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Biological and chemical control of Rhizoctonia

B Hall, K Davies and T Wicks
South Australian Research and Development Institute

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BIOLOGICAL AND CHEMICAL CONTROL OF *RHIZOCTONIA*

HRDC FINAL REPORT
May 2000

PROJECT PT98036

By B Hall, K Davies, T Wicks

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Government of South Australia

HRDC Project PT 98036

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This report is the result of 18 months investigation into the control of *Rhizoctonia solani* on potatoes, using registered and experimental fungicides, and biological agents.

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INDUSTRY SUMMARY

Laboratory, shadehouse and field experiments were carried out to evaluate 2 potential biological agents and 6 fungicides for the control of *Rhizoctonia solani*.

The laboratory experiments tested the ability of the fungicides and biological agents to reduce sclerote viability on tubers. Monceren®, Maxim® and Experimental 1 were the only fungicides which completely inhibited sclerotial viability. Experimental 2 was the most effective of the other fungicides tested, with only 12 to 23% of the sclerotes remaining viable. The effect of the 2 strobilurins tested was variable, and in general not inhibitory at even the highest rates tested. The biological agents were also not inhibitory, except one achieved total inhibition where tubers were immersed for 24 hours in undiluted product.

Neither biological agent controlled *Rhizoctonia* when applied to the seed tuber, the soil at planting, or the soil after emergence. Nor was control achieved with combinations of seed and soil treatments, with or without the addition of humate.

Two strobilurin fungicides were evaluated for the control of *Rhizoctonia*, however one was withdrawn and not tested in field experiments. Amistar®, currently registered for use on Target Spot in potatoes, was in most cases as effective as Monceren® seed treatment when applied in furrow at rates over 100g a.i./Ha. It was not effective as a soil treatment or foliar spray. Monceren® was also very effective when applied in furrow.

All chemical seed treatments were more effective when applied to seed with low tuber infection, or when treated seed was planted into clean ground.

None of the fungicides or biological agents appeared to have any adverse effects on emergence or crop vigour, and no phytotoxic effects were observed. The yield data was extremely variable, which is common in small plot experiments, and no clear conclusions on the effect of the treatments on yield could be drawn from these results. Generally, all fungicides increased yield compared to the untreated control in pot experiments in the shadehouse, but the same chemicals in field experiments often reduced total yield.

Overall these studies showed that the biological agents tested could not be recommended for the control of *Rhizoctonia* in potatoes. Monceren®, Maxim® and 2 of the experimental fungicides could all be recommended as seed treatments. Amistar® and Monceren® also show promise as in furrow treatments for the control of *Rhizoctonia*, and further work should be undertaken on this aspect.

TECHNICAL SUMMARY

Laboratory, shadehouse and field experiments were carried out to evaluate 2 potential biological agents and 6 fungicides for the control of *Rhizoctonia solani*.

In the laboratory experiments, the viability of sclerotes was inhibited completely by Monceren®, Maxim® and one of the experimental fungicides. Experimental 2 was the most effective of the other fungicides tested, with only 12 to 23% of the sclerotes remaining viable. The effect of the 2 strobilurins tested was variable, and in general not inhibitory at even the highest rates tested. Neither of the biological agents inhibited sclerote germination, except for one where tubers were immersed for 24 hours in undiluted product.

In the shadehouse experiments, all seed treatments tested gave equivalent or better control of *Rhizoctonia* than the standard Monceren®. Amistar® applied in furrow was only effective at the highest rate, 112g a.i./Ha, and was not effective as a foliar spray. Experimental 3 applied at 200g a.i./T, although not effective at reducing sclerotial germination in the laboratory tests, was the only fungicide in pot experiments to completely inhibit the development of *Rhizoctonia* on daughter tubers. It was also very effective in field experiments.

Although only a few of the tubers planted in the pot experiment developed disease, the results indicate that neither biological agent, with or without the addition of humate, had any effect on the control of *Rhizoctonia*. Similarly in the field experiments, control of *Rhizoctonia* was not observed with either of the biological agents applied to the seed or soil at planting, to the soil after emergence on up to three occasions, or combinations of these treatments.

Two strobilurin fungicides were evaluated for the control of *Rhizoctonia*, however one was withdrawn and not tested in field experiments. Amistar®, currently registered for use on Target Spot in potatoes, was in most cases as effective as Monceren® seed treatment when applied in furrow at rates over 100g a.i./Ha. It was not effective as a soil treatment or foliar spray. Monceren® was also very effective when applied in furrow.

In the field plantings, where natural levels of *Rhizoctonia* were high from previous diseased crops, none of the fungicides tested were completely effective in reducing the incidence or severity of infections on the underground stems of the potatoes. Amistar® applied in furrow at 224g a.i./Ha was the most effective, reducing stem infection by over 50%. The level of stem infection, however, could not be directly correlated to the level of control achieved on the daughter tubers at harvest. For example in one experiment, Monceren® applied in furrow actually had a higher incidence of stem infection than the untreated control, but by harvest, the incidence of tuber infection was only 6% compared to 84%. Unfortunately, due to an infection of Tomato Spotted Wilt Virus, disease levels at harvest from treated tubers planted into heavily infected ground could not be obtained for many of the fungicides.

All chemicals applied as seed treatments were more effective when applied to seed with low tuber infection and planted into clean ground. For example Monceren® achieved almost total control of *Rhizoctonia* (1% of daughter tubers infected) when applied to seed

tubers with 28% infected and planted into new ground. When applied to tubers with 68% infected and planted into the same ground 2 years later, the incidence of infected daughter tubers was 37%. However this was still a significant reduction in disease, as the incidence of infected tubers in the untreated controls of the same experiments was 22% and 70% respectively.

Overall these studies showed that the biological agents tested could not be recommended for the control of *Rhizoctonia* in potatoes. Monceren®, Maxim® and 2 of the experimental fungicides could all be recommended as seed treatments and Amistar® and Monceren® as in furrow treatments for the control of *Rhizoctonia*.

The results also indicate that any treatment will be more effective if both the soil and tuber inoculum level is low.

TECHNICAL REPORT:

INTRODUCTION

Rhizoctonia, also known as Black scurf, is caused by the fungus *Rhizoctonia solani* and is found in most potato growing areas throughout the world. The fungus causes delayed emergence, reduced stands, and in some cases reduces yield and quality.

Rhizoctonia attacks the underground plant parts causing brownish black sunken areas (cankers) on the stems and stolons. Stolons are also attacked and are pruned when the fungus infects the tips or girdles the stolon completely. On the tuber surface *Rhizoctonia* forms sclerotia, black structures 1m to 10mm in diameter, hence the name Black scurf.

The fungus is both tuber and soil borne and is difficult and expensive to control. On tubers, *Rhizoctonia* survives as sclerotia and as fine strands of fungus that are not visible to the eye. Recent research (Wicks et al. 1996) has shown that the fungus is present on most tuber seed, and this is the main means of introducing the disease into new areas.

In soil, the fungus survives in decomposing plant residues or as free sclerotia. The soil phase is usually associated with rotting of the roots and stolon tips, and causes stolon infection and the formation of sclerotia on the tubers. Sclerotia form late in the season after the potato plants begin to die off, and the longer tubers remain in the soil the greater the sclerotia development.

Both tuber and soil phases of this disease need to be considered in any management program. Existing chemical tuber and soil treatments control the disease, however new chemicals with unique modes of action have recently been developed which show promise. Biological agents have also shown potential (Wicks et al. 1996), but until recently there has been little work in this area.

This report outlines laboratory, shadehouse and field studies into some of these new chemicals, and 2 biological agents developed commercially. The fungicides tested include Maxim® (fludioxonil 100g/L), Amistar® (azoxystrobin 500g/Kg, registered to Zeneca), Monceren® (pencycuron 250g/L), Rovral® (iprodione, 500g/Kg), Rizolex® (tolclofos-methyl 100g/Kg) and 4 experimental fungicides.

LABORATORY EXPERIMENTS

Three separate experiments were carried out to determine the effect of chemical and biological treatments on the viability of *Rhizoctonia* sclerotes.

Materials and methods

Treatments, at the rates shown in tables 1-3, were applied by mixing the desired amount of each fungicide with 15mls of sterile water and spraying the suspension, using a Jet-Pak sprayer, onto ten whole seed tubers cv. Coliban that were covered with sclerotes as a result of natural infection.

The tubers were allowed to dry for 1-2 hours after treatment. Tubers were then placed into trays lined with a moist cloth and sealed in a plastic bag to create humid conditions. After 4 days incubation at 22°C, ten sclerotes were removed from each tuber, transferred onto plates of Tap Water Agar and incubated at 22°C.

The viability of each sclerote was assessed after 48 hours by examining the plates for mycelial growth typical of *Rhizoctonia.* The sclerotes were scored as viable where *Rhizoctonia* mycelial growth was detected. The percent inhibition of sclerote viability was then calculated from the following formula:

$$100 - \frac{(100 \times \text{number of sclerotes that were viable after treatment})}{(\text{number of sclerotes viable in the untreated control})}$$

Results and Discussion

Monceren®, Maxim® and Experimental 1 were the only treatments that consistently killed the sclerotes, with 100% inhibition. Biological 1 also killed all sclerotes when the tubers were dipped for 24 hours (Tables 1-3). In Experiment 2, the viability of sclerotes treated with Experimental 4 increased with higher doses of the chemical (Table 2), however when repeated (Table 3) the viability varied and no dose response was found.

It is possible that the mode of action of some of these fungicides does not act on the sclerotial viability. For example, Amistar® controls disease by inhibiting the mitochondrial growth of the fungi. Sclerotes have no actively growing fungi, so are unlikely to be affected. When the sclerotes were plated, the concentration of the fungicide diffusing into the agar from the sclerotes may have been too low to affect the mycelial growth .

Table 1. Effect of fungicides on viability of sclerotes, laboratory experiment 1.

