unacceptable levels of crop damage were observed. Pledge applied in March followed by Command 250 + Affinity in April was unsafe to the crop at 22DAAT1 and 14DAAT2

All other treatments were safe to the crop at all assessment dates.

All treatments were effective at controlling groundsel at all assessment dates, with the exception of Brodal 300 mL/ha applied in March and April which did not effectively control cleaver or groundsel and cleavers.

Command at 350 mL/ha in a tank-mix with Affinity 60 g/ha and applied in March and April, followed by Raptor 45 g/ha in May, resulted in near complete control of groundsel and cleavers at each assessment date and performed better than Command at 250 mL/ha in the same herbicide regime.

34 Introduction

34.1 Aims

- To evaluate sequential applications of Command at 250 and 350 mL/ha applied alone and tank mixed with Affinity, Brodal or Frontier-p for crop safety and control of groundsel in post-harvest established pyrethrum crops
- To evaluate sequential applications of Brodal tank-mixed with Affinity for crop safety and control of groundsel in post-harvest established pyrethrum crops
- To evaluate the crop safety and efficacy of Goal WP and Pledge applied in a regime with Command + Affinity
- To evaluate the crop safety and efficacy of Raptor at the final application timing within various herbicide regimes

34.2 Target Weed

- Groundsel (*Senecio vulgaris*) SENVU
- Cleavers (*Galium aparine*) GALAP

35 Materials and Methods

35.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Command	clomazone	480 g/L	Emulsifiable Concentrate
Affinity 400 DF	carfentrazone-ethyl	400 g/kg	Wettable Granule
Brodal	diflufenican	500 g/L	Suspension Concentrate
Frontier-p	dimethenamid-p	720 g/L	Emulsifiable Concentrate
Goal WP	oxyflurofen	400 g/kg	Wettable Powder
Raptor WG	imazamox	700 g/kg	Wettable Granule
Pledge 500 WG	flumioxazin	500 g/L	Wettable Granule
BS 1000	alcohol alkoxylate	1000 g/L	Liquid

35.2 Treatment List

No.	Treatment (Product rate, mL or g/ha)		
	Application Timing 1 March	**Application Timing 2 April**	**Application Timing 3 May**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-
10	Brodal 300 mL	Brodal 300 mL	-
11	Hand weed control	-	-
12	Untreated control	-	-

35.3 Chronology of Events

Date	Days After Application Timing (DAAT#)	Crop Stage	Event
01/03/04	0DAAT1	10 - 20 cm rosette	Applied March herbicide treatments 1-10
12/03/04	11DAAT1		Crop safety assessment 1
23/03/04	22DAAT1		Crop safety assessment 2
12/04/04	42DAAT1	30 cm rosette	Applied April herbicide treatments 1-10
26/04/04	14DAAT2		Crop safety assessment 3, weed efficacy assessment 1
07/05/04	25DAAT2		Weed density assessment 1
25/05/04	43DAAT2		Crop safety assessment 4, weed efficacy assessment 2
27/05/04	45DAAT2	30 cm rosette	Applied May herbicide treatments 1-7
18/06/04	22DAAT3		Crop safety assessment 5 and weed efficacy assessment 3
01/07/04	35DAAT3		Weed density assessment 2
21/09/04	117DAAT3		Weed density assessment 3 and weed efficacy assessment 4. Hand weeded treatment 11 plots
22/11/04	179DAAT3		Weed efficacy assessment 5

36 Results and Discussion

36.1 Table 1 - Crop safety at 11 days after application 1 (11DAAT1), 22DAAT1, 14DAAT2 and 22DAAT3

No.	Treatment (product rate, mL or g/ha)			Mean EWRS Rating for crop tolerance				
	March	April	May	12/03/04 11DAAT1	23/03/04 22DAAT1	26/04/04 14DAAT2	25/05/04 43DAAT2	18/06/04 22DAAT3
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.8	2.8	2.5	2.8	3.0
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	3.0	2.5	2.5	3.0	3.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	2.8	2.5	3.0	2.8	5.0
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	3.0	2.5	2.0	2.8	3.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	2.0	4.3	2.8	2.8	3.5
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.3	2.5	2.3	3.0	3.0
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.3	2.0	2.3	2.5	3.3
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-	2.0	2.0	1.8	2.5	2.3
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	4.3	5.0	5.3	4.5	4.3
10	Brodal 300 mL	Brodal 300 mL	-	2.0	2.3	2.8	2.3	2.3
11	Handweed Control			1.0	1.0	-	1.0	-
12	Untreated Control			1.0	1.0	1.0	1.0	-

Pledge applied in March followed by Command 250 mL + Affinity 60 g in April was unsafe to the crop at 22DAAT1 and 14DAAT2, however, the level of crop damage reduced over time and was commercially acceptable by 67 days after Command + Affinity was applied.
Plots treated with Command 250 mL + Brodal 300 mL in March showed severe crop damage symptoms at 22DAAT1. This was followed by Brodal in April and Raptor in May, and although the symptoms on the crop were still recognisable, they were milder and commercially acceptable by 22DAAT3.
Command 250 mL + Affinity 60 g applied in March, followed by Command 250 mL in April and May was safe to the crop at all assessments until 22 days after the second application of Command (22DAAT2), when commercially unacceptable levels of crop damage were observed.

All other treatments were safe to the crop at all assessment dates.

36.2 Table 2 - Weed efficacy at 14DAAT2, 43DAAT2, 22DAAT3 and 117DAAT3

No.	Treatment (product rate, mL or g/ha)			Mean EWRS Rating* for SENVU control			
	March	April	May	26/04/04 14DAAT2	25/05/04 43DAAT2	18/06/04 22DAAT3	21/09/04 117DAAT3
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.3	2.0	2.0	3.5
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.0	1.3	1.3	2.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1.3	1.8	1.8	2.5
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	2.0	2.0	1.8	3.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	1.3	1.0	1.0	2.0
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.0	1.0	1.0	2.8
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.0	1.0	1.0	1.5
8	Goal WP 500	Command 250 mL + Affinity 60 g	-	1.0	1.5	1.8	2.5
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	1.0	1.8	3.3	3.3
10	Brodal 300 mL	Brodal 300 mL	-	4.8	3.5	4.8	5.3
12	Untreated control			9.0	9.0	9.0	9.0
12	Untreated control – Estimated weed density (plants per m^2)			6.5	11.5	Not assessed	Not assessed

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

All treatments were effective at controlling groundsel at all assessment dates, with the exception of Brodal applied in March and April (Table 2). Command at 350 mL/ha in a tank-mix with Affinity and applied in March and April, followed by Raptor in May, resulted in near complete control of groundsel at each assessment date and performed better than Command at 250 mL/ha in the same herbicide regime.

There was a significant treatment effect on mean number of groundsel plants per m^2 at 35DAAT3 (Table 3). All treatments reduced the number of groundsel plants compared to the untreated control. Command 350 + Affinity applied in March and April, followed by Raptor in May resulted in a significantly greater reduction in groundsel plants compared to Command at 250 mL/ha in the same herbicide regime. Treatments 2, 5, 6 and 7 reduced the mean number of groundsel plants to between 0.3 and 1 compared to 42 in the untreated control. Brodal, applied in March and April, was least effective at reducing the number of groundsel plants.

36.3 Table 3 - Weed SENVU density at 25DAAT2, 35DAAT3 and 117DAAT3

No.	Treatment (product rate, mL or g/ha)			Mean number groundsel/m^2			
	March	April	May	07/05/04 25DAAT2	01/07/04 35DAAT3		21/09/04 117DAAT3
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	3.8	7.0	bc	11.3
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.5	0.3	a	6.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	12.0	1.7	ab	6.7
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	14.5	10.7	bc	10.0
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	2.8	0.3	a	3.3
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.3	1.0	a	5.3
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	2.3	0.3	a	5.0
8	Goal WP 500 g	Command 250 mL + Affinity 60 g	-	1.5	4.0	ab	7.7
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	1.8	4.0	bc	7.0
10	Brodal 300 mL	Brodal 300 mL	-	10.8	20.7	c	16.0
12	Untreated control			24.0	42.0	d	14.0
p-value				0.0908	0.00		0.1354
LSD (5% level)				-	1.08894		-

36.4 Table 4 - Weed efficacy at 14DAAT2, 43DAAT2, 22DAAT3, 117DAAT3 and 179DAAT3

No.	Treatment (product rate, mL or g/ha)			Mean EWRS Rating for GALAP control				
	March	April	May	26/04/04 14DAAT2	25/05/04 43DAAT2	18/06/04 22DAAT3	21/09/04 117DAAT3	22/11/04 179DAAT3
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.3	1.8	1.8	3.3	5.3
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.0	1.0	1.0	1.3	2.5
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1.3	2.0	1.8	2.0	3.8
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	2.8	2.0	1.0	1.0	1.3
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	1.3	1.0	1.0	1.0	1.8
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.8	2.0	1.0	3.0	3.5
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	1.3	2.0	1.0	2.0	4.3
8	Goal WP 500g	Command 250 mL + Affinity 60 g	-	1.3	1.5	2.0	2.8	5.8
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	1.5	2.8	3.0	3.5	3.8
10	Brodal 300 mL	Brodal 300 mL	-	5.0	4.5	3.5	5.8	5.8
12	Untreated control			9.0	9.0	9.0	9.0	9.0
12	Untreated control – Estimated weed density (plants per m^2)			31.3	Not assessed	Not assessed	Not assessed	Not assessed

GALAP – Cleavers

Brodal applied alone in March and April did not give a commercially acceptable level of weed control at any of the assessment dates (Table 4). Treatments 2, 3, 4, 5, 6, 7 and 9 controlled cleavers for the duration of the trial and treatments 1 and 8 were effective at controlling cleavers until 117DAAT3, but did not provide adequate control of cleavers at the final assessment (179DAAT3).

Weed density assessments revealed that there was a significant treatment effect on mean number of cleavers per 4 m length of row at 25DAAT2 and mean number of cleavers per m^2 at 35DAAT3 and 117DAAT3 (Table 5). At 25DAAT2, all treatments significantly reduced the mean number of cleavers compared to the untreated control with the exception of treatments 3, 4 and 10. At 35DAAT3, all treatments except for Pledge applied in March followed by Command + Affinity in April, significantly reduced the mean number of cleavers compared to the control. Treatments that incorporated Brodal for at least the first two application timings (treatments 4 and 5), Command 350 for the first and second application timings (treatment 2) and Command 250 for all three application timings (treatment 3) recorded the lowest weed density at 35DAAT3. Treatments 2, 4 and 5 remained the most effective treatments at 117DAAT3, resulting in 14, 1 and 5 mean plants per m^2 respectively compared to 210 in the control.

36.5 Table 5 - Weed density GALAP at 25DAAT2, 35DAAT3 and 117DAAT3

No.	Treatment (product rate, mL or g/ha)			Mean number cleavers/m^2					
	March	April	May	7/05/04 25DAAT2		01/07/04 35DAAT3		21/09/04 117DAAT3	
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	21.8	ab	6.3	bc	36.7	bcd
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	5.8	a	2.7	ab	14.3	abc
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	27.3	bc	1.0	a	50.0	cd
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	62.0	bc	0.0	a	1.3	a
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS 1000 200 mL/100 L	25.8	a	0.3	a	5.0	ab
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	34.0	a	9.0	bc	93.3	d
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS 1000 200 mL/100 L	42.0	a	14.3	c	71.7	d
8	Goal WP 500	Command 250 mL + Affinity 60 g	-	12.0	a	20.7	cd	75.0	d
9	Pledge 200 g	Command 250 mL + Affinity 60 g	-	49.0	a	59.0	de	83.3	d
10	Brodal 300 mL	Brodal 300 mL	-	33.8	bc	9.0	c	58.3	d
12	Untreated control			77.8	c	91.3	e	210.0	e
p-value				0.0007		0.00		0.00	
LSD (5% level)				1.09194		1.2644		2.00751	

37 Conclusions

- Pledge applied in March followed by Command 250 + Affinity in April was unsafe to the crop at 22DAAT1 and 14DAAT2
- Plots treated with Command 250 + Brodal in March, Brodal in April and Raptor in May showed severe crop damage symptoms at 22DAAT1, but recovered by 22DAAT3.
- Command 250 + Affinity applied in March, followed by Command 250 in April and May was safe to the crop at all assessments until 22DAAT3, when commercially unacceptable levels of crop damage were observed.
- All other treatments were safe to the crop at all assessment dates.
- All treatments were effective at controlling groundsel at all assessment dates, with the exception of Brodal applied alone in March and April.
- Command at 350 mL/ha in a tank-mix with Affinity and applied in March and April, followed by Raptor in May, resulted in near complete control of groundsel at each assessment date and performed better than Command at 250 mL/ha in the same herbicide regime.
- Brodal applied alone in March and April did not give a commercially acceptable level of control of cleavers at any of the assessment dates.
- Treatments 2, 3, 4, 5, 6, 7 and 9 controlled cleavers for the duration of the trial and treatments 1 and 8 were effective at controlling cleavers until 117DAAT3, but did not provide adequate control of cleavers at the final assessment (179DAAT3).
- At 25DAAT2, all treatments significantly reduced the mean number of cleavers compared to the untreated control with the exception of treatments 3, 4 and 10. At 35DAAT3, all treatments except for Pledge applied in March followed by Command + Affinity in April, significantly reduced the mean number of cleavers compared to the control.
- Treatments that incorporated Brodal for at least the first two application timings (treatments 4 and 5), Command 350 for the first and second application timings (treatment 2) and Command 250 for all three application timings (treatment 3) recorded the lowest weed density at 35DAAT3 and treatments 2, 4 and 5 remained the most effective treatments at 117DAAT3.

38 Appendices

38.1 Appendix i - Trial Details

38.1.1 Site Details

Grower	Andrew Johnson
Location	Kindred, Tasmania
Soil Type	Ferrosol
Crop	Pyrethrum
Trial Design	Randomised complete block
Replications	4
Plot Size	2 m x 7 m

38.1.2 Trial Plan

10	5	2	6	3	8	4	7	12	11	1	9	**Block 4**
1	7	8	9	12	2	11	6	10	3	5	4	**Block 3**
12	10	7	11	4	9	5	8	1	6	2	3	**Block 2**
2	9	4	1	5	10	7	12	3	11	8	6	**Block 1**

↗N

38.1.3 Application Details

Application Equipment			
Equipment	CO2 pressurised precision knapsack sprayer		
Nozzles	4 X Spraying Systems DG8002 fan jets		
Volume	230 L/ha		
Pressure	280 kPa		
Method	Walked at 1 m/sec		
Treatment Applications			
Application Number	1	2	3
Date	01/03/04	12/04/04	27/05/04
Time	12:00 PM	8:00 AM	10:30 AM
Treatments Applied	1 - 10	1 - 10	1 - 7
Temperature (^{O}C)	19	12.4	8.8
Relative Humidity (%)	41	83	62
Cloud Cover (%)	0	0	20
Wind Direction	NE	-	-
Wind Speed (km/h)	0 - 4	Calm	Calm
Soil Moisture	Dry	Wet	Moist
Weed Growth Stage	Nil weeds present	SENVU cotyledon GALAP cotyledon	SENVU cot - 2 leaf, GALAP cot - 2 leaf,
Crop Stage	10 - 20 cm rosette	30 cm rosette	30 cm rosette
Photographs	Yes	No	Yes

SENVU – Groundsel
GALAP – Cleavers

Meteorological data from Forthside Vegetable Research Station (FVRS) for the months of March to November is included as Appendix v to this report. The trial site was situated approximately 20 km from FVRS.

Assessments

1. Crop Safety Assessment					
Dates	12/03/04	23/03/04	26/04/04	25/05/04	18/06/04
Days After Application	11DAAT1	22DAAT1	14DAAT2	43DAAT2	22DAAT3
Sample Size	Whole plot				
Method	Visual assessment				
Rating Scale	EWRS for crop tolerance - Appendix iii				

2. Weed Control Assessments					
Dates	26/04/04	25/05/04	18/06/04	21/09/04	22/11/04
Days After Application	14DAAT2	43DAAT2	22DAAT3	117DAAT3	179DAAT3
Sample Size	Whole plot				
Method	Visual assessment				
Rating Scale	EWRS for weed control - Appendix iii				

3. Weed Density Assessments			
Dates	07/05/04	01/07/04	21/09/04
Days After Application	25DAAT2	35DAAT3	117DAAT3
Sample Size	07/05/04 4 0.25m2 quadrats per plot 01/07/04 Quadrat size for treated plots = 50 cm x 50 cm, Quadrat size for control plots = 50 cm x 25 cm 21/09/04 Quadrat size = 50 cm x 50 cm		
Method	Counted number of plants		
Statistical Analysis	Appendix iv		

38.2 Appendix ii - Raw Data

38.2.1.1 Crop Safety Assessments

Treatment					EWRS Rating for crop safety				
No.	March	April	May	**Rep**	**12/03/04**	**23/03/04**	**26/04/04**	**25/05/04**	**18/06/04**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	3	2	3	3	3
				2	3	4	2	3	3
				3	3	3	3	3	3
				4	2	2	2	2	3
				Mean	2.8	2.8	2.5	2.8	3.0
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	3	2	3	4	3
				2	3	3	3	3	4
				3	3	3	2	3	3
				4	3	2	2	2	3
				Mean	3.0	2.5	2.5	3.0	3.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	3	3	3	3	5
				2	3	2	3	3	5
				3	2	3	3	3	5
				4	3	2	3	2	5
				Mean	2.8	2.5	3.0	2.8	5.0
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	Brodal 300 mL	1	3	2	2	3	4
				2	3	3	2	2	3
				3	3	3	2	3	3
				4	3	2	2	3	4
				Mean	3.0	2.5	2.0	2.8	3.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	2	4	2	2	3
				2	2	5	3	3	3
				3	2	4	3	3	3
				4	2	4	3	3	5
				Mean	2.0	4.3	2.8	2.8	3.5
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	3	3	3	3
				2	3	3	2	3	3
				3	2	2	2	3	3
				4	2	2	2	3	3
				Mean	2.3	2.5	2.3	3.0	3.0
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	2	2	2	4
				2	1	2	3	3	3
				3	1	2	2	3	3
				4	1	2	2	2	3
				Mean	1.3	2.0	2.3	2.5	3.3
8	Goal WP 500 g	Brodal 300 mL + Affinity 60 g		1	2	2	2	3	3
				2	2	2	1	2	2
				3	2	2	2	2	2
				4	2	2	2	3	2
				Mean	2.0	2.0	1.8	2.5	2.3
9	Pledge 200 g	Pledge 200 g + Command 250 mL		1	4	5	5	5	4
				2	4	5	5	3	4
				3	4	5	5	4	4
				4	5	5	6	6	5
				Mean	4.3	5.0	5.3	4.5	4.3
10	Brodal 300 mL	Brodal 300 mL		1	2	2	2	2	3
				2	2	3	3	2	2
				3	2	2	3	2	2
				4	2	2	3	3	2
				Mean	2.0	2.3	2.8	2.3	2.3
11	Handweed Control			1	1	1		1	
				2	1	1		1	
				3	1	1		1	
				4	1	1		1	
				Mean	1.0	1.0		1.0	
12	Untreated Control			1	1	1	1	1	
				2	1	1	1	1	
				3	1	1	1	1	
				4	1	1	1	1	
				Mean	1.0	1.0	1.0	1.0	

38.2.1.2 Appendix ii - Raw Data (Cont.)

38.2.1.3 Weed Efficacy Assessments

Treatment					EWRS Rating for weed control								
					26/04/04		25/05/04		18/06/04		21/09/04		22/11/04
No.	March	April	May	Rep	SENVU	GALAP	SENVU	GALAP	SENVU	GALAP	SENVU	GALAP	GALAP
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	2	5	3	5	4	6	4	6
				2	1	1	1	1	1	1	4	3	5
				3	1	1	1	1	1	1	2	2	5
				4	1	1	1	2	1	1	2	4	5
				Mean	1.3	1.3	2.0	1.8	2.0	1.8	3.5	3.3	5.3
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	1	1	2	1	2	1	3	2	2
				2	1	1	1	1	1	1	2	1	1
				3	1	1	1	1	1	1	2	1	3
				4	1	1	1	1	1	1	2	1	4
				Mean	1.0	1.0	1.3	1.0	1.3	1.0	2.3	1.3	2.5
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	2	2	4	5	4	4	4	4	7
				2	1	1	1	1	1	1	2	1	1
				3	1	1	1	1	1	1	2	2	4
				4	1	1	1	1	1	1	2	1	3
				Mean	1.3	1.3	1.8	2.0	1.8	1.8	2.5	2	3.8
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	Brodal 300 mL	1	5	4	5	3	1	1	5	1	1
				2	1	4	1	1	4	1	4	1	2
				3	1	2	1	3	1	1	2	1	1
				4	1	1	1	1	1	1	3	1	1
				Mean	2.0	2.8	2.0	2.0	1.8	1.0	3.5	1	1.3
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	2	1	1	1	1	1	3	1	4
				2	1	2	1	1	1	1	2	1	1
				3	1	1	1	1	1	1	2	1	1
				4	1	1	1	1	1	1	1	1	1
				Mean	1.3	1.3	1.0	1.0	1.0	1.0	2.0	1	1.8
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	1	1	1	1	1	1	2	1	3
				2	1	1	1	1	1	1	3	3	3
				3	1	1	1	2	1	1	3	5	3
				4	1	4	1	4	1	1	3	3	5
				Mean	1.0	1.8	1.0	2.0	1.0	1.0	2.8	3	3.5
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	1	1	1	2	1	1	2	1	5
				2	1	2	1	1	1	1	2	2	5
				3	1	1	1	1	1	1	1	1	4
				4	1	1	1	4	1	1	1	4	3
				Mean	1.0	1.3	1.0	2.0	1.0	1.0	1.5	2	4.3
8	Goal WP 500 g	Brodal 300 mL + Affinity 60 g		1	1	1	1	1	3	2	3	2	5
				2	1	1	2	2	1	3	3	3	7
				3	1	2	1	2	2	2	1	3	6
				4	1	1	2	1	1	1	3	3	5
				Mean	1.0	1.3	1.5	1.5	1.8	2.0	2.5	2.8	5.8
9	Pledge 200 g	Pledge 200 g + Command 250 mL		1	1	2	1	2	2	1	4	3	2
				2	1	1	1	1	2	1	3	2	3
				3	1	1	4	4	5	5	4	4	4
				4	1	2	1	4	4	5	2	5	6
				Mean	1.0	1.5	1.8	2.8	3.3	3.0	3.3	3.5	3.8
10	Brodal 300 mL	Brodal 300 mL		1	7	6	6	5	6	4	7	7	6
				2	4	5	3	5	4	3	5	5	6
				3	1	4	1	3	4	4	5	5	5
				4	7	5	4	5	5	3	4	6	6
				Mean	4.8	5.0	3.5	4.5	4.8	3.5	5.3	5.8	5.8
12	Untreated Control			1	15	40	15				9	9	9
				2	5	30	10				9	9	9
				3	5	30	20				9	9	9
				4	1	25	1				9	9	9
				Mean	6.5	31.3	11.5				9.0	9	9.0

Appendix ii - Raw Data (Cont.)

38.3.1.1 Weed Density Assessment 1 (07/05/04)

Treatment					1m length of row		1m length of row		1m length of row		1m length of row	
No.	March	April	May	**Rep**	**GALAP**	**SENVU**	**GALAP**	**SENVU**	**GALAP**	**SENVU**	**GALAP**	**SENVU**
1	Command 250 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	14	0	4	3	2	0	4	2
				2	1	2	2	0	6	0	1	2
				3	11	1	11	2	2	0	10	0
				4	13	1	0	0	5	2	1	0
				Mean	9.8	1.0	4.3	1.3	3.8	0.5	4.0	1.0
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + Wetter	1	2	1	0	1	7	0	3	2
				2	0	0	1	0	0	1	0	0
				3	1	0	0	1	2	0	5	0
				4	0	0	1	0	1	0	0	0
				Mean	0.8	0.3	0.5	0.5	2.5	0.3	2.0	0.5
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	1	5	13	4	4	9	25	5
				2	1	1	1	0	5	10	5	0
				3	25	0	6	0	9	8	1	2
				4	4	1	4	1	5	0	0	2
				Mean	7.8	1.8	6.0	1.3	5.8	6.8	7.8	2.3
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	Brodal 300 mL	1	4	19	20	8	9	1	33	8
				2	26	3	40	6	45	2	13	0
				3	2	1	4	0	4	0	44	1
				4	0	1	1	1	1	3	2	4
				Mean	8.0	6.0	16.3	3.8	14.8	1.5	23.0	3.3
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + Wetter	1	35	3	4	0	0	0	3	0
				2	1	0	5	0	1	0	0	0
				3	0	2	4	0	1	0	0	0
				4	5	1	22	1	18	3	4	1
				Mean	10.3	1.5	8.8	0.3	5.0	0.8	1.8	0.3
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	0	1	1	0	0	0	6	0
				2	14	0	0	1	11	2	0	1
				3	4	1	1	2	0	0	0	0
				4	85	0	4	1	6	0	4	0
				Mean	25.8	0.5	1.5	1.0	4.3	0.5	2.5	0.3
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + Wetter	1	17	0	9	0	16	0	3	0
				2	14	1	17	0	10	0	3	0
				3	5	0	4	0	25	2	12	1
				4	0	0	1	0	1	2	31	3
				Mean	9.0	0.3	7.8	0.0	13.0	1.0	12.3	1.0
8	Goal WP 500 g	Brodal 300 mL + Affinity 60 g		1	1	1	3	0	1	1	2	2
				2	0	0	0	0	2	0	1	0
				3	4	0	17	0	3	0	10	1
				4	2	0	1	1	1	0	0	0
				Mean	1.8	0.3	5.3	0.3	1.8	0.3	3.3	0.8
9	Pledge 200 g	Pledge 200 g + Command 250 mL		1	0	0	2	1	3	0	2	4
				2	1	0	1	0	2	1	1	1
				3	1	0	2	0	2	0	52	0
				4	21	0	66	0	20	0	20	0
				Mean	5.8	0.0	17.8	0.3	6.8	0.3	18.8	1.3
10	Brodal 300 mL	Brodal 300 mL		1	8	9	13	1	7	3	10	6
				2	0	2	17	5	5	1	43	2
				3	1	2	3	0	5	1	1	1
				4	12	1	3	0	4	7	3	2
				Mean	5.3	3.5	9.0	1.5	5.3	3.0	14.3	2.8
12	Untreated Control			1	5	5	60	5	108	8	5	10
				2	16	8	25	12	18	12	14	3
				3	3	3	0	10	8	2	25	17
				4	3	0	4	0	3	1	14	0
				Mean	6.8	4.0	22.3	6.8	34.3	5.8	14.5	7.5

Appendix ii - Raw Data (Cont.)