Treatment	Rate	% inhibition of sclerote viability
Experimental 1	10g a.i./tonne	100 a
	20g a.i./tonne	100 a
	40g a.i./tonne	100 a
	80g a.i./tonne	100 a
Amistar®	10g a.i./tonne	26 e
	20g a.i./tonne	45 d
	40g a.i./tonne	6 fg
	80g a.i./tonne	6 fg
Experimental 2	30g a.i./tonne	75 bc
	45g a.i./tonne	82 b
	60g a.i./tonne	81 b
	75g a.i./tonne	87 ab
Maxim®	1.5g a.i./tonne	100 a
	2g a.i./tonne	100 a
	2.5g a.i./tonne	100 a
Biological 1	1:1 dilution, sprayed	18 ef
	Undiluted, sprayed	1 g
	Undiluted, dipped for 30 mins	6 fg
	Undiluted, dipped for 2 hours	61 c
	Undiluted, dipped for 24 hours	100 a
Biological 2	1:1 dilution, sprayed	0 g
	Undiluted, sprayed	0 g
Monceren®	0.6ml product/Kg	100 a
Control	Sprayed with water	0 g
Control	Dipped in water 24 hours	0 g
LSD (P=0.05)		**16.12**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Table 2. Effect of fungicides on viability of sclerotes, laboratory experiment 2.

Treatment	Rate	% inhibition of sclerote viability
Experimental 3	12.5g a.i./tonne	12 d
	25g a.i./tonne	9 d
	50g a.i./tonne	0 e
	100g a.i./tonne	26 cd
	200g a.i./tonne	0 e
Experimental 4	10g a.i./tonne	82 a
	20g a.i./tonne	61 ab
	40g a.i./tonne	59 ab
	80g a.i./tonne	45 bc
	160g a.i./tonne	33 bcd
	320g a.i./tonne	18 cd
Amistar®	80g a.i./tonne	9 d
	160g a.i./tonne	44 bc
	240g a.i./tonne	23 cd
	320g a.i./tonne	55 ab
Control	water	0 e
L.S.D. (P=0.05)		**28.12**

Table 3. Effect of fungicides on viability of sclerotes, laboratory experiment 3.

Treatment	Rate	% inhibition of sclerote viability
Experimental 3	200g a.i./tonne	89 a
Amistar®	240g a.i./tonne	83 ab
	132g a.i./tonne	72 ab
Experimental 4	10g a.i./tonne	33 cd
	20g a.i./tonne	63 abc
	40g a.i./tonne	0 d
	80g a.i./tonne	46 bc
	160g a.i./tonne	65 abc
	320g a.i./tonne	48 bc
Control	water	0 d
L.S.D. (P=0.05)		**38.19**

Note: Values followed by the same letter are not significantly different (P = 0.05).

SHADEHOUSE EXPERIMENTS

Two experiments were carried out using tubers planted in pots in a shadehouse. These evaluated the efficacy of various chemical and biological treatments of tuber seed and soil for the control of *Rhizoctonia*.

Experiment 1.

Materials And Methods

Whole tubers, cv. Coliban, with *Rhizoctonia* sclerotes at various severity levels on all tubers were planted on the 19th January 1999. Two seed tubers per pot were planted into 15L pots of UC mix soil, with eight pots per treatment. Pots were arranged in a randomised complete block design in the shadehouse. Plants emerged on 10/2/99 and irrigation commenced two days later. Each pot received 1.3 litres of water per day thereafter until 2 weeks before harvest.

Tuber seed and soil treatments were applied at the rates shown in Table 4. Seed treatments were applied by mixing the desired amount of each fungicide with 15ml of sterile water and spraying the suspension onto tubers using a Jet-Pak sprayer. This method ensured that the tubers were completely covered with the fungicide suspension. The control was sprayed with sterile water. A Jet Pak sprayer was used to apply the in furrow treatments where 5ml of the chemical was sprayed onto the tubers and the surrounding soil in the pot. Tubers were allowed to dry before they were covered with more soil. Foliar sprays were applied with a hand held atomiser to the foliage, using water rates equivalent to 500L/Ha, and applied on 5 occasions at biweekly intervals commencing 4 weeks after planting.

Tubers from each pot were counted and weighed and the severity of *Rhizoctonia* assessed.

Results And Discussion

All tubers in the control treatment were infected, whereas most of the other treatments significantly reduced the incidence of *Rhizoctonia* on tubers to below 50% (Table 5). Amistar® was the least effective, with only the highest rate significantly reducing the incidence of sclerotes on the tubers compared to those in the untreated. A dose response was obvious in those treatments where Experimental 3 was applied to tubers. In these treatments the highest rate completely controlled *Rhizoctonia*.

These chemicals were tested under extreme conditions, as all the seed tubers planted were infected at levels much higher than would normally be used in commercial plantings.

Tuber yields in all fungicide treatments were higher than those in the untreated, but due to the large variation those differences were not significant (Table 6).

Table 4. Fungicides and rates applied to tubers and soil – Shadehouse experiment 1.

Treatment	Timing and Application	Rate of active ingredient applied
Control	-	-
Monceren® 250FS	Seed treatment	150g/T
Maxim® 100FS	Seed treatment	25g/T
Amistar® 500WG	In furrow	28g/Ha
	In furrow	56g/Ha
	In furrow	112g/Ha
	Foliar spray	112g/Ha
Experimental 2	Seed treatment	15g/T
	Seed treatment	30g/T
	Seed treatment	60g/T
	Seed treatment	120g/T
Experimental 3	Seed treatment	25g/T
	Seed treatment	50g/T
	Seed treatment	100g/T
	Seed treatment	200g/T

Table 5. Effect of seed tuber treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes grown in pots – Shadehouse experiment 1.

Treatment	*Rhizoctonia*	
	Incidence (%)	Severity
Control	100 a	76.0 a
Monceren® 150g a.i./T- seed treatment	42.7 c	19.9 cd
Maxim® 25g a.i./T - seed treatment	22.9 cd	8.9 cd
Amistar® 28g a.i./Ha – in furrow	100 a	73.4 ab
Amistar® 56g a.i./Ha – in furrow	91.0 ab	53.2 b
Amistar® 112g a.i./Ha – in furrow	40.1 c	20.5 cd
Amistar® 112g a.i./Ha – 5 biweekly sprays	97.7 a	64.0 ab
Experimental 2 15g a.i./T- seed treatment	50.0 c	26.5 c
Experimental 2 30g a.i./T - seed treatment	25.0 cd	18.3 cd
Experimental 2 60g a.i./T - seed treatment	25.3 cd	10.9 cd
Experimental 2 120g a.i./T - seed treatment	56.9 bc	27.1 c
Experimental 3 25g a.i./T - seed treatment	42.7 c	15.0 cd
Experimental 3 50g a.i./T - seed treatment	50.0 c	24.4 c
Experimental 3 100g a.i./T - seed treatment	3.9 d	1.3 d
Experimental 3 200g a.i./T - seed treatment	0.0 d	0.0 d
L.S.D (P = 0.05)	**35.83**	**21.63**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Table 6. Effect of seed tuber treatment on mean yield per pot and mean tuber weight- Shadehouse experiment 1.

Treatment	Yield (g)	Mean tuber weight (g)
Control	392 d	55.1
Monceren® 150g a.i./T - seed treatment	474 abc	52.3
Maxim® 25g a.i./T- seed treatment	526 a	56.4
Amistar® 28g a.i./Ha – in furrow	500 ab	71.8
Amistar® 56g a.i./Ha – in furrow	455 bcd	58.1
Amistar® 112g a.i./Ha – in furrow	425 cd	59.4
Amistar® 112g a.i./Ha – 5 biweekly sprays	419 cd	60.1
Experimental 2 15g a.i./T- seed treatment	450 bcd	58.2
Experimental 2 30g a.i./T - seed treatment	442 bcd	53.9
Experimental 2 60g a.i./T - seed treatment	470 abc	58.0
Experimental 2 120g a.i./T - seed treatment	484 abc	50.9
Experimental 3 25g a.i./T - seed treatment	424 cd	48.3
Experimental 3 50g a.i./T - seed treatment	453 bcd	53.6
Experimental 3 100g a.i./T - seed treatment	475 abc	61.3
Experimental 3 200g a.i./T - seed treatment	447 bcd	57.8
L.S.D (P = 0.05)	**68.75**	**n.s.**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Experiment 2

Materials And Methods

Coliban tubers infected with *Rhizoctonia* sclerotes were planted on 21st Jan 2000 into 15L pots of UC mix soil, 2 tubers per pot, with eight pots per treatment arranged in a randomised complete block design. Treatments and rates are shown in table 7.

Treatments were applied as in the previous experiment, except for the in furrow applications. After spraying, the seed and treated soil was then promptly covered with more soil to prevent the treated tubers or soil drying. Soil treatments used the same volume as in furrow, but were applied to the soil surface using a hand held atomiser at emergence (17/2), 3 weeks after emergence (10/3) and at a further 4 weeks (7/4).

K – Humate, produced by HRL Agriculture, was applied the day of planting and the day prior to each of the Biological soil treatments. A hand held atomiser was used to spray 2Kg/Ha of granulated K-Humate in a volume of 800L/Ha to the soil surface. In all cases where soil was treated, either using biologicals or K-Humate, pots were given a light sprinkling of water to aid the leaching of treatments into the soil.

Plants were grown in a shade house and watered using an automated dripper system. Each pot received 1 litre of water every 3rd day from emergence until 1 week before harvest (18/5/2000). Tubers from each pot were counted, weighed and the severity of *Rhizoctonia* sclerotia assessed.

Table 7. Treatments and rates applied, – Shadehouse experiment 2.

Treatment	Rate of product
Control	-
Control + K-Humate	2Kg/Ha
Biological 1 In furrow + Soil treatments	1L/Ha
Biological 1 In furrow + Soil treatments + K-Humate	1L/Ha + 2Kg/Ha
Biological 1 In furrow + Soil treatments	2L/Ha
Biological 1 In furrow + Soil treatments + K-Humate	2L/Ha + 2Kg/Ha
Biological 2 In furrow + Soil treatments	2L/Ha
Biological 2 In furrow + Soil treatments + K-Humate	2L/Ha + 2Kg/Ha
Biological 2 In furrow + Soil treatments	4L/Ha
Biological 2 In furrow + Soil treatments + K-Humate	4L/Ha + 2Kg/Ha
Monceren®	6ml/10Kg seed

Results And Discussion

Tubers infected with *Rhizoctonia* were only found in 7 pots, suggesting that most of the sclerotes on the seed tubers were not viable. Sclerote viability had not been tested before planting. Of those pots with infected tubers, 78 to 98% of the tubers were infected, with the control having the lowest level of infection (Table 8).