38.3.1.2 Weed Density Assessment 2 (01/07/04)

Treatment					Quadrat 1		Quadrat 2		Quadrat 3	
No.	**March**	**April**	**May**	**Rep**	**SENVU**	**GALAP**	**SENVU**	**GALAP**	**SENVU**	**GALAP**
1	Command 250 mL + Affinity 60 g	Command) 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	8	2	0	7	8	0
				2	0	0	1	1	1	0
				3	0	1	3	3	0	1
				4	0	2	0	1	0	1
				Mean	2.0	1.3	1.0	3.0	2.3	0.5
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	1	0	0	2	0	0
				2	0	0	0	0	0	0
				3	0	0	0	0	0	0
				4	0	1	0	0	0	5
				Mean	0.3	0.3	0.0	0.5	0.0	1.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	2	0	2	0	0	3
				2	0	0	0	0	0	0
				3	1	0	0	0	0	0
				4	0	0	0	0	0	0
				Mean	0.8	0.0	0.5	0.0	0.0	0.8
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	1	2	0	1	0	24	0
				2	3	0	1	0	0	0
				3	0	0	0	0	0	0
				4	0	0	1	0	0	0
				Mean	1.3	0.0	1.0	0.0	6.0	0.0
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS1000 200 mL/100 L	1	0	0	0	1	0	0
				2	0	0	0	0	1	0
				3	0	0	0	0	0	0
				4	0	0	0	0	0	0
				Mean	0.0	0.0	0.0	0.3	0.3	0.0
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	0	0	0	1	0	0
				2	0	0	0	0	0	2
				3	3	5	0	5	0	8
				4	0	0	0	5	0	1
				Mean	0.8	1.3	0.0	2.8	0.0	2.8
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	1	4	0	4	0	0
				2	0	4	0	5	0	2
				3	0	0	0	0	0	0
				4	0	4	0	2	0	18
				Mean	0.3	3.0	0.0	2.8	0.0	5.0
8	Goal WP 500 g	Command 250 mL + Affinity 60 g		1	1	2	4	2	1	2
				2	1	13	2	5	2	8
				3	0	3	0	15	0	5
				4	0	3	0	2	1	2
				Mean	0.5	5.3	1.5	6.0	1.0	4.3
9	Pledge 200 g	Command 250 mL + Affinity 60 g		1	2	5	0	4	1	0
				2	2	5	1	3	0	1
				3	0	14	1	25	3	13
				4	0	48	0	40	2	19
				Mean	1.0	18.0	0.5	18.0	1.5	8.3
10	Brodal 300 mL	Brodal 300 mL		1	31	0	4	3	14	8
				2	1	4	4	1	2	0
				3	0	4	3	2	1	1
				4	1	1	1	2	0	1
				Mean	8.3	2.3	3.0	2.0	4.3	2.5
12	Untreated Control			1	3	27	3	12	11	8
				2	9	4	4	23	9	5
				3	6	5	12	5	3	4
				4	1	7	0	32	2	5
				Mean	4.8	10.8	4.8	18.0	6.3	5.5

Appendix ii - Raw Data (Cont.)

38.3.1.3 Weed Density Assessment 3 (21/09/04)

Treatment					Quadrat 1		Quadrat 2		Quadrat 3	
No.	March	April	May	**Rep**	**SENVU**	**GALAP**	**SENVU**	**GALAP**	**SENVU**	**GALAP**
1	Command 250 mL + Affinity 60 g	Command) 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	12	5	4	5	1	10
				2	1	0	2	35	2	15
				3	2	5	2	5	3	0
				4	1	10	3	15	1	5
				Mean	4.0	5.0	2.8	15.0	1.8	7.5
2	Command 350 mL + Affinity 60 g	Command 350 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	2	5	6	5	1	0
				2	0	0	0	0	1	0
				3	2	2	4	0	1	1
				4	1	20	1	10	0	0
				Mean	1.3	6.8	2.8	3.8	0.8	0.3
3	Command 250 mL + Affinity 60 g	Command 250 mL	Command 250 mL	1	6	40	4	10	4	5
				2	1	5	1	0	0	5
				3	1	0	0	55	0	5
				4	0	5	0	10	3	10
				Mean	2.0	12.5	1.3	18.8	1.8	6.3
4	Brodal 300 mL + Affinity 60 g	Brodal 300 mL + Affinity 60 g	Brodal 300 mL	1	1	2	8	0	10	0
				2	2	0	2	0	3	0
				3	0	0	0	0	0	2
				4	1	0	2	0	1	0
				Mean	1.0	0.5	3.0	0.0	3.5	0.5
5	Command 250 mL + Brodal 300 mL	Brodal 300 mL	Raptor 45 g + BS1000 200 mL/100 L	1	2	5	2	5	2	5
				2	0	0	2	0	0	0
				3	0	0	0	0	2	0
				4	0	0	0	0	0	0
				Mean	0.5	1.3	1.0	1.3	1.0	1.3
6	Brodal 300 mL + Affinity 60 g	Command 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	0	5	1	5	0	0
				2	2	5	2	0	0	10
				3	2	60	1	30	0	50
				4	2	40	5	55	1	20
				Mean	1.5	27.5	2.3	22.5	0.3	20.0
7	Command 250 mL + Frontier-p 2 L	Command 250 mL + Affinity 60 g	Raptor 45 g + BS1000 200 mL/100 L	1	2	30	1	5	2	5
				2	1	15	0	10	6	15
				3	1	0	0	10	2	20
				4	0	35	0	0	0	70
				Mean	1.0	20.0	0.3	6.3	2.5	27.5
8	Goal WP 500 g	Command 250 mL + Affinity 60 g		1	1	10	4	15	3	20
				2	4	5	2	45	3	45
				3	0	30	0	20	0	15
				4	0	10	3	5	3	5
				Mean	1.3	13.8	2.3	21.3	2.3	21.3
9	Pledge 200 g	Command 250 mL + Affinity 60 g		1	3	10	3	5	1	5
				2	2	5	3	20	2	0
				3	1	20	2	10	4	15
				4	0	90	0	20	0	50
				Mean	1.5	31.3	2.0	13.8	1.8	17.5
10	Brodal 300 mL	Brodal 300 mL		1	12	0	4	50	6	5
				2	6	5	4	10	3	10
				3	0	45	3	15	1	0
				4	0	10	6	0	3	25
				Mean	4.5	15.0	4.3	18.8	3.3	10.0
12	Untreated Control			1	6	95	1	80	3	50
				2	2	80	8	60	7	30
				3	3	20	4	25	5	40
				4	2	45	1	55	0	50
				Mean	3.3	60.0	3.5	55.0	3.8	42.5

38.4 Appendix iii - Rating Scales

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

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	Heavy damage to total kill
7	30.1 - 45	
8	45.1 - 70	
9	70.1 - 100	

The EWRS (European Weed Research System) scale is based on comparison of the treated plots with the untreated control plot. The aim is to assess as accurately as possible the decrease in the natural number of plants per weed species (still visible in the untreated plot). This decrease in the weed population corresponds to the action of the product. The EWRS scale is logarithmic, the intervals decreasing as the action increases. This enables detailed assessment in the range of effective herbicide action.

Reference: Puntener W. 1981. Manual for Field Trials in Plant Protection. Second Edition. Ciba-Geigy Limited, Basle, Switzerland.

38.5 Appendix iv - Statistical Analysis

Analysis of Variance for log(assess 4 SENVU+1) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	19.5071	10	1.95071	1.87	0.0908
B:rep	1.28958	3	0.429859	0.41	0.7459
RESIDUAL	31.3381	30	1.0446		
TOTAL (CORRECTED)	52.1348	43			

All F-ratios are based on the residual mean square error.

Analysis of Variance for log(assess 4 GALAP+1) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	25.2159	10	2.52159	4.41	0.0007
B:rep	3.69228	3	1.23076	2.15	0.1144
RESIDUAL	17.1521	30	0.571736		
TOTAL (CORRECTED)	46.0603	43			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for log(assess 4 GALAP+1) by treatment

Method: 95.0 percent LSD

treatment	Count	LS Mean	Homogeneous Groups
9	4	0.722593	X
8	4	0.748933	X
2	4	0.748933	X
7	4	0.9678	X
6	4	1.09551	X
5	4	1.1077	X
1	4	1.54345	XX
10	4	2.35024	XX
4	4	2.37426	XX
3	4	2.41757	XX
12	4	2.78512	X

Analysis of Variance for log(assess 7 GALAP+1) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	80.694	10	8.0694	10.53	0.0000
B:rep	2.1126	3	0.704201	0.92	0.4437
RESIDUAL	22.9979	30	0.766596		
TOTAL (CORRECTED)	105.804	43			

All F-ratios are based on the residual mean square error.

Appendix iv - Statistical Analysis (Cont.)

Multiple Range Tests for log(assess 7 GALAP+1) by treatment

Method: 95.0 percent LSD

treatment	Count	LS Mean	Homogeneous Groups
4	4	0.0	X
5	4	0.208227	X
3	4	0.402359	X
2	4	0.876389	XX
1	4	1.81991	XX
6	4	1.88934	XX
7	4	2.17744	X
10	4	2.24189	X
8	4	2.89021	XX
9	4	3.5876	XX
12	4	4.42879	X

Appendix iv - Statistical Analysis (Cont.)

Analysis of Variance for log(assess7 SENVU+1) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	44.8468	10	4.48468	7.89	0.0000
B:rep	11.4334	3	3.81112	6.70	0.0013
RESIDUAL	17.0581	30	0.568604		
TOTAL (CORRECTED)	73.3383	43			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for log(assess7 SENVU+1) by treatment

Method: 95.0 percent LSD

treatment	Count	LS Mean	Homogeneous Groups
7	4	0.208227	X
5	4	0.208227	X
2	4	0.208227	X
6	4	0.402359	X
3	4	0.668365	XX
8	4	1.26784	XX
1	4	1.50559	XX
4	4	1.57109	XX
9	4	1.59194	XX
10	4	2.4188	X
12	4	3.54119	X

Appendix iv - Statistical Analysis (Cont.)

Analysis of Variance for sqrt(assess 8 per cent GALAP+0.5) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	126.176	10	12.6176	6.53	0.0000
B:rep	4.7888	3	1.59627	0.83	0.4899
RESIDUAL	57.9748	30	1.93249		
TOTAL (CORRECTED)	188.94	43			

All F-ratios are based on the residual mean square error.

Appendix iv - Statistical Analysis (Cont.)

Multiple Range Tests for sqrt(assess 8 per cent GALAP+0.5) by treatment

Method: 95.0 percent LSD

treatment	Count	LS Mean	Homogeneous Groups
4	4	0.901276	X
5	4	1.11663	XX
2	4	1.7804	XXX
1	4	3.00507	XXX
3	4	3.44486	XX
10	4	3.83073	X
7	4	4.15706	X
9	4	4.2304	X
8	4	4.25162	X
6	4	4.34844	X
12	4	7.18126	X

Appendix iv - Statistical Analysis (Cont.)

Analysis of Variance for sqrt(assess 8 SENVU+0.5) - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:treatment	17.0218	10	1.70218	1.67	0.1354
B:rep	17.1995	3	5.73316	5.62	0.0035
RESIDUAL	30.6269	30	1.0209		
TOTAL (CORRECTED)	64.8482	43			

All F-ratios are based on the residual mean square error.

39 Photographs

38.5.1.1.1 Photograph 1 – Untreated Control

38.5.1.1.2 Photograph 2 – Treatment 1 Command 250 mL/ha + Affinity 60 g/ha (x 2 applications March and April) followed by Raptor 45 g/ha.

FINAL REPORT

Management of weed escapes following pyrethrum

Client: Botanical Resources Australia Pty Ltd

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Report Number: BRA03134#1

Report Date: 10 August 2004

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39 Summary

The following review covers some issues relating to the management of groundsel, cleavers, ryegrass, burr chervil and knotted hedge parsley, which are common weed problems in ex pyrethrum crops. This review has focused on the biology of the individual weeds and how this relates to their management and also includes information on suitable crops, which can be grown in which these weeds can be managed either culturally, physically or with herbicides. With research currently being conducted on improved weed management practices in pyrethrum crops, weeds in following crops will become less of an issue in the future.

The information listed on herbicide registrations is a guide only. It is essential to consult herbicide labels for crop registration and use rates etc. Also, some of the weeds described here are not listed on the herbicide label, however trial work has shown that the herbicide does have some activity on the weed. The level of weed control with the listed herbicide will vary depending on a number of factors. Timeliness of herbicide application is also important as weeds such as groundsel and cleavers are difficult to control once they become too large.

Groundsel

- Seed is dispersed by wind, so control of groundsel in surrounding areas such as fence lines is important.
- Seed survives in soil for two years, so intensive management in two years following pyrethrum should significantly reduce seed bank.
- Fallow ground in autumn following pyrethrum termination.
- Plant crops such as potatoes, beans and cereals or pasture where groundsel can be managed.