There were no significant differences between the treatments in either total weight or mean tuber weight (Table 9). In most cases, the addition of humic acid increased both yield measurements, and the double recommended rates of both biologicals reduced the mean tuber weight compared to the recommended rates.

Table 8. Effect of treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes grown in pots – Shadehouse experiment 2.

Treatment	No of pots with infected tubers	% of tubers infected
Control	1	79
Control + K-Humate	1	96
Biological 1 1L/Ha	1	97
Biological 1 1L/Ha + K-Humate	0	0
Biological 1 2L/Ha	0	0
Biological 1 2L/Ha + K-Humate	0	0
Biological 2 2L/Ha	1	93
Biological 2 2L/Ha + K-Humate	0	0
Biological 2 4L/Ha	2	91, 98
Biological 2 4L/Ha + K-Humate	1	82
Monceren®	0	0

Table 9. Effect of treatment on yield of potatoes grown in pots – Shadehouse experiment 2.

Treatment	Total weight of tubers (g)	Mean tuber weight (g)
Control	353.8	11.2
Control + K-Humate	379.2	9.7
Biological 1 1L/Ha	346.4	10.0
Biological 1 1L/Ha + K-Humate	390.3	9.25
Biological 1 2L/Ha	358.9	8.9
Biological 1 2L/Ha + K-Humate	378.2	10.5
Biological 2 2L/Ha	344.2	10.2
Biological 2 2L/Ha + K-Humate	369.1	11.4
Biological 2 4L/Ha	356.9	8.4
Biological 2 4L/Ha + K-Humate	356.3	9.7
Monceren®	350.5	11.5
L.S.D. (P=0.05)	**n.s.**	**n.s.**

FIELD EXPERIMENTS

Seven field experiments were undertaken to evaluate various seed tuber and soil treatments of chemical and biological agents for the control of *Rhizoctonia*. Three experiments were planted on a commercial potato growing property in Angle Vale. The site consisted of red brown earths which had been planted to potatoes in the previous year and was known to be infected with *Rhizoctonia*. Three were planted in heavy loam soil at the Lenswood Research Centre, approximately 30km east of Adelaide. Two of these were in an area not previously planted to potatoes, the third where potatoes had been planted 2 years previously. The final field experiment was on a commercial potato growing property near Narrung, 150km south-east of Adelaide, where soil was a sandy loam. The site had been planted to potatoes in the previous year and was naturally infected with *Rhizoctonia*, as high levels of sclerotes were observed at harvest.

General application methods

Tuber seed treatments were applied to 10Kg batches of tubers, using a hand held atomiser. 30ml of fungicide suspension was applied to tubers as they were rotated in a hand-operated cement mixer. This method ensured that the tubers were evenly covered with fungicide without excessive run off. Rizolex® was applied to 5Kg batches of tubers by shaking the chemical and tubers in a plastic bag until all tubers were evenly covered with fungicide.

All spray and in furrow applications, unless otherwise indicated, were applied using a "Solo" knapsack sprayer. Foliar sprays were applied to the foliage in a volume equivalent to 500L/Ha. Soil treatments were applied by spraying the soil surface on the top of the row with a volume equivalent of 1250L/Ha. This was followed by the application of 2500L/Ha of water to leach the products into the soil.

Fungicides were applied in furrow by spraying the chemical in a volume of 500L/Ha or the biological in a volume of 625L/Ha over the seed and surrounding soil at planting, after the tuber dropped into the furrow but prior to burial. With the biological treatments, the soil was watered before or after planting to ensure adequate levels of moisture were maintained for biological activity.

Biological tuber seed treatments were applied by spraying the seed just prior to being dropped into the furrow. This method prevented the suspension from drying on the seed before planting, in an attempt to maintain viability of the biological agents.

Assessments

Emergence:

The number of plants emerged was counted at 3 and 6 weeks after planting.

Stem Assessment:

At 14 weeks after planting, 10 plants per plot were removed and the *Rhizoctonia* cankers on individual stems assessed using a 0-5 scale as shown in Appendix 2. This was used to

calculate the percentage of stems infected, and the severity of that infection on a scale of 0 –100 using the following formula:

$$\frac{\Sigma(\text{No. of tubers/stems in each rating x rating})}{\text{Total No. of tubers/stems}} \times \frac{100}{\text{No. of ratings}}$$

The percentage of pruned stolons was also assessed.

Harvest assessments:

At harvest, tubers from each plot were sorted into "smalls" (below 80g), "marketable" (80-450g) and "large" (above 450g) and each category counted and weighed. 100 tubers were selected at random from each plot, washed and assessed for the level of *Rhizoctonia* sclerotes on each tuber using the keys shown in Appendix 1. This was used to calculate the percentage of tubers infected, and the severity of that infection as a rating from 0-100 using the formula described above.

Analysis:

Data from all experiments was analysed using the program "STATISTIX for Windows" V2. The Least Significant Differences (LSD) were calculated by General ANOVA unless otherwise specified.

Field Experiment 1, Angle Vale

Materials and methods

This experiment was planted on 24th March 1998 and harvested late July 1998. Biologicals and fungicides were used at recommended rates with a range of application methods outlined in table 10. Recommended rates of product were 1L/Ha, 2L/Ha and 600ml/Tonne for Biological 1, Biological 2 and Monceren® respectively. The experiment was arranged in randomised complete block design with plots consisting of four rows by 15 metres with 6 replications per treatment.

Stems were assessed on 10 plants per plot at 10 weeks after planting (1/6/98). At harvest, 100 tubers were hand dug, weighed and assessed for *Rhizoctonia*.

Table 10. Treatments applied, Field experiment 1, Angle Vale.

Treatments
Control (Untreated)
Biological 1 in furrow only
Biological 1 Tuber only
Biological 1 Tuber + in furrow
Biological 1 Tuber + in furrow + soil @ planting
Biological 1 soil @ emergence
Biological 1 soil @ emergence & flowering
Biological 1 soil @ emergence, 3 weeks later & flowering
Biological 2 in furrow only
Biological 2 Tuber only
Biological 2 Tuber + in furrow
Biological 2 Tuber + in furrow + soil @ planting
Biological 2 soil @ emergence
Biological 2 soil @ emergence & flowering
Biological 2 soil @ emergence, 3 weeks later & flowering
Monceren® seed treatment
Monceren® seed treatment + Biological 1
Monceren® seed treatment + Biological 2

Results and discussion

Stem Assessments:

Rhizoctonia stem cankers developed on over 50% of the stems from the control and most of the biological treatments (Table 11). Significantly lower levels of disease were only found in the treatments where Monceren® had been applied to the tubers. Both the incidence and severity of stem infections was higher in the biological treatments compared to the control, but this increase was not statistically significant. Sclerotes were found on 19% of the stems in the untreated control, and on 11-33% of stems from plants treated with biological agents. The lowest infection was observed with Monceren® treated tubers, where less than 3.5% of stems were found to have sclerotes.

Harvest disease assessments:

Rhizoctonia developed on 61% of the tubers in the control treatments (Table 12). Similar high levels of disease developed on most of the biological treatments, and none were significantly less than the control. Treatments that included Monceren® were the only ones with significantly less *Rhizoctonia* on the tubers. The addition of soil treatments of biologicals to the Monceren® tuber treatments showed a trend of improved control of *Rhizoctonia* compared to the Monceren® alone, however this reduction in disease level was not statistically significant.

Biological 1 generally reduced the disease more than the Biological 2 treatments, however in most cases these differences were not statistically significant. The results were very variable, and the addition of extra treatments of biologicals over the initial in furrow treatment rarely improved disease control.

No significant differences in mean tuber weights were observed between the treatments (Table 13).

Table 11. Level of *Rhizoctonia* on stems of plants treated with biological agents, Field experiment 1, Angle Vale.

Treatment	*Rhizoctonia* on stems		Stems with sclerotes (%)
	Incidence (%)	Severity	
Control (Untreated)	50.2 abcd	24.3 abcd	18.7 abc
Biological 1 in furrow only	55.1 ab	37 ab	23.2 ab
Biological 1 Tuber only	64.3 ab	31.7 ab	12.2 abc
Biological 1 Tuber + in furrow	62.0 ab	36.1 ab	26.8 a
Biological 1 Tuber + in furrow + soil @ planting	68.3 ab	33.4 ab	14.3 abc
Biological 1 soil @ emergence	73.3 a	41.8 a	24.8 ab
Biological 1 soil @ emergence & flowering	66.9 ab	36.1 ab	23.2 ab
Biological 1 soil @ emergence, 3 weeks later & flowering	41.4 bcde	22.1 bcde	11.4 abc
Biological 2 in furrow only	65.7 ab	35.1 ab	33.0 a
Biological 2 Tuber only	67.8 ab	40.1 ab	32.2 a
Biological 2 Tuber + in furrow	68.5 ab	36 ab	19.3 abc
Biological 2 Tuber + in furrow + soil @ planting	51.3 abc	28.4 ab	21.9 abc
Biological 2 soil @ emergence	50.6 abc	26.7 abc	25.2 ab
Biological 2 soil @ emergence & flowering	51.7 abc	27.5 abc	14.7 abc
Biological 2 soil @ emergence, 3 weeks later & flowering	60.5 ab	22.1 bcd	24.5 ab
Monceren® seed treatment	21.6 de	5.8 e	0 c
Monceren® seed treatment + Biological 1	21.4 e	9.4 de	3.3 bc
Monceren® seed treatment + Biological 2	24.9 cde	9.4 de	3.6 bc
LSD (P=0.05)	**28.7**	**18.4**	**22.9**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Table 12. Level of *Rhizoctonia* on tubers of plants treated with biological agents, Field experiment 1, Angle Vale.

Treatment	*Rhizoctonia* on tubers	
	Incidence (%)	Severity
Control (Untreated)	61.0 ab	31.9 abcd
Biological 1 in furrow only	44.2 b	21.1 d
Biological 1 Tuber only	52.6 ab	25.2 bcd
Biological 1 Tuber + in furrow	53.3 ab	26.8 abcd
Biological 1 Tuber + in furrow + soil @ planting	45.3 b	21.5 cd
Biological 1 soil @ emergence	65.1 ab	35.9 abc
Biological 1 soil @ emergence & flowering	45.6 b	19.5 d
Biological 1 soil @ emergence, 3 weeks later & flowering	52.0 ab	25.3 abcd
Biological 2 in furrow only	57.5 ab	28.3 abcd
Biological 2 Tuber only	60.7 ab	31.2 abcd
Biological 2 Tuber + in furrow	65.2 ab	33.0 abcd
Biological 2 Tuber + in furrow + soil @ planting	53.7 ab	29.7 abcd
Biological 2 soil @ emergence	73.7 a	40.0 a
Biological 2 soil @ emergence & flowering	55.2 ab	25.3 abcd
Biological 2 soil @ emergence, 3 weeks later & flowering	68.6 ab	39.0 ab
Monceren® seed treatment	9.8 c	4.0 e
Monceren® seed treatment + Biological 1	6.5 c	2.5 e
Monceren® seed treatment + Biological 2	2.0 c	0.5 e
LSD (P=0.05)	**25.1**	**14.8**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Table 13. Effect of treating seed with biological agents on yield, Field experiment 1, Angle Vale.

Treatments	Mean tuber weight (g)
Control (Untreated)	69.0
Biological 1 in furrow only	71.7
Biological 1 Tuber only	62.7
Biological 1 Tuber + in furrow	73.9
Biological 1 Tuber + in furrow + soil @ planting	69.4
Biological 1 soil @ emergence	69.1
Biological 1 soil @ emergence & flowering	67.9
Biological 1 soil @ emergence, 3 weeks later & flowering	66.0
Biological 2 in furrow only	70.5
Biological 2 Tuber only	69.0
Biological 2 Tuber + in furrow	70.9
Biological 2 Tuber + in furrow + soil @ planting	68.9
Biological 2 soil @ emergence	70.0
Biological 2 soil @ emergence & flowering	67.9
Biological 2 soil @ emergence, 3 weeks later & flowering	67.9
Monceren® seed treatment	69.9
Monceren® seed treatment + Biological 1	67.9
Monceren® seed treatment + Biological 2	62.3
LSD (P=0.05)	**n.s.**

Field Experiment 2, Angle Vale

Materials and methods

This experiment was planted on 11th February 1999 on the same commercial potato growing property as used in the previous year. Seed for this experiment was whole cv. Atlantic, with at least 25% of the tubers naturally infected with *Rhizoctonia*. Treatments for this experiment are shown in table 14 below. Treatments were arranged in a randomised complete block design with plots consisting of two rows, each containing 40 seed pieces. Plots were separated along the row by 3 red seed tubers cv. Red Lasoda, assisting in identification of plots at harvest. Soil treatments were applied at emergence (4/3/99), 3 weeks later (25/3/99) and at flowering (8/4/99).

This experiment was infected with Tomato Spotted Wilt Virus (TSWV) 4 - 5 weeks after planting, resulting in over 90% of plants with obvious stunting and flowering occurring 2 weeks early. After a stem assessment at 14 weeks after planting, plants began to collapse and the few tubers present were small and badly deformed. As a result the experiment was abandoned and the plants rotary hoed into the ground to prevent spread of the disease to nearby crops.

Table 14. Treatments and Rates applied – Field experiment 2, Angle Vale.

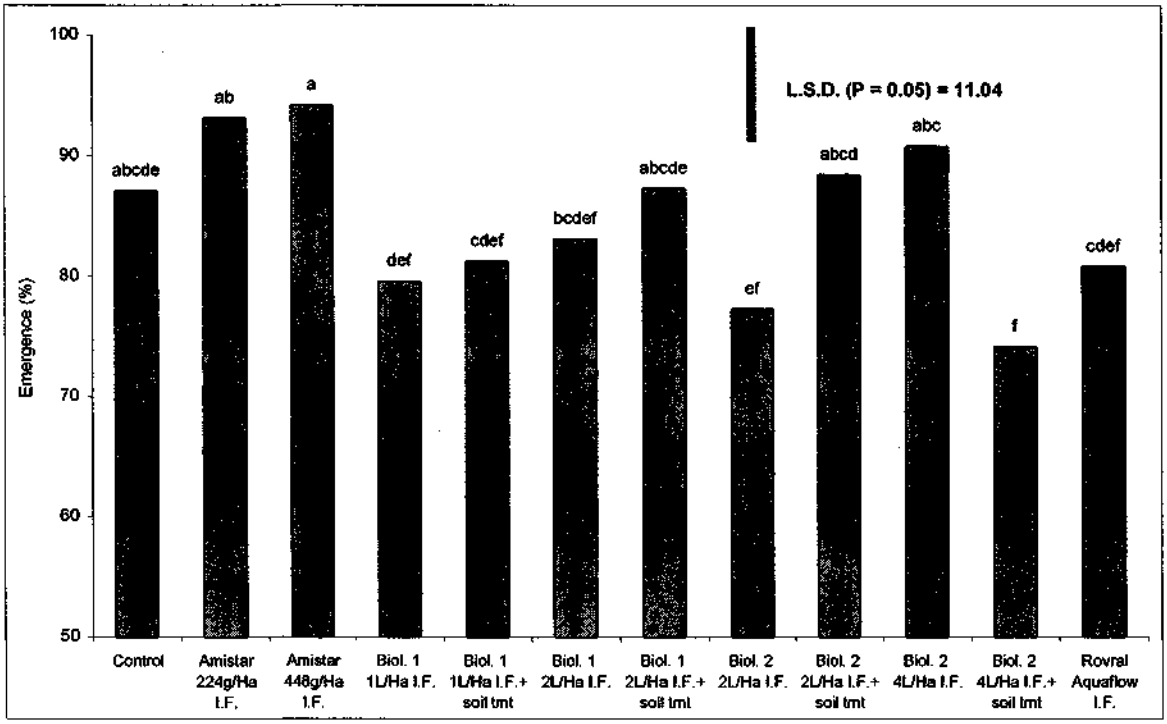
Treatment	Rate of product/Ha
Control	-
Amistar®	224g
Amistar®	448g
Biological 1 in furrow	1 L
Biological 1 in furrow + 3 soil treatments	1 L
Biological 1 in furrow	2 L
Biological 1 in furrow + 3 soil treatments	2 L
Biological 2 in furrow	2 L
Biological 2 in furrow + 3 soil treatments	2 L
Biological 2 in furrow	4 L
Biological 2 in furrow + 3 soil treatments	4 L
Rovral® Aquaflow in furrow	1.5 L

Results and discussion

Emergence:

Between 70 and 95% of plants had emerged by 6 weeks after planting, with the tubers treated with Amistar® in furrow having the highest number of plants emerged. The emergence in the biological treatments was extremely variable and no correlations with treatments could be found. For example the two treatments with the lowest number of plants emerged, and the two biological treatments with the most number of plants emerged were all treated with Biological 2. This variability suggests the low emergence was due to a factor other than the treatments (Figure 2).

Figure 2. Mean emergence of plants untreated or treated with Biological agents – Angle Vale 1999.



Note: Bars with the same letter above are not significantly different (P = 0.05).

Crop vigour and phytotoxicity:

Crop vigour at full emergence was very poor in this experiment due to the TSWV infection. This resulted in severe stunting over the entire planting with no treatment effect evident. Phytotoxicity was unable to be assessed due to the high level of TSWV infection.

Stem Assessments:

Rhizoctonia stem cankers developed on more than 70% of the control plants, with similar high levels found in the biological treatments. Amistar® applied in furrow at 224 or 448g product/Ha significantly reduced both incidence and severity of stem infection compared to the untreated control and many of the biological treatments (Table 15). Although not

statistically significant, less disease also developed where Rovral® was applied in furrow. There was a slight trend for Biological 2 to reduce incidence and severity of *Rhizoctonia* when applied as a soil treatment on tubers treated in furrow, compared to the corresponding rate applied in furrow only. For Biological 1 the trend was opposite with slightly higher levels found when soil treatments were applied in addition to the in furrow application, in comparison to the corresponding rate applied in furrow only.

Both Amistar® and Rovral® applied in furrow also significantly reduced the percentage of stolons pruned by *Rhizoctonia* compared to the untreated control (Table 15).

The TSWV infection appeared to reduce the ability of the plants to withstand infection by *Rhizoctonia*. With the high levels of *Rhizoctonia* in the soil, the treatments had little effect in reducing infection. Plants that emerged slightly later were not infected with TSWV and it was observed that these had no *Rhizoctonia* on the stems. Unfortunately there were not enough of these plants to obtain a meaningful assessment.

Table 15. Effect of treatments on incidence and severity of *Rhizoctonia* on stems and percentage of stolons pruned on plants grown from infected potatoes – Field experiment 2, Angle Vale.

Treatment	Rate of product	*Rhizoctonia* on stems		Stolons pruned (%)
		Incidence (%)	Severity	
Control	-	71.6 abc	25.0 ab	24.3 a
Amistar® in furrow	224g/Ha	48.2 de	13.9 cd	8.3 cd
Amistar® in furrow	448g/Ha	32.9 e	8.0 d	5.6 d
Biological 1 in furrow	1L/Ha	62.0 bcd	24.0 abc	17.6 abc
Biological 1 in furrow + soil treatment	1L/Ha	87.4 a	31.7 a	23.6 ab
Biological 1 in furrow	2L/Ha	65.9 bcd	26.3 ab	20.8 ab
Biological 1 in furrow + soil treatment	2L/Ha	75.0 abc	28.6 a	17.4 abc
Biological 2 in furrow	2L/Ha	81.4 ab	31.0 a	18.6 ab
Biological 2 in furrow + soil treatment	2L/Ha	67.5 abcd	25.2 ab	21.1 ab
Biological 2 in furrow	4L/Ha	82.2 ab	29.2 a	26.5 a
Biological 2 in furrow + soil treatment	4L/Ha	78.0 abc	25.3 ab	17.3 abc
Rovral® Aquaflow in furrow	1.5L/Ha	59.0 cd	17.1 bcd	14.3 bcd
L.S.D (P = 0.05)		**21.12**	**10.6**	**9.84**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Field Experiment 3, Angle Vale

Materials and methods

A second experiment was planted adjacent to Experiment 2, using the treatments and rates outlined in table 16. The same seed and experiment layout was used, with all chemicals applied as seed treatments. This experiment was also infected with TSWV, and was abandoned before harvest.