Burr Chervil

- Germination occurs mid autumn to early winter, so growing spring/summer crops will provide cultural control.
- Intensive management of this weed will be required for a two to three year period to reduce seedbank.
- Crops including peas, potatoes, cereals and pasture have herbicides registered for control of burr chervil.

Knotted Hedge Parsley

- No seed dormancy and the seed bank is non-persistent so intensive management in the first year should significantly reduce the impact of this weed. Higher temperatures favour germination.
- Knotted hedge parsley doesn't occur on any herbicide labels, however, research has shown that herbicides currently registered in cereals, pasture, potatoes, beans, poppies and pumpkins control knotted hedge parsley

Summary (Cont.)

Ryegrass

- On mainland Australia the main species of ryegrass, which occurs as a weed in annual crops, is *L rigidum* or annual ryegrass. Annual ryegrass populations on mainland Australia have commonly developed resistance to a range of herbicides which are used for its control.

- In pyrethrum crops a range of different ryegrass species have been identified including *L. rigidum* (annual ryegrass), *L. perenne* (perennial ryegrass), *L. multiflorum* (Italian ryegrass) and various crosses between these species.
- Shallow cultivation at the autumn break can stimulate germination of annual ryegrass.
- Crops should be chosen in which ryegrass can be controlled by means other than Group A herbicides.
- Crops such as brassicas or beans, where Dual Gold can be used, and also inter-row cultivation would be a suitable option.

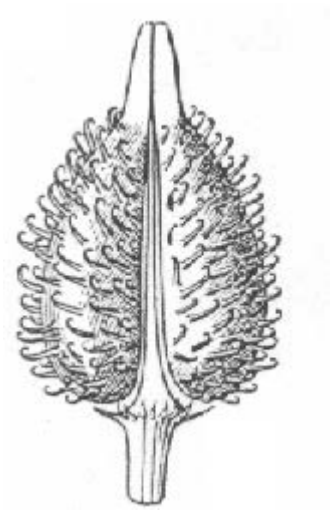
Cleavers

- Due to seed dormancy in this weed it will be required to be managed over a longer period of time (5-6 years minimum).
- Suggested crops that have herbicides registered for control of cleavers include brassicas, poppies, potatoes, beans and cereals.

40 Burr Chervil

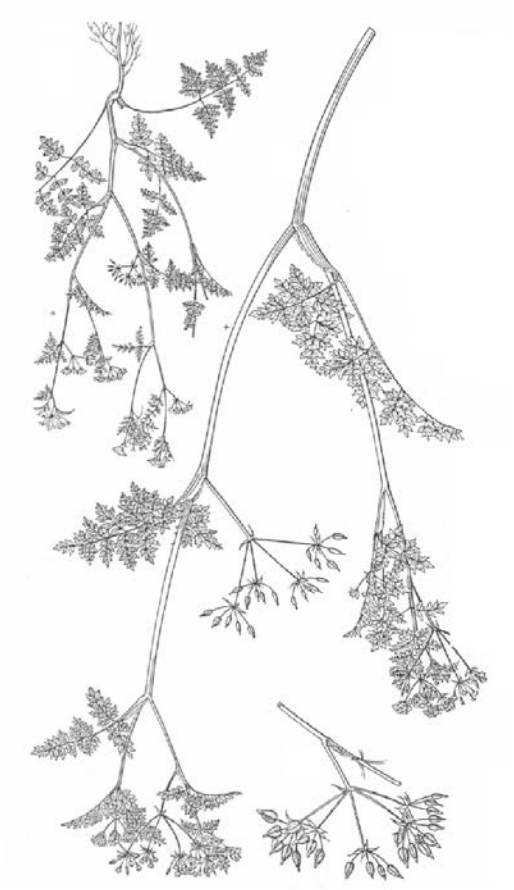
40.1 Biology

Burr Chervil (*Anthriscus caucalis* M. Bieb.) is an annual Apiaceae weed native to Europe, Asia and Africa (Clapham *et al*. 1987) and introduced to Australasia and North America. Although not widely recognised as a weed, Burr Chervil has established itself as a problematic weed in pyrethrum. In Europe, Burr Chervil emerges in autumn (Roberts, 1986) and flowers in late spring early summer (Clapham *et al*. 1987). In Tasmania, emergence of Burr Chervil predominantly occurs in mid autumn to early winter. Burr Chervil over winters as a rosette and during late winter early/spring has rapid vegetative growth. Flowering commences in early to mid spring. Seed maturation occurs approximately 12 weeks after flowering and the seeds are readily dispersed from the open umbel structure of the plant. The seeds are ovoid is shape, 3 mm in length and dark green in colour with distinguishing hook spines that aid in attachment and transportation. The potential number of seed propagules is approximately 7500 per plant. According to records obtained from the Tasmanian herbarium, D.I. Morris collected the first specimen of Burr Chervil in Tasmania in October 1967 in Sassafras. Specimens have also been recorded at Molesworth (December 1967), Gretna (1987) and again at Sassafras (December 1998), in a pyrethrum field.



Freshly shed seeds of Burr Chervil are generally dormant and require a period of after-ripening and/or scarification to overcome this dormancy. The after ripening requirement is satisfied during the warm dry periods of summer allowing germination to proceed in the autumn. The impermeable seed coat permits Burr Chervil to survive for more than one year. Burr Chervil produces seeds with variable levels of seed coat dormancy with a large proportion of the seed population emerging in the first two to three years. However, a small proportion of seeds may persist for longer. Reports on the seedbank longevity in the northern hemisphere are variable. Roberts (1986) found that Burr Chervil was able to persist for periods greater than 5 years and Levassor *et al*. (1990) reported that the seedbank was transient (lasting only one year). The optimum germination temperature for Burr Chervil is between 6.0^0C and 15.0^0C and the optimum planting depth for emergence is between 0 and 30 mm. At planting depths of 50 mm and below, the emergence of Burr Chervil is restricted. Burr Chervil seeds are sensitive to osmotic stress and fail to germinate at water potentials of - 1.0 Mpa or below.

Burr Chervil (Cont.)



40.2 Management Considerations

Burr Chervil is a strong competitor due to its plasticity in growth habit. At high densities Burr Chervil has rapid upright growth of the main vegetative stems allowing it to compete for light resources. At low densities Burr Chervil colonises the surrounding bare ground with large prostrate leaf growth and is therefore capable of reducing crop yields if not controlled. At present, Burr Chervil is not listed as a weed on any registered herbicide label. Research has indicated that Burr Chervil is susceptible to Group I herbicides (MCPA), Group C herbicides (simazine, cyanazine, and metribuzin) and Group B herbicides (rimsulforuon and imazamox). Burr Chervil displays high tolerance to Group D herbicides (pendimethalin and trifluralin) and Group F herbicide (diflufenican and clomazone). It also displays some level of tolerance to Group G herbicides (oxyfluorfen).

Spring sown crops will potentially provide cultural control of Burr Chervil through cultivation, since Burr Chervil emergence predominantly occurs between mid autumn and early winter. Crops that allow for the selective use of herbicides with activity against Burr Chervil should be grown for at least two to three years following pyrethrum in order to reduce the seedbank of Burr Chervil and limit its impact as a weed in future crops. Crops that satisfy this criterion include pastures and cereals, potatoes, beans and peas. Crops that should be avoided include carrots, onions and lettuces. Due to the high number of seed propagules that can be produced per plant, and their potential to persist within the seed bank, management should focus on preventing seed production of this species in all areas on the farm property. Spraying of Burr Chervil with a non-selective herbicide such as glyphosate in waste areas, fence-rows and headlands should take place prior to the commencement of flowering in early spring.

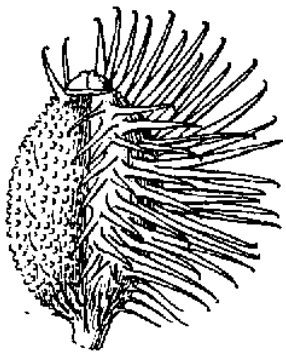
40.3 Herbicide Control Options

Product	Active	Crop Registrations
MCPA 500	MCPA	cereals and pastures
Kamba M	dicamba and MCPA	cereals and pastures
Bladex	cyanazine	Potatoes, onions and peas
Lexone	metribuzin	peas, potatoes and barley
Gesatop	simazine	lupins,

41 Knotted Hedge Parsley

41.1 Biology

Knotted Hedge Parsley (*Troilis nodosa* L. Gaertn.) is an annual Apiaceae weed native to Africa, Asia and Europe (Clapham *et al*, 1987) and introduced to Australia (Curtis, 1963). Although not widely recognised as a weed, Knotted Hedge Parsley has established itself as a problematic weed in pyrethrum. Knotted Hedge Parsley has a trailing prostrate growth habit and grows to a height of 50 cm. Flowering takes place in spring and seed maturation occurs during late summer. The potential number of seed propagules is approximately 6000 per plant. Knotted Hedge Parsley produces paired seeds with differing morphology. The outer seeds have distinct spines. The inner seeds are warty. Both seeds are ovoid in shape and 2.5 mm in length. Knotted Hedge Parsley has a compact flower structure. The seeds are held within a compact umbel structure close to the flowering stem. As a result of this, seed dispersal is slow, taking place during senescence of the parent plant in late summer. According to records obtained from the Tasmanian herbarium, L. Rodway collected the first specimen of Knotted Hedge Parsley in Tasmania at Bellerive in November 1915. W.M. Curtis recorded Knotted Hedge Parsley at Low Head in December 1955, while more recent recordings have occurred on the north-west coast of Tasmania in pyrethrum fields.



Germination of the dispersed seed can occur immediately if conditions are favorable (moisture, temperature and light) as there is no innate seed dormancy associated with Knotted Hedge Parsley. Emerged seedlings over-winter as rosettes and during the spring produce trailing stems that inter-twine and grow vertically upright with the surrounding vegetation. The seedbank is generally non-persistent with a large percentage of the viable seedbank emerging within the first year. The seedbank longevity of Knotted Hedge Parsley in the northern hemisphere has also been reported as being transient (lasting < 1 year) (Maranon and Bartolome, 1989). Dispersed seeds of Knotted Hedge Parsley display high initial germination (>90%) with optimum germination occurring between 18^0C and 24^0C. Germination is reduced without light and emergence is restricted at planting depths of
50 mm or below. Knotted Hedge Parsley seeds are sensitive to osmotic stress and fail to germinate at water potentials of - 1.0 Mpa or below.

Knotted Hedge Parsley (Cont.)

41.2 Management Considerations

Knotted Hedge Parsley can reduce crop yields because of its climbing growth habit, especially at high densities, although it is generally viewed as not being a strongly competitive weed. Knotted Hedge Parsley has a transient seedbank lasting only one to two years and intensive management in the short-term will therefore significantly reduce the seedbank. Knotted Hedge Parsley is not listed as a weed on any herbicide label. Research has indicated that Knotted Hedge Parsley is susceptible to Group I herbicides (MCPA), Group C herbicides, (simazine, cyanazine and bentazone), Group B herbicides (flumetsulam, rimsulfuron and imazamox) and Group F herbicides (clomazone). Knotted Hedge Parsley displays high tolerance to Group D herbicides (pendimethalin and trifluralin).

Spring cultivation will provide substantial control of emerged Knotted Hedge Parsley as emergence predominantly occurs in the autumn following seed dispersal. To prevent a build-up of the seedbank of Knotted Hedge Parsley, consideration should be given to crop rotations in the first 1-2 years following pyrethrum. This would include growing crops that allow for the selective use of herbicides with activity against Knotted Hedge Parsley, such as pastures and cereals, poppies, pumpkins, potatoes, beans and peas. Crops that should be avoided include carrots, onions and lettuces.

41.3 Herbicide Control Options

Product	Active	Crop Registrations
MCPA 500	MCPA	cereals and pastures
Kamba M	dicamba and MCPA	cereals and pastures
Bladex	cyanazine	potatoes, onions and peas
Basagran	bentazone	beans and peas
Gesatop	simazine	lupins
Command	clomazone	beans, poppies, potatoes, pumpkins
Broadstrike	flumetsulam	wheat

42 Cleavers

42.1 Biology

Cleavers (*Galium aparine*) is an annual weed which is common in cultivated high rainfall regions. Fresh seed has been reported to germinate readily and germination is inhibited by light, therefore, seeds do not germinate unless covered with soil.

A study of the decline of seeds broadcast on to the soil surface and then ploughed to 20 cm was followed over a six year period of cropping with winter or spring wheat grown as commercial crops. Every effort was made to prevent further seed return to the soil. Cleavers had a mean annual decline rate of 58% and an estimated time to 95% decline of 4-5 years. In a similar trial over four years, the annual loss was 66% and the time to 99% decline was 3.6 years. Annual seedling emergence represented just 2% of the seedbank (Bond and Turner, 2004).

The seed surfaces are covered with hooked bristles and are carried on clothes and animal fur. Seeds sometimes occur in cereal and other crop seed samples.

Surface cultivations encourage the seeds to germinate and the seedlings can be killed by cultivation.

42.2 Management Considerations

Due to seed dormancy in this weed, this weed needs to be managed over a longer period of time (five to six years minimum). Its staggered germination pattern, ability to climb over crops and also its tolerance to most herbicides makes cleavers a problem weed in vegetable crops.

Herbicides which are active on cleavers include Command, Starane, Dacthal, Goal and Affinity and the crops in which they can be used are listed in the table below. Cleavers can not be controlled in carrot crops.

42.3 Herbicide Control Options

Product	Active	Crop Registrations
Command	clomazone	beans, poppies and potatoes
Affinity	carfentrazone	cereals, pasture
Starane	fluroxypyr	poppies, cereals, pasture
Dacthal	clorthal-dimethyl	onions, beans, brassicas, potatoes and pasture
Goal	oxyfluorfen	brassicas
Bladex and Totril	cyanazine and ioxynil	onions

43 Groundsel

43.1 Biology

Groundsel (*Senecio vulgaris* L.) is an annual weed of Mediterranean origin that has become a worldwide problem in many crop production systems. The seeds are widely dispersed by the wind.

Freshly shed groundsel seed generally requires light but not stratification for germination. However, it has been noted that seed produced in spring is generally more dormant than seed produced in summer or autumn. Seed germinates better at lower (10-15 ^{o}C) rather than higher (20-30 ^{o}C) temperatures. Seeds buried for six months in soil under natural conditions germinate readily on exposure to light. Studies were conducted in Ohio, USA to determine the effect of groundsel's maternal environment on seed dormancy. In growth chamber studies, seeds maturing on plants growing in cold short day conditions were mostly dormant, whereas seeds produced on plants in warm long day conditions were mostly non-dormant. The dormancy status of buried seeds varied throughout the year, mostly in response to soil temperature. Nearly all buried seeds germinated or died during two years of burial in soil (Rodrigo, 2003).

Field seedlings emerge from the top 30-40 mm of soil with up to 80% emerging from the surface 5 mm. Seed numbers in soil may be reduced by around 70% by fallowing for one year.

43.2 Management Considerations

Groundsel is a prolific seeder and although it is not a strong competitor, at high density it can significantly reduce crop yields. Many herbicides commonly used in vegetable cropping systems in Tasmania do not control groundsel. Due to the fact that groundsel seed does not survive in the soil for more than two years, intensive management of the weed should significantly reduce the seed bank, however, due to the fact that groundsel seed can travel in the wind, management of this weed in surrounding areas such as fence lines is also important. The weed is more likely to cause problems in crops planted in the winter and early spring than crops planted in the summer, due to its preference to germinate under cooler conditions.

If groundsel is a problem, it would be best to manage the weed intensively for one to two years following pyrethrum. This could be achieved growing crops such as cereals, brassicas, pasture, beans or potatoes where groundsel can be controlled by herbicides, inter-row cultivation or fallow/pasture phases in autumn, winter and early spring when groundsel typically germinates. Intensive management will quickly deplete the seed bank. Resistance to Group C herbicides has been reported in the US and Europe.

Biological control of groundsel with the naturalised rust fungus, *Puccinia lagenophorae* has been the subject of much research. The fungus now occurs widely in Tasmania and may cause considerable damage to groundsel plants, but there is no guarantee of an attack by the pathogen (Bond and Turner, 2004). Fungicides used in pyrethrum crops have been shown to suppress the fungus and hence reduce its effectiveness.

43.3 Herbicide Control Options

Product	Active	Crop Registrations
Lontrel	clopyralid	pasture, poppies
Kamba M	dicamba and MCPA	pasture and cereals
Goal	oxyfluorfen	onions, brassicas
Command	clomazone	beans, poppies, potatoes, pumpkins
Bladex	cyanazine	potatoes, peas (groundsel not on label)
Bromicide	bromoxynil	pasture, cereals
Linuron + Gesagard	linuron + prometryne	carrots

44 Ryegrass

44.1 Biology

The genus *Lolium* (ryegrass) plays a central role in southern Australian agriculture. *Lolium perenne* (perennial ryegrass), *L. multiflorum* (Italian ryegrass) and their hybrids are the basis of most southern Australian perennial pastures.

On mainland Australia the main species of ryegrass occurring as a weed in annual crops is *L. rigidum* or annual ryegrass. The annual ryegrass is commonly resistant to Group A herbicides.

In pyrethrum crops a range of different ryegrass species have been identified including:

- *L. rigidum*
- *L. perenne*
- *L. multiflorum*
- *L. perenne x rigidum*
- *L. multiflorum x rigidum*

A significant amount of work has been conducted on the biology of annual ryegrass in Australia and how this may relate to its management. It is not known how the biology of all these different ryegrass species differ, given that most of the research has been done on annual ryegrass (*L. rigidum*).

Australian research has shown annual ryegrass seed banks diminish exponentially over time, but a small amount of seed can emerge up to 5 years after seed set. Seed dormancy is the main cause of the spread in emergence of ryegrass over time and dormancy release can occur by either dark stratification or after ripening.

Populations of annual ryegrass that have developed resistance to a range of herbicide groups (Groups A, B, C, D and M) are common throughout Southern Australia (estimated to be one million ha). The fact that ryegrass is extremely common throughout Southern Australia, is genetically diverse, outcrosses, and produces masses of seed with low dormancy, are all factors that have driven rapid evolutionary change and have contributed to the creation of the worst herbicide resistant weed in the world (Heap, 2002).

44.2 Management Considerations

Shallow cultivation at the autumn break can stimulate germination of annual ryegrass in the first year after seed set, but it is not effective on seeds that have been in the seed bank for more than one season. Dormancy can be removed if seeds are dark and wet for 2 weeks then exposed to light (Steadman and Ellery, 2003). A light cultivation 2-3 weeks after the autumn break could be used to stimulate germination in a fallow situation, which could be controlled with a non-selective herbicide and then cultivated again to promote further weed germination.

Ryegrass (Cont.)

To manage herbicide resistance it is recommended to use a double knockdown with glyphosate and paraquat/diquat in a fallow situation. Paraquat/diquat followed by glyphosate is usually more effective against small ryegrass plants (1 leaf) than the reverse sequence. Spraying at the 3-6 leaf stage gives the best control. The interval between sprays needs to be at least 2 days (Stewart 2004).

Crops should be chosen in which ryegrass can be controlled by means other than Group A herbicides. Group K is probably the most effective group on ryegrass, which is compatible with vegetable cropping systems. Crops such as brassicas or beans where Dual Gold can be used and also inter-row cultivation would be a suitable option. Ryegrass resistance to Group K herbicides has never been reported anywhere else in the world.

Some Group B and C herbicides control ryegrass, however, development of resistance is an issue with these products and they are not tolerated by most vegetable crops and most have long soil residual periods.

44.3 Herbicide Control Options

Product	Active	Crop Registrations
Dual Gold	s-metolachlor	beans, brassicas

45 References

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Steadman, K. and Ellery, A. (2003) Annual ryegrass seedbanks: The good, the bad and the ugly. Agribusiness Crop Updates 2003.

Final Report

Screening of Onduty, Terbuthylazine and Betanal for crop safety in post harvest pyerthrum

Tasmania, 2005

Client: Botanical Resources Australia Pty Ltd

Author: Phillip Frost B Agr Sc Hons

Project Leader: Phillip Frost
Serve-Ag Research Pty Ltd

Report Number: BRA03134#7

Report Date: 12 May 2006

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46 Summary

At Forth in 2005, Onduty 700 WG at 50 g/ha, Betanal 157 EC at 2 and 4 L/ha, Terbuthylazine 750 WG at 250 and 500 g/ha, Brodal 500 EC at 300 mL/ha and Command 480 EC at 300 mL/ha were applied to a pyrethrum crop post harvest to evaluate their crop safety. .

Crop safety was assessed visually at 29 and 70 days after application (DAA).

Onduty 700 WG at 50 g/ha, Betanal 157 EC at 2 and 4 L/ha, Terbuthylazine 750 WG at 250 and 500 g/ha, Brodal 500 EC at 300 mL/ha and Command 480 EC at 300 mL/ha were applied to a pyrethrum crop post harvest to evaluate their crop safety. .

Crop safety was assessed visually at 29 and 70 days after application (DAA). The crop was showing symptoms of damage from previous herbicide applications, approximately 5% necrosis and 7.5% chlorosis at 29DAA. The commercial standard Brodal 300 mL/ha did not cause any additional necrosis at 29DAA but did significantly increase chlorosis, compared to the untreated control at both 29 and 70DAA. Command also caused a significant increase in chlorosis, compared to the untreated control, at 29DAA but not 70DAA. Onduty, Betanal or terbuthylazine did not cause significant chlorosis at either 29 or 70DAA.

No herbicide treatments affected crop biomass at 70DAA.

47 Introduction

47.1 Aims

- To evaluate terbuthylazine 750 WG at 250 and 500 g/ha for crop safety in post harvest pyrethrum
- To evaluate Betanal 157 EC at 2 and 4 L/ha for crop safety in post harvest pyrethrum
- To evaluate Onduty 700 WG at 50 g/Ha for crop safety in post harvest pyrethrum
- To compare terbuthylazine, Betanal and Onduty to Command and Brodal fro crop safety in post harvest pyrethrum

47.2 Target

Crop Safety

48 Materials and Methods

48.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Brodal	diflufenican	500 g/L	Suspension Concentrate
Betanal	phenmedipham	157 g/L	Emulsifiable Concentrate
Onduty	Imazapic imazapyr	525 g/kg 175 g/kg	Wettable Granule
Terbuthylazine 750 WG	terbuthylazine	750 g/kg	Wettable Granule

48.2 Treatment List

No.	Product	Rate		Application Schedule
		Product (L/ha) or (kg/ha)	Active Ingredient (g ai/ha)	
1	Untreated Control	nil	nil	nil
2	Brodal 500 SC	300 mL	150	Single application in June
3	Command 480 EC	300 mL	144	
4	Betanal 157 EC	2 L	314	
5	Betanal 157 EC	4 L	628	
6	Gardoprim 750 DF	250 g	187.5	
7	Gardoprim 750 DF	500 g	375	
8	Onduty 700 WG	50 g	26.3 + 8.75	

48.3 Table 1 - Crop Safety Assessments 14DAAT1 and 14DAAT2

No.	Treatment	% Necrosis	Crop Biomass (%)	% Chlorosis	
		29DAA	70DAA	29DAA	70DAA
1	Untreated Control	5.0	100	7.5 a	5.0 a
2	Brodal 500 SC 300 mL	5.0	100	15.0 b	17.5 c
3	Command 480 EC 300 mL	5.0	100	15.0 b	7.5 ab
4	Betanal 157 EC 2 L	7.5	100	10.0 ab	12.5 bc
5	Betanal 157 EC 4 L	5.0	100	7.5 a	7.5 ab
6	Gardoprim 750 DF 250 g	5.0	100	12.5 ab	7.5 ab
7	Gardoprim 750 DF 500 g	5.0	100	7.5 a	5.0 a
8	Onduty 700 WG 50 g	5.0	100	12.5 ab	7.5 ab
P vaule		0.5000	-	0.0405	0.0551

49 Results and Discussion

Onduty 700 WG at 50 g/ha, Betanal 157 EC at 2 and 4 L/ha, Terbuthylazine 750 WG at 250 and 500 g/ha, Brodal 500 EC at 300 mL/ha and Command 480 EC at 300 mL/ha were applied to a pyrethrum crop post harvest to evaluate their crop safety. .

Crop safety was assessed visually at 29 and 70 days after application (DAA). The crop was showing symptoms of damage from previous herbicide applications, approximately 5% necrosis and 7.5% chlorosis at 29DAA. The commercial standard Brodal 300 mL/ha did not cause any additional necrosis at 29DAA but did significantly increase chlorosis, compared to the untreated control at both 29 and 70DAA. Command also caused a significant increase in chlorosis, compared to the untreated control, at 29DAA but not 70DAA. Onduty, Betanal or terbuthylazine did not cause significant chlorosis at either 29 or 70DAA.

No herbicide treatments affected crop biomass at 70DAA.

50 Appendices

50.1 Appendix i - Trial Details

50.1.1 Site Details

Grower	Werrin Farms, Botanical Resources Australia
Location	Forth
Grid Reference	Paddock
Soil Type	Ferrosol
Crop	Pyrethrum
Trial Design	Randomised Complete Block
Replications	2
Plot Size	2 x 6m

50.1.2 Trial Plan

5	7	3	4	**Block 4**
1	7	8	2	**Block 3**
8	2	3	6	**Block 2**
4	7	1	5	**Block 1**

↗N

50.1.3 Application Details

Application Equipment	
Equipment	Carbon Dioxide Pressurised Spray Unit
Nozzles	DG 8002 fan jets
Volume	250L/ha
Pressure	2.8 bar
Method	Walked at 1m / sec
Treatment Applications	
Application Number	1
Date	01/06/05
Time	11.00 am
Treatments Applied	2-8
Temperature (^{O}C)	12.4
Relative Humidity (%)	58
Cloud Cover (%)	5
Wind Direction	SW
Wind Speed (km/h)	5
Soil Moisture or Leaf Wetness	Soil and crop dry
Weed Growth Stage	No weeds
Crop Stage	10-20 cm Rosette

Complete meteorological data from Forthside Vegetable Research Station for the months of June, July and August 2005are included as Appendix iv to this report. The trial site was situated 25 km from Forthside.