Table 16. Fungicides and rates applied – Field experiment 3, Angle Vale.

Treatment	Rate (g a.i./tonne)	Rate (product/10Kg)
Control	-	-
Experimental 2	15	0.375ml
Experimental 2	30	0.75ml
Experimental 2	60	1.5ml
Experimental 2	120	3.0ml
Experimental 3	50	2.08ml
Experimental 3	100	4.16ml
Experimental 3	200	8.32ml
Monceren® 250FS	150	6.0ml
Rizolex® 100D	200	20g

Results and discussion

Emergence:

Over 90% of plants emerged by 4 weeks after planting with no significant differences being detected between treatments (Figure 2).

Stem Assessments:

The incidence of *Rhizoctonia* stem canker was high in this experiment with no significant differences in either incidence or severity between tuber treatments and the control (Table 17).

In addition 20 - 34% of the stolons were pruned by *Rhizoctonia* and none of the fungicide treatments significantly reduced the incidence of stolon pruning.

Figure 2. Mean emergence of plants from seed tubers untreated or treated with fungicides before planting – Field Experiment 3, Angle Vale.

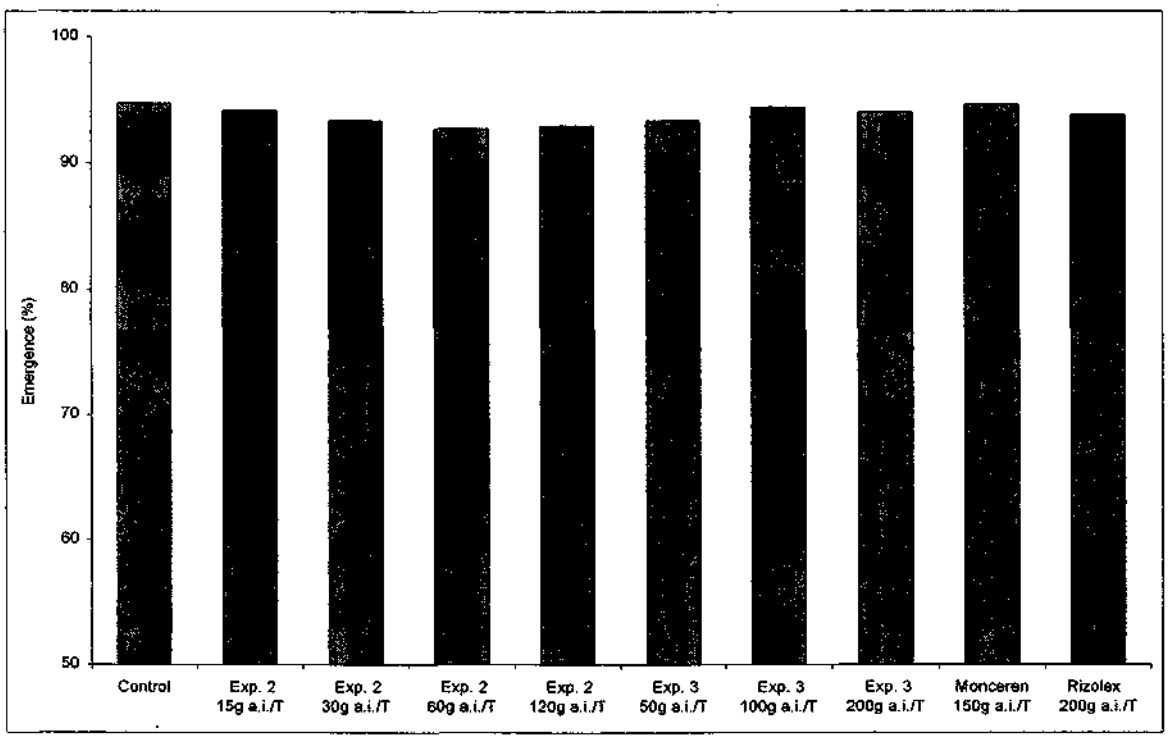


Table 17. Effect of seed tuber treatments on incidence and severity of *Rhizoctonia* on stems and percentage of stolons pruned on plants grown from infected potatoes – Field Experiment 3, Angle Vale.

Treatment	*Rhizoctonia* on stems		Stolons pruned (%)
	Incidence (%)	Severity	
Control	58.4	25.0	29.7
Experimental 2 15g a.i./T	64.4	22.9	25.4
Experimental 2 30g a.i./T	49.3	17.2	22.9
Experimental 2 60g a.i./T	56.0	20.4	26.9
Experimental 2 120g a.i./T	54.7	21.8	29.4
Experimental 3 50g a.i./T	47.6	18.0	20.4
Experimental 3 100g a.i./T	56.7	22.1	29.7
Experimental 3 200g a.i./T	54.6	20.1	19.5
Monceren®	70.4	30.0	33.7
Rizolex®	66.1	29.5	26.5
L.S.D (P = 0.05)	**n.s.**	**n.s.**	**n.s.**

Field Experiment 4, Lenswood

Materials and methods

Certified seed tubers cv. Coliban, of which 27.5% were naturally infected with *Rhizoctonia,* were planted on the 29th January 1999. All fungicides were applied the day prior to planting at the rates shown in table 18, except Amistar®, which was applied in furrow at planting. The experiment was arranged in a randomised complete block design, with 6 replicates of each treatment. Each plot was 2 rows wide and contained 40 seed pieces per row. The plots were separated by 3 red seed tubers cv. Red Lasoda to assist in identifying plots at harvest. The experiment was harvested using a commercial single row harvester on the 11th June 1999.

Table 18. Fungicides and rates applied - Field Experiment 4, Lenswood.

Treatment	Application	Rate (g a.i.)
Control	-	-
Experimental 2	Seed treatment	15g/T
Experimental 2	Seed treatment	30g/T
Experimental 2	Seed treatment	60g/T
Experimental 2	Seed treatment	120g/T
Experimental 3	Seed treatment	25g/T
Experimental 3	Seed treatment	50g/T
Experimental 3	Seed treatment	100g/T
Experimental 3	Seed treatment	200g/T
Maxim® 100FS	Seed treatment	25g/T
Amistar® 500WG	In furrow	28g/Ha
Amistar® 500WG	In furrow	56g/Ha
Amistar® 500WG	In furrow	112g/Ha
Monceren® 250FS	Seed treatment	150g/T
Rizolex® 100D	Seed treatment	200g/T

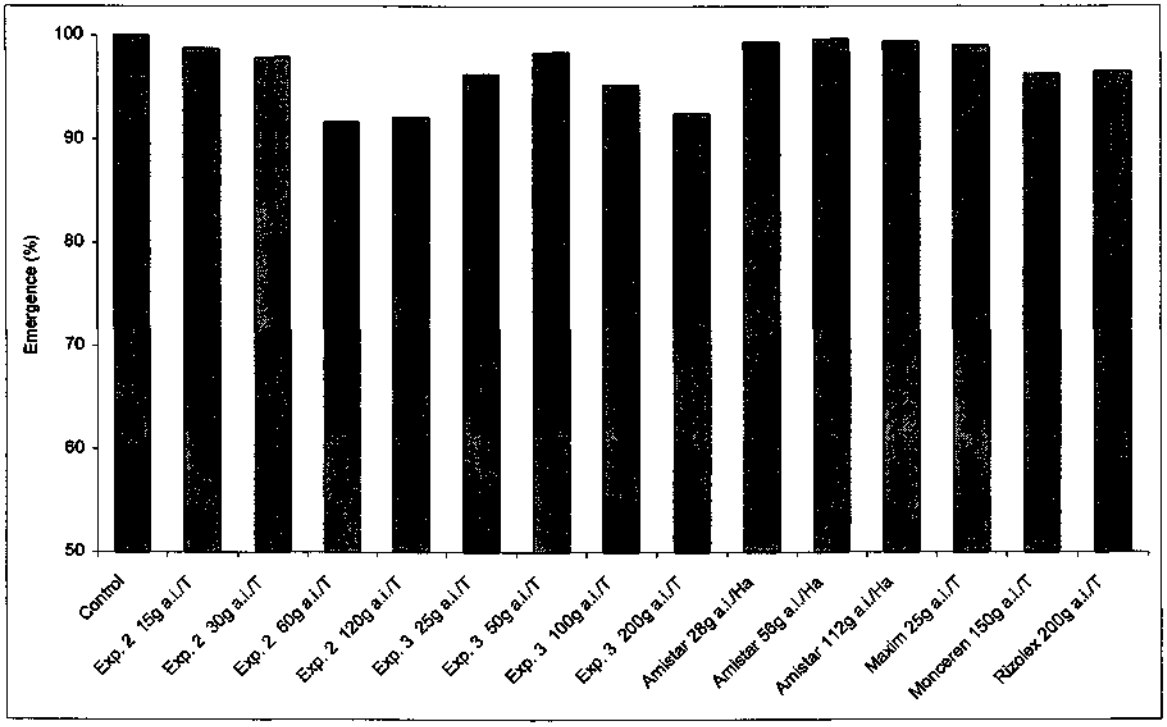
Due to interruption by rain and mechanical breakdown of the harvester, not all plots could be harvested, and the number of replicates available for each treatment to measure total yield varied between 4 and 6. The yield data was therefore analysed using a one way analysis of variance rather than the general ANOVA. To obtain disease data for all replicates, 100 tubers were hand dug at random from the unharvested plots for disease assessment.

Results and discussion

Emergence:

While the emergence varied substantially at the 3 week assessment, by 6 weeks most plants had emerged with little variation between treatments except for the two highest rates of Experimental 2 (Figure 3). These had significantly lower emergence counts than other treatments and the control at both 3 and 6 weeks (LSD = 3.8).

Figure 3. Mean emergence of plants from seed tubers untreated or treated with fungicides before planting – Field experiment 4, Lenswood.



Crop vigour and phytotoxicity:

At 100% emergence no variation in crop vigour or phytotoxicity was detected between treated plots and the control. All plants grew extremely vigorously and no phytotoxic symptoms were evident during the experiment.

Harvest disease assessments:

Although there were obvious reductions in both incidence and severity of *Rhizoctonia* in most treatments, log transformations needed to be carried out on the data due to poor homogeneity of variance. Analysis of the transformed data showed that all fungicide treatments, except Experimental 2 at 30g a.i./T and the 2 lowest rates of Amistar®, significantly reduced both incidence and severity of *Rhizoctonia* (Table 19).

The Monceren® treatment provided the best reductions in the incidence of *Rhizoctonia* with 0.8% of tubers infected compared to 21.8% in the control plots. Amistar® at 56g

a.i./T and Experimental 2 at 30g a.i./T had the highest level of disease with 11.3 and 19.8% of tubers infected respectively.

Differences in the level of control varied in the Experimental 2 treatments but this did not correlate with the rates applied. There were no significant differences detected between the Experimental 3 treatments but there did appear to be a dose response, with less disease in treatments with the highest rate of fungicide. No significant differences were detected between the Amistar® treatments, but the severity ratings suggested there was a dose response.

The amount of surface russetting on the tubers was also assessed, as this is thought to be associated with *Rhizoctonia*. However no differences were detected between the treatments, as over 60% of tubers were russetted. In this experiment, russetting was more likely attributed to a physiological cause or mechanical abrasions.

Yield:

Due to the extreme variations in yield between plots, no significant differences in total or marketable yield were detected (Table 20). All treatments except Amistar® reduced the mean tuber weight, and in many of these the reductions were statistically significant. This is often an indication of higher disease levels, as the pruned stolons do not produce tubers so fewer but larger tubers are produced.

Unlike the results from the pot experiment, there was a trend for all treatments, particularly the 2 highest rates of Experimental 2, to reduce the yield compared to the untreated plots. Only the highest rate of Amistar® had a higher total and marketable yield than the untreated plots. The fact that lower disease levels did not correlate with the higher yields, indicates that other factors may have influenced the yield in this experiment, and the effects observed may have little to do with the treatments applied.

Table 19. Effect of seed tuber treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes – Field experiment 4, Lenswood.

Treatment	*Rhizoctonia*		*Rhizoctonia* Log transformation	
	Incidence (%)	Severity	Incidence (%)	Severity
Seed tubers	27.5	9.5	-	-
Control	21.8 a	8.8 a	1.16 a	0.79 a
Experimental 2 15g a.i./T	1.7 b	0.4 c	0.34 cd	0.13 d
Experimental 2 30g a.i./T	19.8 a	8.2 ab	0.90 ab	0.65 a
Experimental 2 60g a.i./T	4.2 b	1.9 c	0.43 bcd	0.26 bcd
Experimental 2 120g a.i./T	6.5 b	2.5 c	0.40 cd	0.28 bcd
Experimental 3 25g a.i./T	4.7 b	1.7 c	0.43 bcd	0.26 bcd
Experimental 3 50g a.i./T	3.8 b	1.0 c	0.41 cd	0.22 cd
Experimental 3 100g a.i./T	2.1 b	0.7 c	0.30 d	0.15 cd
Experimental 3 200g a.i./T	1.9 b	0.5 c	0.25 d	0.10 d
Amistar® 28g a.i./Ha	9.0 ab	3.2 bc	0.97 a	0.59 ab
Amistar® 56g a.i./Ha	11.3 ab	4.2 abc	0.82 abc	0.51 abc
Amistar® 112g a.i./Ha	1.5 b	0.5 c	0.33 cd	0.16 cd
Maxim® 25g a.i./T	1.4 b	0.4 c	0.22 d	0.10 d
Monceren® 150g a.i./T	0.8 b	0.5 c	0.05 d	0.04 d
Rizolex® 200g a.i./T	2.8 b	0.9 c	0.37 cd	0.19 cd
L.S.D(P=0.05)	**12.89**	**5.11**	**0.49**	**0.36**

Note: Values followed by the same letter are not significantly different (P = 0.05)

Table 20. Effect of seed tuber treatments on mean yields per plot – Field experiment 4, Lenswood.

Treatment	Mean tuber weight (g)	Marketable Yield (Kg)	Total yield (Kg)
Control	164.1 abc	83.48	94.15
Experimental 2 15g a.i./T	142.6 ef	80.37	93.53
Experimental 2 30g a.i./T	144.9 def	68.04	81.36
Experimental 2 60g a.i./T	154.6 bcde	61.22	69.56
Experimental 2 120g a.i./T	149.0 def	62.72	75.95
Experimental 3 25g a.i./T	141.7 ef	63.87	76.90
Experimental 3 50g a.i./T	151.1 cdef	82.55	93.21
Experimental 3 100g a.i./T	136.9 f	82.62	93.47
Experimental 3 200g a.i./T	146.1 def	60.57	72.61
Amistar® 28g a.i./Ha	167.6 ab	78.35	89.69
Amistar® 56g a.i./Ha	167.3 ab	83.27	89.84
Amistar® 112g a.i./Ha	174.6 a	86.09	101.45
Maxim® 25g a.i./T	151.5 cde	67.85	80.68
Monceren® 150g a.i./T	159.1 bcd	74.91	87.24
Rizolex® 200g a.i./T	147.5 def	74.33	85.90
L.S.D (P = 0.05)	**14.3**	**n.s.**	**n.s.**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Field Experiment 5, Lenswood

Materials and methods

Certified whole seed tubers, cv. Coliban, naturally infected with *Rhizoctonia* (28%), were planted on the 29th January 1999. Treatments were applied in furrow at the rates shown in table 21. The experiment was arranged in a randomised complete block design, with 6 replicates of each treatment except for Biological 2 in furrow + 3 soil treatments and Biological 1 in furrow + 3 soil treatments, both of which were reduced to 5 replicates due to a shortage in seed. Soil treatments were applied on at emergence (26/2/99), 3 weeks later (11/3/99) and at flowering (25/3/99).

Each plot contained 40 seed pieces in a single row. The plots were flanked on either side by buffer rows planted using whole cv. Coliban seed from a different source with lower disease levels. Plots were separated along the rows by 3 red seed tubers cv. Red Lasoda, assisting in identifying plots at harvest. The experiment was harvested using a commercial single row harvester on the 11th June 1999.

Table 21. Treatments and rates applied – Field Experiment 5, Lenswood.

Treatment	Rate of product
Control	-
Biological 1 in furrow	1L/Ha
Biological 1 in furrow + 3 soil treatments	1L/Ha
Biological 2 in furrow	2L/Ha
Biological 2 in furrow + 3 soil treatments	2L/Ha

Results and discussion

Emergence:

In most treatments, 95% of plants had emerged by 6 weeks after planting (Figure 4), and no significant differences were detected between treatments.

Harvest assessments:

At harvest, 20% of tubers from the control plots were infected with *Rhizoctonia*. Similar levels were found in the other treatments, except for the Biological 1 in furrow plus soil treatment where 14% of the tubers were infected (Table 22). None of the treatments significantly reduced the severity of the disease.

The yield was highest in the in furrow treatments, however the extreme variations between plots in each treatment mean that these differences were not statistically significant (Table 23).

Figure 4. Mean emergence of plants untreated or treated with Biologicals – Field Experiment 5, Lenswood.

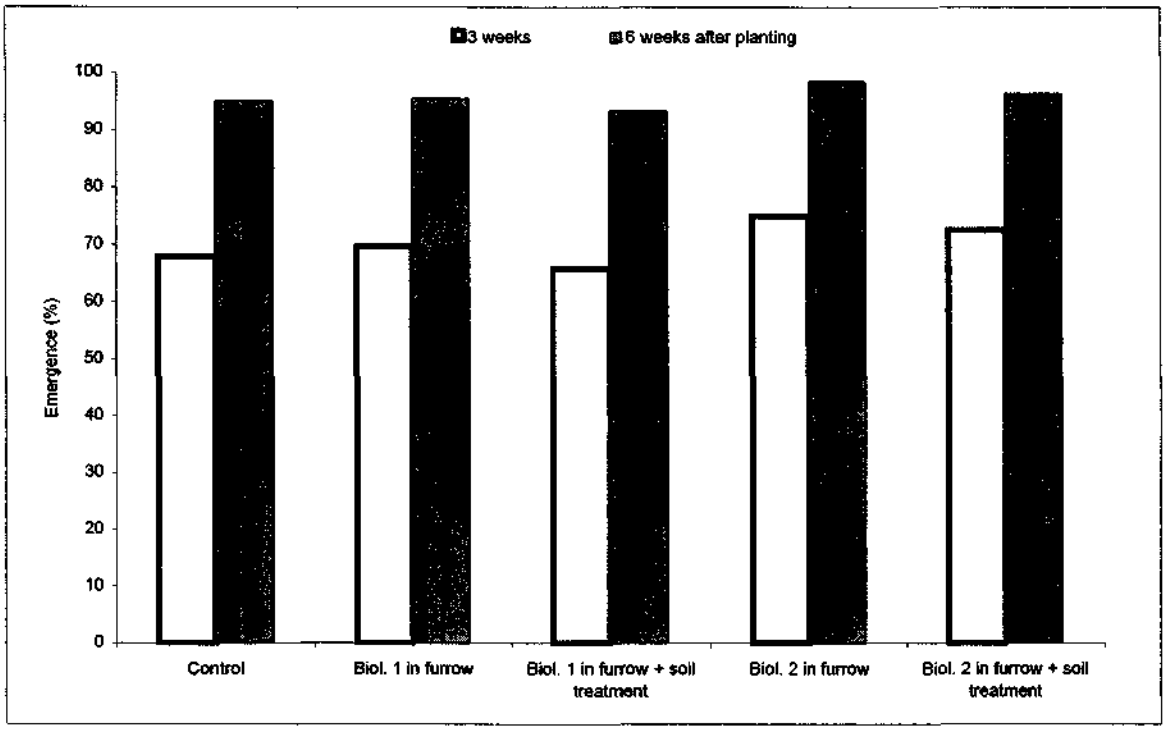


Table 22. Effect of treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes – Field experiment 5, Lenswood.