50.1.4 Assessments

1. Crop Safety Assessment		
Dates	30/06/05	10/08/05
Days After Application	29DAA	70DAA
Sample Size	Whole Plot	
Method	Plants observed for symptoms of chlorosis and necrosis and also visually rated for biomass compared to the untreated control.	
Statistical Analysis	Analysis of Variance tests and Fischers least significant difference (LSD) tests were conducted using Statgraphics Plus	

50.2 Appendix ii - Raw Data

50.2.1.1 Crop Safety Assessments 30/06/05 and 10/08/05

No.	Treatment	Rep	% Necrosis	% Chlorosis	Crop Biomass (%)	% Chlorosis
1	Untreated Control	1	5	5	100	5
		2	5	10	100	5
		Mean	5.0	7.5	100.0	5.0
2	Brodal 300 mL	1	5	15	100	20
		2	5	15	100	15
		Mean	5.0	15.0	100.0	17.5
3	Command 300 mL	1	5	15	100	10
		2	5	15	100	5
		Mean	5.0	15.0	100.0	7.5
4	Betanal 2 L	1	10	5	100	10
		2	5	15	100	15
		Mean	7.5	10.0	100.0	12.5
5	Betanal 4 L	1	5	5	100	5
		2	5	10	100	10
		Mean	5.0	7.5	100.0	7.5
6	Gardoprim 750 DF 250 g	1	5	10	100	5
		2	5	15	100	10
		Mean	5.0	12.5	100.0	7.5
7	Gardoprim 750 DF 500 g	1	5	5	100	5
		2	5	10	100	5
		Mean	5.0	7.5	100.0	5.0
8	Onduty 50 g	1	5	10	100	5
		2	5	15	100	10

50.3 Appendix iii - Statistical Analysis

Analysis of Variance for Chlorosis 29DAA - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Treatment	148.438	7	21.2054	4.13	0.0405
B:Replicate	76.5625	1	76.5625	14.91	0.0062
RESIDUAL	35.9375	7	5.13393		
TOTAL (CORRECTED)	260.938	15			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for Chlorosis 29DAA by Treatment

Method: 95.0 percent LSD

Treatment	Count	LS Mean	Homogeneous Groups
1	2	7.5	X
5	2	7.5	X
7	2	7.5	X
4	2	10.0	XX
6	2	12.5	XX
8	2	12.5	XX
3	2	15.0	X
2	2	15.0	X

Analysis of Variance for Chlorosis 70DAA - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Treatment	250.0	7	35.7143	3.64	0.0551
B:Replicate	6.25	1	6.25	0.64	0.4512
RESIDUAL	68.75	7	9.82143		
TOTAL (CORRECTED)	325.0	15			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for Chlorosis 70DAA by Treatment

Method: 95.0 percent LSD

Treatment	Count	LS Mean	Homogeneous Groups
7	2	5.0	X
1	2	5.0	X
6	2	7.5	XX
3	2	7.5	XX
8	2	7.5	XX
5	2	7.5	XX
4	2	12.5	XX

2	2	17.5	X

Analysis of Variance for Necrosis 29DAA - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Treatment	10.9375	7	1.5625	1.00	0.5000
B:Replicate	1.5625	1	1.5625	1.00	0.3506
RESIDUAL	10.9375	7	1.5625		
TOTAL (CORRECTED)	23.4375	15			

All F-ratios are based on the residual mean square error.

50.4 Appendix iv - Meteorological Details

Observations from Devonport Airport, about 6 km east of the city centre.

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am						3 pm					
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
1	We	2.0	16.3	0			SW	31	09:44	10.8	54	1	SSW	19	1023.9	15.7	44	3	W	22	1021.4
2	Th	1.3	17.1	0			SSW	33	06:25	8.5	74	1	SSE	9	1024.3	16.4	52	5	ENE	13	1022.1
3	Fr	2.7	13.9	0			WNW	30	17:21	6.2	70	7	S	15	1023.8	12.9	71	2	NW	9	1020.8
4	Sa	1.8	15.1	0			WNW	44	17:11	7.2	90	7	SSE	9	1018.9	14.2	81	8	NW	28	1016.1
5	Su	5.1	12.9	0			SE	33	11:15	8.3	75	5	SSE	20	1026.1	12.2	50	7	SE	15	1026.4
6	Mo	7.2	13.5	0			ENE	24	12:17	10.8	76	8	S	15	1026.4	12.6	79	8	SE	11	1022.2
7	Tu	7.9	14.3	0			S	20	23:38	9.1	93	7	S	13	1023.2	14.1	70	8	N	7	1021.8
8	We	5.9	16.4	0			SSE	28	09:16	8.2	87	3	S	17	1023.6	14.7	71	2	N	9	1021.6
9	Th	8.1	14.1	0.4			N	41	15:20	10.3	87	8	SSE	15	1020.9	13.2	97	8	NE	28	1017.7
10	Fr	10.1	17.4	6.0			ENE	52	22:25	13.5	96	7	SSE	13	1017.7	15.8	78	7	NE	26	1013.8
11	Sa	13.5	14.6	9.2			NNW	69	11:31	14.5	93	8	NNE	39	1004.2	13.6	93	8	NNW	17	1005.5
12	Su	9.4	15.8	17.2			NE	31	00:00	11.5	96	7	SSE	9	1012.4	15.0	84	6	NW	4	1011.8
13	Mo	10.7	16.7	0			ENE	52	14:46	13.8	86	5	E	19	1014.0	16.1	72	3	ENE	39	1009.1
14	Tu	8.2	15.1	1.6			NNW	48	00:00	10.9	89	6	SE	7	1003.8	13.4	70	7	NW	33	1003.3
15	We	10.4	13.6	9.4			NW	61	02:13	13.0	70	6	NNW	28	1005.3	13.2	73	6	NW	31	1003.5
16	Th	6.2	12.5	17.8			NW	31	16:03	7.8	95	8	S	11	1003.7	12.1	72	5	NW	20	1002.8
17	Fr	3.7	13.3	4.2			WNW	37	14:01	8.5	78	1	W	17	1008.2	12.2	58	7	W	22	1008.3
18	Sa	0.8	12.1	0.1			SSE	26	23:08	4.3	91	4	S	11	1011.4	11.7	72	4	NW	6	1008.6
19	Su	4.3	10.9	1.4			E	24	11:25	8.5	92	8	S	13	1003.0	10.8	81	8	ESE	9	998.4
20	Mo	6.4	11.7	0.8			SE	30	23:53	8.1	85	7	SSE	19	994.8	10.6	82	8	SE	11	992.0
21	Tu	8.0	10.9	12.0			SSE	39	03:11	10.6	85	7	SSE	26	991.3	10.4	92	7	W	7	993.4
22	We	4.8	13.9	7.2			SE	39	21:35	6.7	99	8	S	19	1003.6	12.8	75	7	S	15	1005.8
23	Th	5.0	13.4	0			SE	35	11:02	8.8	68	1	SSW	7	1020.6	12.9	52	0	SE	15	1022.6
24	Fr	1.8	11.6	0			SSE	22	00:26	4.6	87	1	S	13	1029.5	11.0	67		NW	7	1029.0
25	Sa	3.7	13.2	0			SSE	30	06:18	5.6	82	5	SSE	20	1034.3	12.7	62	3	N	9	1032.7
26	Su	3.3	13.7	0			S	26	09:47	5.3	80	2	S	20	1033.3	11.9	73	2	N	9	1031.2
27	Mo	2.1	12.8	0			WNW	26	17:40	3.9	87	1	S	11	1032.3	12.1	76	2	NW	15	1030.4
28	Tu	1.8	14.0	0			WNW	39	14:07	5.7	95	2		Calm	1030.5	13.8	77	5	WNW	28	1028.6
29	We	3.9	14.5	0			S	26	03:53	6.4	91	1	S	11	1032.8	13.0	78	1	NNE	9	1031.0
30	Th	5.9	15.1	0			ENE	35	14:29	10.0	83	8	SSE	20	1029.5	14.7	69	8	E	19	1024.8
Statistics for June 2005																					
Mean		5.5	14.0							8.7	84	5		15	1017.6	13.2	72	5		16	1015.9
Lowest		0.8	10.9	0						3.9	54	1		Calm	991.3	10.4	44	0	NW	4	992.0
Highest		13.5	17.4	17.8			NNW	69		14.5	99	8	NNE	39	1034.3	16.4	97	8	ENE	39	1032.7
Total				87.3																	

Observations from Devonport Airport, about 6 km east of the city centre.

7	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am						3 pm					
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
1	Fr	9.9	14.1	6.6			ENE	57	05:23	13.7	92	8	E	19	1010.8	13.5	91	8	S	11	1000.9
2	Sa	11.4	16.4	29.4			W	48	01:08	12.1	79	8	W	28	1011.9	15.9	54	2	W	28	1013.7
3	Su	7.9	15.2	0			WNW	39	13:28	11.8	89	6	WNW	24	1022.8	14.7	49	4	WSW	24	1023.1
4	Mo	4.9	12.9	0			NNW	30	23:12	7.9	91	8	S	9	1027.9	12.0	85	8	ENE	6	1025.7
5	Tu	7.9	14.6	0			NNW	33	13:17	12.8	75	8	N	15	1024.4	12.6	72		NNW	20	1021.9
6	We	7.9	15.4	0			NW	54	17:59	13.7	84	6	NW	22	1019.5	13.8	84	6	NNW	28	1017.5
7	Th	6.9	12.3	4.6			WNW	43	16:34	8.3	92	4	SW	6	1017.6	11.8	70	5	NW	26	1015.8
8	Fr	1.6	12.1	0.2			SSE	26	23:56	3.5	88	1	S	15	1022.2	11.3	57	2	NW	11	1020.3
9	Sa	1.5	10.4	0			SE	46	14:56	3.2	81	5	S	20	1020.9	9.9	52	2	SE	35	1018.3
10	Su	-0.6	12.7	0			WSW	26	17:35	4.0	81	1	SSW	9	1025.2	11.6	67	1	NW	15	1024.8
11	Mo	1.3	14.9	0			WNW	35	11:39	6.2	85	1	SW	15	1026.7	14.5	47		WSW	24	1024.3
12	Tu	2.1	12.6	0			S	20	06:41	5.5	81	8	S	13	1023.7	10.9	63	8	NNW	13	1019.2
13	We	4.2	10.0	0.2			SSE	19	23:03	5.9	91	8	S	9	1012.6	9.9	76	7		Calm	1009.3
14	Th	4.8	12.4	0			SSE	31	20:52	6.4	83	8	S	22	1008.8	12.0	51	7	ESE	15	1008.0
15	Fr	5.5	11.9	0			SSE	35	10:24	7.0	68	8	S	19	1011.7	11.0	65	7	SSE	6	1010.3
16	Sa	2.7	12.2	0			NNW	70	15:08	6.0	95		S	13	1006.1	11.0	68		NNW	44	1000.0
17	Su	3.4	11.8	0			W	83	04:57	7.0	64		W	22	1012.1	11.1	53		WSW	24	1015.5
18	Mo	4.9	13.9	0			WNW	46	23:52	8.4	73	1	WSW	15	1025.8	12.8	52	2	W	26	1025.5
19	Tu	6.2	16.6	0			WNW	44	01:27	10.7	81	2	W	17	1032.4	15.6	54	5	WSW	24	1031.6
20	We	7.4	15.0	0			NW	35	14:49	11.2	85	4	W	19	1037.5	13.9	75	2	WNW	22	1035.8
21	Th	6.4	14.0	0			NNW	30	14:39	9.8	92	7	SSE	6	1035.9	12.1	68	3	NNW	24	1032.2
22	Fr	5.4	13.9	0			WNW	61	12:52	12.9	77	7	NW	35	1024.4	12.4	93	3	WNW	24	1022.2
23	Sa	4.6	14.2	5.0			NW	57	13:54	9.7	95	8	NW	7	1021.0	12.8	89	7	NW	35	1017.0
24	Su	9.6	14.2	4.0			NW	87	13:55	13.0	83	8	NW	37	1007.7	12.5	87	7	NW	44	1000.9
25	Mo	9.0	14.2	2.4			WNW	69	23:46	11.8	88	5	WNW	33	1004.5	13.4	86	6	NW	41	1000.8
26	Tu	9.6	12.3	2.6			WNW	78	01:19	10.0	81	7	W	19	998.7	12.0	55	4	WSW	28	1001.7
27	We	6.2	15.3	0			NW	37	14:56	10.2	88	2	WNW	24	1012.7	12.6	86	7	NW	26	1013.6
28	Th	10.0	14.8	3.4			W	46	15:20	11.9	92	6	WNW	26	1011.8	14.5	60	4	WNW	28	1010.7
29	Fr	5.4	13.1	2.2			NW	80	07:20	10.4	77	8	WNW	24	1008.6	11.7	77	7	NW	35	1007.2
30	Sa	9.5	13.5	1.2			WNW	52	03:18	11.3	74	2	WNW	35	1015.5	12.5	80	8	WNW	30	1016.0
31	Su	5.5	14.5	0.4			W	39	14:29	10.3	67	3	W	26	1021.5	12.9	64	7	WNW	24	1021.7
Statistics for July 2005																					
Mean		5.9	13.6							9.2	82	5		19	1018.2	12.6	68	5		23	1016.3
Lowest		-0.6	10.0	0						3.2	64	1	#	6	998.7	9.9	47	1		Calm	1000.0
Highest		11.4	16.6	29.4			NW	87		13.7	95	8	NW	37	1037.5	15.9	93	8	#	44	1035.8
Total				62.2																	

50.5

50.6 Observations from Devonport Airport, about 6 km east of the city centre.

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9 am						3 pm					
		Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
1	Mo	6.3	13.4	0			NW	37	13:58	9.2	90	7	W	9	1026.0	12.6	86	6	NW	28	1022.9
2	Tu	9.2	14.5	0			NW	37	22:41	11.6	89	7	NW	9	1024.0	13.9	84	7	NNW	20	1020.3
3	We	7.7	15.4	0			NW	46	13:13	13.8	74	6	NW	24	1012.7	13.9	78	7	NW	20	1006.0
4	Th	3.1	11.8	1.0			WSW	43	17:17	8.0	63	2	WSW	17	1010.5	9.6	49	2	WSW	22	1012.0
5	Fr	1.2	12.0	0			NW	56	14:31	6.4	79	7	WSW	4	1021.5	10.9	89	8	NW	43	1017.1
6	Sa	2.0	12.5	2.4			NW	70	23:46	6.5	93	7	SSE	7	1020.1	10.6	91	8	WNW	24	1016.2
7	Su	6.1	12.9	45.2			NW	81	03:44	11.4	55	6	WNW	30	1009.6	11.1	53	4	W	43	1009.2
8	Mo	4.9	12.7	0			NNW	63	23:37	8.1	68	8	WNW	20	1017.8	10.6	76	8	NNW	30	1016.0
9	Tu	8.0	13.3	7.0			WNW	72	22:44	12.7	81	8	NNW	48	1004.3	10.2	89	8	NNW	41	998.8
10	We	2.9	9.2	13.3			SW	52	00:19	5.2	68	6	W	19	1001.9	7.3	48	6	WSW	31	1002.2
11	Th	0.6	9.6	0			WSW	41	15:09	5.2	60	1	W	22	1008.3	9.2	38	2	WSW	24	1009.6
12	Fr	1.0	10.8	0			W	44	12:44	5.6	80	2	WSW	17	1018.8	8.1	62	7	W	19	1017.5
13	Sa	5.6	14.2	0			WNW	44	17:49	10.4	85	8	WNW	24	1021.1	12.7	84	8	NW	26	1019.8
14	Su	9.8	14.3	0			NW	46	13:21	12.5	81	7	NNW	24	1018.0	12.9	69	8	NW	28	1012.5
15	Mo	10.4	13.0	4.2			NNW	69	07:38	11.3	84	8	NNW	43	1000.7	12.1	49	3	W	41	1006.3
16	Tu	7.4	16.6	0.4			WSW	52	13:41	11.3	86	7	WNW	28	1020.8	16.5	49	7	W	30	1022.3
17	We	6.6	14.0	0			NE	26	12:33	9.7	91	5	S	7	1028.8	13.2	85	8	NE	19	1025.4
18	Th	8.2	14.1	4.8			NW	39	04:15	11.9	94	7	NNE	15	1021.3	13.6	83	8	N	15	1018.4
19	Fr	10.7	12.9	14.8			N	24	06:46	12.2	98	8	NW	11	1010.4	12.3	97	8	NE	9	1007.2
20	Sa	3.7	13.1	3.0			NW	80	20:46	8.8	71	2	WSW	15	1008.5	12.5	75	6	NW	33	1006.9
21	Su	8.1	11.9	1.0			WNW	81	13:48	10.3	77	6	WNW	41	1005.2	11.0	60	7	W	50	1001.5
22	Mo	4.4	13.2	1.7			SW	46	11:18	10.2	53	1	SW	26	1014.3	13.0	42	2	WSW	26	1018.7
23	Tu	2.9	16.4	0			WSW	33	15:43	9.6	75	1	WNW	20	1024.4	16.0	38	1	WSW	24	1022.4
24	We	2.2	15.5	0			SSE	20	04:24	9.0	100	0		Calm	1026.9	14.9	60	1	NNE	9	1026.0
25	Th	2.5	13.8	0			WNW	48	16:45	7.5	77	3	SE	7	1029.9	13.1	76		NW	39	1026.8
26	Fr	4.0	14.0	0			W	30	00:04	10.9	62	4	W	13	1032.6	13.4	63	1	NW	15	1033.3
27	Sa	4.5	12.2	0			NW	24	13:46	9.2	88	8	SW	2	1032.7	11.3	66		NNW	15	1029.4
28	Su	7.1	14.7	0			NE	30	11:26	10.1	86	8	S	13	1026.1	13.5	88	8	NE	19	1022.1
29	Mo	7.8	16.6	0			NNW	43	22:52	12.5	84	8	ENE	17	1018.0	14.7	71	8	ENE	17	1013.1
30	Tu	12.0	14.1	6.0			NNW	61	10:04	13.2	89	8	NNW	19	1005.8	13.0	92	8	N	24	1001.6
31	We	9.5	12.4	47.2			NNW	91	11:16	10.9	70	6	NW	54	991.6	9.8	68	7	WNW	63	993.3
Statistics for August 2005																					
Mean		5.8	13.4							9.8	79	5		19	1016.5	12.2	69	5		27	1014.7
Lowest		0.6	9.2	0						5.2	53	0		Calm	991.6	7.3	38	1	#	9	993.3
Highest		12.0	16.6	47.2			NNW	91		13.8	100	8	NW	54	1032.7	16.5	97	8	WNW	63	1033.3
Total				152.0																	

50.7 Appendix v - Acknowledgements

The assistance of Werrin Farms staff who provided the trial site is gratefully acknowledged.

Serve-Ag Research staff who contributed to this project included Kate Williams, Sarah Flynn and Karon Faulkner.

50.7.1.1

INTERIM REPORT AS AT 01/05/06

Evaluation of Baron 40 WG for control of Groundsel (*Senecio vulgaris*) in post harvest pyerthrum

Tasmania, 2006

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Report Number: BRA03134#10

Report Date: 12 May 2006

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51 Summary

At Moriarty in 2006 Simazine 500 SC, Baron 40 WG, Onduty 700 WG and Terbuthylazine 750 WG were applied to a pyrethrum crop post harvest to evaluate their crop safety and efficacy on groundsel (*Senecio vulgaris*). Onduty at 38.5 g ai/ha and terbuthylazine at 1012 g ai/ha and simazine at 1000 g ai/ha were applied once in March 2006 pre weed emergence when the pyrethrum were 10-15 cm rosettes. Baron was applied as a single application pre weed emergence in March at 400, 600, 800 and 1200 g ai/ha and compared to 3 applications of either 132, 200 and 264 g ai/ha applied at approximately monthly intervals beginning in March.

Weed efficacy was assessed by quadrant density counts and crop safety was assessed visually at 14 days after application timing 1 (14DAAT1) and 14DAAT2.

Groundsel started emerging in the untreated controls around the beginning of April. A weeds efficacy assessment was conducted on 01/05/06 when the groundsel was at the cotyledon – 2 leaf growth stage At this time the treatments with sequential Baron applications had only received 2 of the 3 applications. At this assessment there was an average of 238 groundsel plants per square meter in the untreated control. All Baron Treatments provided 100% control of groundsel at 46DAAT1 and 22DAAT2. Simazine was also very effective with only an average goundel density of 1.7 m2 in simazine treated plots. Terbuthlazine and Onduty did not effectively control groundsel.

There was no treatment related phytotoxicity in any treatments at either 14DAAT1 or 14DAAT2.

52 Introduction

52.1 Aims

- To evaluate Baron 40 WG for control of groundsel in pyrethrum post harvest.
- To compare a single application of Baron in March with 3 sequential applications at monthly intervals.
- To evaluate crop safety and pyrethrum yield with various Baron 40 WG treatments.
- To screen terbuthylazine and Onduty and compare them with Baron 40 WG for crop safety and weed efficacy.

52.2 Target Weed

Groundsel (*Senecio vulgaris*)

53 Materials and Methods

53.1 Product List

Product Name	Active Ingredient (ai)	Concentration of Active Ingredient	Formulation
Baron 40 WG	oxyfluorfen	400 g/kg	Wettable Granule
Gesatop	simazine	500 g/L	Suspension concentrate
Onduty	imazapic imazapyr	525 g/kg 175 g/kg	Wettable Granule
Terbuthylazine	terbuthylazine	750 g/kg	Wettable Granule

53.2 Treatment List

No.	Product	Rate		Application Schedule
		Product (L/ha) or (kg/ha)	Active Ingredient (g ai/ha)	
1	Untreated control	nil	nil	nil
2	Baron	1 Kg	400 g	1 application in March
3	Baron	1.5 Kg	600 g	
4	Baron	2 Kg	800 g	
5	Baron	3 Kg	1200 g	
6	Baron	330 g	132 g	3 applications at 4 weekly intervals beginning in March
7	Baron	500 g	200 g	
8	Baron	660 g	264 g	
9	Onduty	55 g	38.5	1 application in March
10	Gardoprim 750 WG	1.35 Kg	1012	
11	Simazine 500 SC	2 L	1000	
12	Handweed Control	nil	nil	nil

53.3 Chronology of Events

Date	Days After Application (DAA)	Crop Stage	Event
16/03/06	-	10 -15 cm Rosette	Application Timing 1
30/03/06	14DAAT1	10 -15 cm Rosette	Crop safety Assessment 1
09/04/06		10 -15 cm Rosette	Application Timing 2
23/04/06	14DAAT2	10 -15 cm Rosette	Crop safety Assessment 2
01/05/06	46DAAT1 and 22DAAT2	10 -15 cm Rosette	Weed density Count

54 Results

54.1 Table 1 - Crop Safety Assessments 14DAAT1 and 14DAAT2

No.	Application Timing 1 Groundsel – pre emergence 16/03/06	Application Timing 2 Grounsel - cotyledon 09/04/06	% Crop Biomass Reduction	
			14DAAT1 30/03/06	14 DAAT2 23/04/06
1	Untreated control		0	0
2	Baron 40 WG 1 kg		0	0
3	Baron 40 WG 1.5 kg		0	0
4	Baron 40 WG 2 kg		0	0
5	Baron 40 WG 3 kg		0	0
6	Baron 40 WG 330 g	Baron40 WG 330 g	0	0
7	Baron 40 WG 500 g	Baron40 WG 500 g	0	0
8	Baron 40 WG 660 g	Baron40 WG 660 g	0	0
9	Onduty 55 g		0	0
10	Gardoprim 750 WG 1.35 kg		0	0
11	Simazine 500 SC 2 L		0	0
12	Hand weeded control		0	0

54.2 Table 2 - Groundsel density count 01/05/06 46 DAAT1 and 22 DAAT2

No.	Application Timing 1 Groundsel – pre emergence 16/03/06	Application Timing 2 Grounsel - cotyledon 09/04/06	Mean Grounsel seedlings / m^2	
1	Untreated Control		238.0	b
2	Baron 40 WG 1 kg		0.0	a
3	Baron 40 WG 1.5 kg		0.0	a
4	Baron 40 WG 2 kg		0.0	a
5	Baron 40 WG 3 kg		0.0	a
6	Baron 40 WG 330 g	Baron40 WG 330 g	0.0	a
7	Baron 40 WG 500 g	Baron40 WG 500 g	0.0	a
8	Baron 40 WG 660 g	Baron40 WG 660 g	0.0	a
9	Onduty 55 g		184.7	b
10	Gardoprim 750 WG 1.35 kg		79.0	a
11	Simazine 500 SC 2 L		1.7	a
12	Hand weeded control		-	-
p value			0.0000	
LSD (5% level)			90.3	

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

55 Results and Discussion

Grounsel started emerging in the untreated controls around the beginning of April. A weeds efficacy assessment was conducted on 01/05/06 when the grounsel was at the cotyledon – 2 leaf growth stage At this time the treatments with sequential Baron applications had only received 2 of the 3 applications. At this assessment there was an average of 238 grounsel plants per square meter in the untreated control. All Baron Treatments provided 100% control of groundsel at 46DAAT1 and 22DAAT2. Simazine was also very effective with only an average goundel density of 1.7 m2 in simazine treated plots. Terbuthlazine and Onduty did not effectively control groundsel.

There was no treatment related phytotoxicity in any treatments at either 14DAAT1 or 14DAAT2.

56 Conclusions

- Baron 40 WG at rates of 132 g ai/ha (x2 applications) and above provided 100% control of groundsel (*Senecio vulgaris*) at 46DAAT1 and 22DAAT2.
- Simazine 500 SC at 1000 kg ai/ha controlled grounsel.
- Onduty 700 WG at 38.5 g ai/ha and terbuthylazine 750 WG at 1012 g ai/ha did not control groundsel.
- There was no treatment related phytotoxicity in any treatments at either 14DAAT1 or 14DAAT2.