Treatment	*Rhizoctonia*	
	Incidence (%)	Severity
Seed tubers	27.5	9.5
Control	20.3	6.9
Biological 1 in furrow	26.3	8.1
Biological 1 in furrow + soil treatment	14.0	4.4
Biological 2 in furrow	16.9	5.1
Biological 2 in furrow + soil treatment	20.1	6.1
L.S.D (P = 0.05)	**n.s.**	**n.s.**

Table 23. Effect of Biological treatments on mean yields per plot – Field experiment 5, Lenswood.

Treatment	Mean tuber weight (g)	Marketable Yield (Kg)	Total yield (Kg)
Control	139.5	30.4	34.1
Biological 1 in furrow	137.3	35.7	39.9
Biological 1 in furrow + soil treatment	132.2	30.5	34.4
Biological 2 in furrow	149.0	35.4	38.7
Biological 2 in furrow + soil treatment	144.1	27.9	30.6
L.S.D (P = 0.05)	**n.s.**	**n.s.**	**n.s.**

Field Experiment 6, Lenswood

Materials and methods

Whole seed tubers, cv. Coliban, naturally infected with *Rhizoctonia* (68%) were planted on the 10th December 1999. Treatments were applied at the rates shown in Table 24. In two treatments Amistar® was applied to the foliage 4, 6 and 8 weeks after emergence, and at the same time Bravo® was applied to all other treatments.

Three applications of Score® were applied to all treatments at 10, 12 and 14 weeks after emergence using a battery powered Silvan backpack sprayer. The experiment was arranged in a randomised complete block design, with 5 replicates per treatment. Each plot was 2 rows wide with 20 seed pieces per row and were separated by one red seed tuber (cv. unknown) to assist in identifying plots at harvest. The experiment was harvested using a commercial single row harvester on 9th April 2000.

Table 24. Fungicides and rates applied to soil and tubers - Field experiment 6, Lenswood.

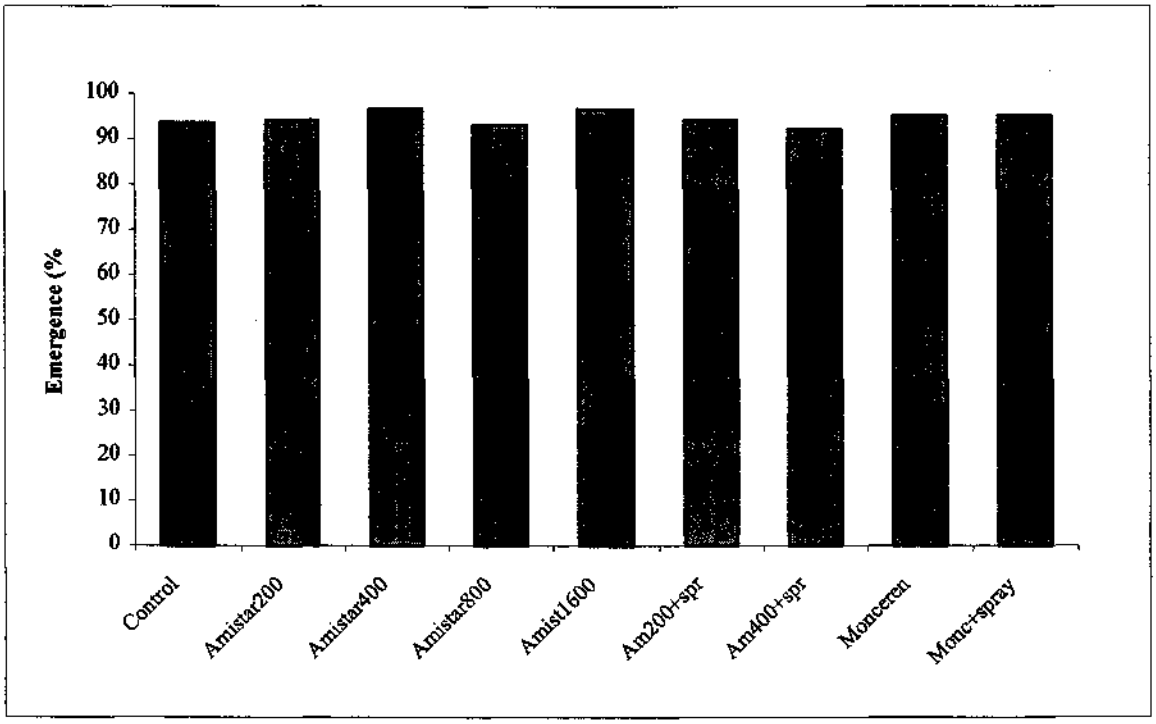
Treatment	Method of and time of Application	Rate of product
Control	-	-
Amistar® 500 WG	In furrow	200g/Ha
Amistar® 500 WG	In furrow	400g/Ha
Amistar® 500 WG	In furrow	800g/Ha
Amistar® 500 WG	In furrow	1600g/Ha
Amistar® 500 WG	In furrow plus Foliar	400g/Ha – 200g/Ha
Amistar® 500 WG	In furrow plus Foliar	200g/Ha – 200g/Ha
Monceren® 250FS	Seed treatment	600ml/T
Monceren® 250FS - Amistar®	Seed treatment plus Foliar	600ml/T – 200g/Ha

Results and discussion

Emergence:

Amistar® did not inhibit emergence, with nearly all plants emerged by 6 weeks after planting (Figure 5). At this stage all plants were vigorous and showed no abnormal symptoms. For the remainder of the experiment all plants grew vigorously and showed no symptoms of phytotoxicity.

Figure 5. Mean emergence of plants from seed tubers untreated or treated with fungicides before planting –Field experiment 6, Lenswood.



Harvest assessments:

All fungicide treatments significantly reduced both incidence and severity of *Rhizoctonia* compared to the control (Table 25). No significant differences were detected between the fungicide treatments. The addition of foliar sprays improved the lower rate of Amistar® applied in furrow, but the opposite was observed with the higher rate. However these differences were also not statistically significant. The addition of Amistar® sprays to the Monceren® seed treatment did not improve the control of *Rhizoctonia*.

The resistance strategy for Amistar® indicates that no more than 3 sprays should be applied in one season, in combination with at least 3 other applications of another chemical. Hence the applications of Score and Bravo. While the foliar sprays did not appear to greatly reduce the level of *Rhizoctonia*, good control of Target spot was achieved compared to an adjacent experiment that received only 2 Target spot sprays. Target spot appeared late in the season, and thus would not have been expected to affect the yield.

The fungicide treatments did not significantly increase total yield in comparison to the control (Table 26). The mean tuber weight in the Amistar® treatments was not statistically different to the untreated, although the highest mean tuber weight was found in the highest two rates of Amistar® applied in furrow. The two Monceren® treatments had the lowest total yield, and the mean tuber weight was significantly lower than all other treatments and the control.

Table 25. Effect of seed tuber treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes – Field experiment 4, Lenswood.

Treatment	*Rhizoctonia*	
	Incidence (%)	Severity
Seed tubers	67.5	25.3
Control	70.4 a	25.3 a
Amistar® 100g a.i./Ha in furrow	43.6 b	17.6 ab
Amistar® 200g a.i./Ha in furrow	29.4 b	10.0 b
Amistar® 400g a.i./Ha in furrow	40.0 b	13.9 b
Amistar® 800g a.i./Ha in furrow	26.3 b	9.3 b
Amistar® 100g a.i./Ha in furrow + 3 sprays	32.6 b	10.9 b
Amistar® 200g a.i/Ha in furrow + 3 sprays	41.8 b	11.1 b
Monceren® 150g a.i./T	36.8 b	14.3 b
Monceren® 150g a.i/T seed treatment plus 3 Amistar sprays	37.7 b	14.6 b
L.S.D(P=0.05)	**23.7**	**8.9**

Note: Values followed by the same letter are not significantly different (P = 0.05)

Table 26. Effect of fungicide treatments on mean yields per plot – Field experiment 4, Lenswood.

Treatment	Mean tuber weight (g)	Total yield (Kg)
Control	153.4 a	32.5
Amistar® 100g a.i./Ha in furrow	148.6 a	32.0
Amistar® 200g a.i./Ha in furrow	144.8 a	39.0
Amistar® 400g a.i./Ha in furrow	164.5 a	35.0
Amistar® 800g a.i./Ha in furrow	164.2 a	34.8
Amistar® 100g a.i/Ha in furrow + 3 sprays	151.8 a	33.2
Amistar® 200g a.i/Ha in furrow + 3 sprays	159.3 a	33.0
Monceren® 150g a.i./T	115.3 b	27.6
Monceren® 150g a.i/T seed treatment plus 3 Amistar® sprays	116.3 b	24.2
L.S.D. (P=0.05)	**20.5**	**n.s.**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Field Experiment 7, Narrung

Materials and methods

This experiment was planted on 22nd February 1999. Seed for this experiment was cut cv. Coliban treated with lime and naturally infected with *Rhizoctonia* (14%). Treatments for this experiment are shown in table 27. Treatments were arranged in randomised complete block design with plots consisting of two rows by 10m. Soil treatments for this experiment were applied at Emergence (26/3/99), 3 weeks later (9/4/99) and at flowering (6/5/99).

Assessments included emergence at 6 weeks after planting, a stem assessment on 5 plants per plot 14 weeks after planting and yield and tuber disease assessments on 100 tubers hand dug at harvest.

Table 27. Treatments and rates applied –Field Experiment 7, Narrung.

Treatment	Application method	Rate of product
Control		-
Biological 1	in furrow	1L/Ha
Biological 1	in furrow	2L/Ha
Biological 1	3 soil treatments	2L/Ha
Biological 2	in furrow	2L/Ha
Biological 2	in furrow	4L/Ha
Biological 2	3 soil treatments	4L/Ha
Amistar®	3 soil treatments	448g/Ha
Monceren®	in furrow	1.5L/Ha

Results and discussion

Emergence:

Over 85% of plants emerged by 6 weeks after planting (Figure 6) with no significant differences between treatments.