57 Appendices

57.1 Appendix i - Trial Details

57.1.1 Site Details

Grower	Chaplins
Location	Wesley Vale
Grid Reference	Paddock
Soil Type	Ferrosol
Crop	Pyrethrum
Variety	Pyper
Trial Design	Randomised complete block
Replications	4
Plot Size	2 x 8m
Sowing Date	

57.1.2 Trial Plan

6	3	8	4	7	2	11	1	9	12	5	10	**Block 4**
9	2	12	11	6	10	3	5	4	1	8	7	**Block 3**
11	4	9	5	8	1	6	2	3	7	10	12	**Block 2**
1	5	10	7	12	3	11	8	6	9	4	2	**Block 1**

↙N

57.1.3 Application Details

Application Equipment		
Equipment	Carbon Dioxide Pressurised Spray Unit	
Nozzles	XR8002	DG8002
Volume	250L/ha	240L/ha
Pressure	2.8 bar	2.8 bar
Method	1m / sec	1m / sec
Treatment Applications		
Application Number	1	2
Date	16/03/06	09/04/06
Time	3-4 pm	12-1 pm
Treatments Applied	Application Timing 1 March	Application Timing 2 April
Temperature (^{O}C)	22 ^{O}	20 ^{O}
Relative Humidity (%)	53	20
Cloud Cover (%)	100	30
Wind Direction	NW	SW
Wind Speed (km/h)	0-5	0-5
Soil Moisture or Leaf Wetness	Moist	Dry
Pest / Weed / Disease Growth Stage / Level	No weeds	Groundsel just beginning to emerge
Crop Stage	10-15cm Rosette	10-15cm Rosette

Meteorological data from Forthside Vegetable Research Station for the months of March and April are included as Appendix iv to this report. The trial site was situated 25 km from Forthside.

57.1.4 Assessments

1. Crop Safety Assessment		
Dates	30/03/06	23/04/06
Days After Application	14DAAT1	14DAAT2
Sample Size	Whole Plot	
Method	Plants observed for symptoms of pytotoxicity and also visually rated for biomass compared to the hand weeded control.	
Statistical Analysis	Analysis of Variance tests and Fischers least significant difference (LSD) tests were conducted using Statgraphics Plus	
2. Weed Efficacy Assessment		
Date	01/05/06	
Days After Application	46DAAT1 and 22DAAT2	
Sample Size	3 0.25m2 quadrants per plot	
Method	Weeds counted within quadrant	
Statistical Analysis	Analysis of Variance tests and Fischers least significant difference (LSD) tests were conducted using Statgraphics Plus	

57.2 Appendix ii - Raw Data

57.2.1.1 Weed Efficacy Assessment 01/05/06

No.	Application Timing 1 March (16th)	Application Timing 2 April (9th)	Rep	Quadrat 1	Quadrat 2	Quadrat 3	Groundsel /m2
1	Untreated Control		1	46	92	51	252
			2	12	211	90	417
			3	36	121	18	233
			4	12	4	21	49
			Mean	26.5	107.0	45.0	238
2	Baron 1 kg		1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
3	Baron 1.5 kg		1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
4	Baron 2 kg		1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
5	Baron 3 kg		1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
6	Baron 330 g	Baron 330 g	1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
7	Baron 500 g	Baron 500 g	1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
8	Baron 660 g	Baron 660 g	1	0	0	0	0
			2	0	0	0	0
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.0	0.0	0.0	0
9	Onduty 55g		1	15	42	8	87
			2	140	41	92	364
			3	41	17	112	227
			4	0	19	27	61
			Mean	49.0	29.8	59.8	185
10	Gardoprim 750 WG 1.35 kg		1	56	32	21	145
			2	73	15	35	164
			3	1	2	2	7
			4	0	0	0	0
			Mean	32.5	12.3	14.5	79
11	Simazine 500 SC 2 L		1	0	0	0	0
			2	2	0	3	7
			3	0	0	0	0
			4	0	0	0	0
			Mean	0.5	0.0	0.8	2
12	Handweed Control		1	65	52	48	220
			2	0	0	0	0
			3	38	125	94	343
			4	33	14	0	63
			Mean	34.0	47.8	35.5	156

57.3 Appendix iii - Statistical Analysis

Analysis of Variance for Groundsel per square metre - Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
MAIN EFFECTS					
A:Treatment	295833.0	10	29583.3	7.56	0.0000
B:Replicate	32473.4	3	10824.5	2.77	0.0590
RESIDUAL	117371.0	30	3912.37		
TOTAL (CORRECTED)	445677.0	43			

All F-ratios are based on the residual mean square error.

Multiple Range Tests for Groundsel per square metre by Treatment

Method: 95.0 percent LSD

Treatment	Count	LS Mean	Homogeneous Groups
6	4	0.0	X
7	4	0.0	X
3	4	0.0	X
4	4	0.0	X
2	4	0.0	X
8	4	0.0	X
5	4	0.0	X
11	4	1.66667	X
10	4	79.0	X
9	4	184.667	X
1	4	238.0	X

57.4 Appendix iv - Meteorological Details

Date	Time	Min AirTemp (degC)	Ave AirTemp (degC)	Max AirTemp (degC)	Min Humidity (%)	Ave Humidity (%)	Max Humidity (%)	Ave SoilTmp (degC)	Min WndSpd (m/s)	Ave WndSpd (m/s)	Max WndSpd (m/s)	RainTot (mm)
1/03/2006	9:00 AM	9	15.3	22.2	38.4	61.8	78.2	19.1	0	3.59	12.42	0
2/03/2006	9:00 AM	11.4	16	20.6	51.4	73.3	90.4	19.5	0	2.41	7.62	0
3/03/2006	9:00 AM	14.2	18	22.6	30.5	70.1	88.7	20.6	0	1.97	6.35	0
4/03/2006	9:00 AM	12	17.8	23.5	60	82.8	96.5	21.7	0	1.58	7.31	0
5/03/2006	9:00 AM	14.2	17.5	21	74.5	90.1	95.6	20.1	0	1.8	4.91	1.6
6/03/2006	9:00 AM	9.2	14.8	18.7	62.5	80	94.8	18.9	0	2.46	8.74	0
7/03/2006	9:00 AM	10.4	14.1	20.2	39	58.6	75.3	18.1	0.43	4.33	14.34	0.2
8/03/2006	9:00 AM	11.3	13.2	16.9	45.8	66.5	82	16.9	0.43	3.87	10.82	0
9/03/2006	9:00 AM	11.4	16.4	23.5	41.2	66.9	88.5	18.2	0.59	3.42	10.98	0
10/03/2006	9:00 AM	11.6	16.5	22.5	38.8	66.1	90.9	18.9	0	3.39	10.5	0
11/03/2006	9:00 AM	12.5	16.4	20.8	57.2	77.5	88.5	19.7	0	2.46	8.42	0
12/03/2006	9:00 AM	15.9	18.2	21.4	57.4	79.6	90.4	20.6	0	2.31	6.83	0
13/03/2006	9:00 AM	12.6	18.8	22.4	70.3	82.7	95	20.8	0	2.42	11.78	8.6
14/03/2006	9:00 AM	8	13.8	19.7	38.1	63.1	82.1	17.7	0	4.46	14.81	0
15/03/2006	9:00 AM	7.8	12	17	39.8	71.1	89.8	16	0	2.2	9.86	0
16/03/2006	9:00 AM	10.4	14.3	19.3	49.4	74.4	92.6	17.1	0	1.78	6.35	0.6
17/03/2006	9:00 AM	9.8	13.6	18.2	66.5	79.1	91.9	16	0	2.28	8.74	7
18/03/2006	9:00 AM	11.3	15.5	20.9	47	62.1	80.6	16.4	0	3.92	11.3	0
19/03/2006	9:00 AM	8.3	14	19.1	45.8	77.2	93.7	16.1	0	2.14	8.26	0
20/03/2006	9:00 AM	6.3	12.7	19.4	39.9	62.9	81.4	15.7	0	3.66	14.02	0
21/03/2006	9:00 AM	10	13.6	18.4	55.9	77.5	92.2	16.2	0	1.83	6.51	0
22/03/2006	9:00 AM	9.9	14.3	20.1	52.3	80.2	94.3	16.7	0	1.85	6.51	0
23/03/2006	9:00 AM	11.7	15.8	21.5	49.2	74.8	89.8	17.5	0	1.85	6.51	0
24/03/2006	9:00 AM	13.4	17.5	23.4	45.3	67.5	88.6	18.6	0	3.15	9.38	0
25/03/2006	9:00 AM	11.3	15.6	21.3	50.7	66.6	74.5	18.3	0.43	3.15	8.9	0
26/03/2006	9:00 AM	10.4	15.5	20.9	47.1	76.3	95.3	18	0	1.9	8.1	0
27/03/2006	9:00 AM	13.8	16.4	20.3	63	83.2	95	18	0	1.46	5.87	2.4
28/03/2006	9:00 AM	8.4	13.2	20.2	58.9	77.7	93.3	17.4	0	2.62	10.02	2.6
29/03/2006	9:00 AM	9.1	13.5	18.3	46.6	69.4	87.8	16.3	0	2.19	6.83	0
30/03/2006	9:00 AM	9.4	14.7	19.1	56.5	77.8	95.1	17	0	1.45	6.67	0.2
31/03/2006	9:00 AM	10.7	15	21	35.6	65	92.8	16.6	0	3.65	12.1	0

Date	Time	Min AirTemp (degC)	Ave AirTemp (degC)	Max AirTemp (degC)	Min Humidity (%)	Ave Humidity (%)	Max Humidity (%)	Ave SoilTmp (degC)	Min WndSpd (m/s)	Ave WndSpd (m/s)	Max WndSpd (m/s)	RainTot (mm)
1/04/2006	9:00 AM	5	9.9	16.8	42.2	64	82.6	14.5	0	4.83	15.61	0
2/04/2006	9:00 AM	3.6	9.1	15.6	30.5	57	74.6	12.8	0	3.35	14.18	0
3/04/2006	9:00 AM	4.7	9.8	16.8	30.9	59.3	84.7	12.8	0	2.49	9.38	0
4/04/2006	9:00 AM	8.8	11.5	15.3	46.3	77.1	95.1	13.6	0	1.58	7.31	4.2
5/04/2006	9:00 AM	8.6	12.3	16.5	62.6	79.7	96.1	14.3	0	2.55	11.94	3.8
6/04/2006	9:00 AM	5	9.3	14.5	57.9	77.3	92.7	12	0	4.07	12.9	5.8
7/04/2006	9:00 AM	8.6	10.2	13.6	43.5	63.6	79.7	11.1	0.75	7.39	19.61	0.2
8/04/2006	9:00 AM	6.3	9.8	13.4	45.5	58.7	68.7	10.9	0	5.76	17.53	0
9/04/2006	9:00 AM	6.1	10.2	14	47.5	56.1	69.1	10.7	0	6	19.45	0
10/04/2006	9:00 AM	4.3	10.4	17	42.3	67	91.7	11.5	0	2.37	7.47	0
11/04/2006	9:00 AM	6.7	11.4	14.9	64.9	82	94.4	11.8	0	1.61	7.15	0
12/04/2006	9:00 AM	9.2	13.5	18	64.4	78.9	94.3	12.8	0	4.8	15.77	3.2
13/04/2006	9:00 AM	9.4	12.3	16.5	57.1	77.6	93	12.4	0	2.65	11.78	0.2
14/04/2006	9:00 AM	11.3	13.4	16.5	70.4	86.2	94.7	13.4	0	2.86	10.66	1
15/04/2006	9:00 AM	6.2	11.4	16.8	65.3	81.4	94.7	13.3	0	2.86	10.5	8.2
16/04/2006	9:00 AM	4.5	9.4	14.5	44.8	60.3	75.3	11.2	0	3.69	13.38	0
17/04/2006	9:00 AM	3.8	8.5	14.4	44.1	72	90.9	10.8	0	2.04	6.99	0
18/04/2006	9:00 AM	5.7	12.4	15.5	61.6	78.8	94.1	12	0	3.29	19.61	12.6
19/04/2006	9:00 AM	11.3	13.6	15.2	61.5	80.6	93.7	12.7	1.39	7.77	19.61	18.2
20/04/2006	9:00 AM	7.4	11.1	15.2	77.4	90.5	96.4	12.8	0	4.29	16.41	40.6
21/04/2006	9:00 AM	2.1	6.6	11.1	57.6	79.2	92.3	9.9	0	3.4	18.17	2
22/04/2006	9:00 AM	1.4	6.8	13.3	44.5	73.9	93.4	9.4	0	2.22	9.38	0
23/04/2006	9:00 AM	5.2	9.5	13.8	61.6	72.5	85.7	9.3	0	3.38	12.74	0
24/04/2006	9:00 AM	3.4	7.8	13.6	49.1	70.7	86.3	9.4	0.43	2.82	9.06	0
25/04/2006	9:00 AM	4.3	8.3	14.2	45.9	76.7	93.5	9.6	0	1.68	5.39	0
26/04/2006	9:00 AM	4.4	9.4	15.5	54.4	79.8	95.7	10.3	0	1.7	5.71	0
27/04/2006	9:00 AM	5	9.8	15.5	60.1	85	95.7	10.8	0	1.64	5.23	0
28/04/2006	9:00 AM	6.3	10.7	15.5	66.9	84.5	95.7	11.2	0	1.57	4.75	0
29/04/2006	9:00 AM	8	10.7	12.3	72.2	80.6	89.6	11.4	0	1.88	6.03	0
30/04/2006	9:00 AM	8	12.3	16.2	55.1	72.3	88.6	12.2	0	1.8	6.35	0

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57.6 Appendix v - Acknowledgements

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