Stem Assessments:

Rhizoctonia stem cankers developed on 90% of the stems in the control treatments, with similar or higher levels in the other treatments (Table 28). In some treatments, including Monceren®, the level of disease on the stems was significantly higher than in the untreated control. A similar trend was not obvious in the severity or the stolon pruning assessments, as these showed high disease levels with no significant differences between treatments.

Figure 6. Mean emergence of plants untreated or treated with biologicals at 6 weeks after planting – Field experiment 7, Narrung.

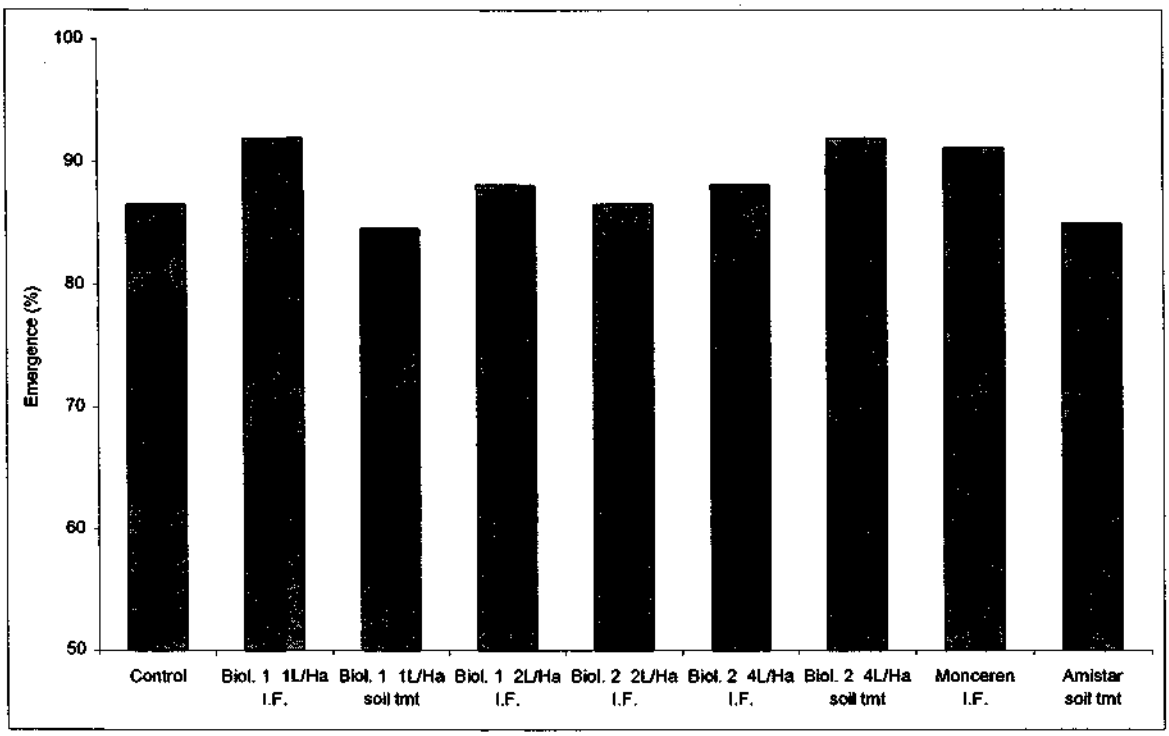


Table 28. Effect of treatments on incidence and severity of *Rhizoctonia* on stems and percentage of stolons pruned on plants grown from infected potatoes – Field experiment 6, Narrung.

Treatment	Rate of product	*Rhizoctonia* on stems		Stolons pruned (%)
		Incidence (%)	Severity	
Control	-	89.6 c	42.4	52.2
Biological 1 in furrow	1L/Ha	94.5 abc	46.4	59.7
Biological 1 in furrow	2L/Ha	98.6 a	46.7	53.3
Biological 1 soil treatment	2L/Ha	100 a	43.9	55.9
Biological 2 in furrow	2L/Ha	100 a	47.7	58.6
Biological 2 in furrow	4L/Ha	92.4 bc	39.9	47.5
Biological 2 soil treatment	4L/Ha	94.9 abc	40.1	55.3
Amistar® soil treatment	448g/Ha	100 a	51.9	62.3
Monceren® in furrow	1.5L/Ha	97.4 ab	38.1	35.9
L.S.D (P = 0.05)		**5.84**	**n.s.**	**n.s.**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Harvest disease assessments:

At last 85% of the tubers from the control treatments were infected with *Rhizoctonia*. Similar levels were found in all other treatments except where Monceren® was applied in furrow (Table 29). Applying double the recommended rate of the biological agents did not improve control. The Monceren® treatment, while not controlling the early *Rhizoctonia* infection on the stems, provided complete control on daughter tubers.

Table 29. Effect of treatment on incidence and severity of *Rhizoctonia* on progeny of infected potatoes – Field experiment 7, Narrung.

Treatment	Rate of product	*Rhizoctonia* on tubers	
		Incidence (%)	Severity
Control	-	84.0 ab	41.1 ab
Biological 1 in furrow	1L/Ha	89.8 a	35.5 abc
Biological 1 in furrow	2L/Ha	86.0 a	41.6 a
Biological 1 soil treatment	2L/Ha	80.8 ab	31.7 bcd
Biological 2 in furrow	2L/Ha	81.5 ab	35.8 abc
Biological 2 in furrow	4L/Ha	77.8 ab	34.1 abc
Biological 2 soil treatment	4L/Ha	79.2 ab	32.8 bc
Amistar® soil treatment	448g/Ha	67.5 b	23.7 c
Monceren® in furrow	1.5L/Ha	5.7 c	2.2 d
L.S.D (P = 0.05)		**17.43**	**8.65**

Note: Values followed by the same letter are not significantly different (P = 0.05).

Yield:

The total yield was not improved significantly by any treatment, however this may have been a results of the extreme variations between plots (Table 30). Differences were observed in the marketable yield (tubers between 80 and 450g) with the Biological 1 in furrow treatments having a significantly higher yield than the control. However the addition of the soil treatment to the in furrow application reduced the yield with both biologicals.

Table 30. Effect of treatment on mean yields per plot – Field experiment 7, Narrung.

Treatment	Rate of product	Mean tuber weight (g)	Marketable Yield (Kg)	Total Yield (Kg)
Control	-	99.2	8.09 c	11.77
Biological 1 in furrow	1L/Ha	106.2	10.32 a	14.28
Biological 1 in furrow	2L/Ha	114.2	9.87 ab	13.10
Biological 1 soil treatment	2L/Ha	96.8	7.94 c	11.98
Biological 2 in furrow	2L/Ha	106.1	9.24 abc	12.41
Biological 2 in furrow	4L/Ha	103.8	8.57 bc	11.88
Biological 2 soil treatment	4L/Ha	101.0	8.00 c	11.75
Amistar® soil treatment	448g/Ha	105.5	8.16 c	12.01
Monceren® in furrow	1.5L/Ha	109.9	9.38 abc	12.60
L.S.D (P = 0.05)		**n.s.**	**1.63**	**n.s.**

Note: Values followed by the same letter are not significantly different (P = 0.05).

TECHNOLOGY TRANSFER

- Results from the Amistar®, Maxim® and Monceren® treatments in field experiments 4 and 7, and shadehouse experiment 1 were reported at the 12th Australasian Plant Pathology Conference in Canberra, Sept 1999. (Abstract of poster attached)

- The 2 growers who provided land for experiment work were advised of the results of experiments on their land to the limit allowed by confidentiality.

- Full confidential reports have so far been presented to all of the companies involved.

- An article on *Rhizoctonia* was published in the September 1999 issue of Potato Australia.

RECOMMENDATIONS

Extension/adoption

- The biological agents tested in these experiments could not be recommended for the control of *Rhizoctonia* in potatoes.

- Monceren® and Maxim® are recommended as seed treatments for the control of *Rhizoctonia.*

- Two of the experimental fungicides should be registered as seed treatments for the control of *Rhizoctonia.*

- Amistar® and Monceren® show promise as in furrow treatments for the control of *Rhizoctonia.*

- The chance of infecting new ground with *Rhizoctonia* can be reduced by selecting seed tubers with low levels of sclerote infection, and treating them with fungicides before or at planting.

Directions for future work

- Further evaluation of new fungicides and new biologicals as tuber seed treatments to reduce tuber infection of *Rhizoctonia.*

- Further evaluation of in furrow applications of fungicides at planting. Monceren® was very effective as an in furrow treatments in one experiment, and has also been used by a grower with outstanding success. However there have been problems with tubers rotting after in furrow applications in some areas, and some fungicides can bind to the soil. The evaluation would need to include different soil types and different levels of soil inoculum.

- Evaluation of fungicides applied to seed in the planter while planting. Monceren® is applied this way by some growers with good results, and needs to be compared to the results from seed treatments applied prior to planting.

- Development and evaluation of techniques to identify and quantify soil borne levels of *Rhizoctonia*.

- Evaluation of techniques to reduce soil borne inoculum, eg biofumigation, green manure, rotations, fumigation.

- Determination of threshold levels of soil and seed borne inoculum acceptable to achieve the most effective use of fungicides.

REFERENCES

Wicks, T.J., Morgan, B. and Hall, B (1996). Influence of soil fumigation and seed tuber treatments on the control of *Rhizoctonia solani* on potatoes. *Aust J Exp Ag* **36**:339-45.

Wicks, T.J., McMahon, R., Morgan, B. and Hall, B (1996). Control of *Rhizoctonia* on fresh market potatoes. Final Report, HRDC Project PT315 – 1995/96.

APPENDIX

1. Assessment key for Rhizoctonia stem canker.

Based on rating system published in the reference:

Frank, J.A., Leach, S.S. & Webb, R.E. 1976 'Evaluation of Potato Clone Reaction to *Rhizoctonia* solani' *Plant Disease Reporter* vol. 60 no. 11, pp. 910 – 912.

0: no lesion

1: single lesion, less than 25mm

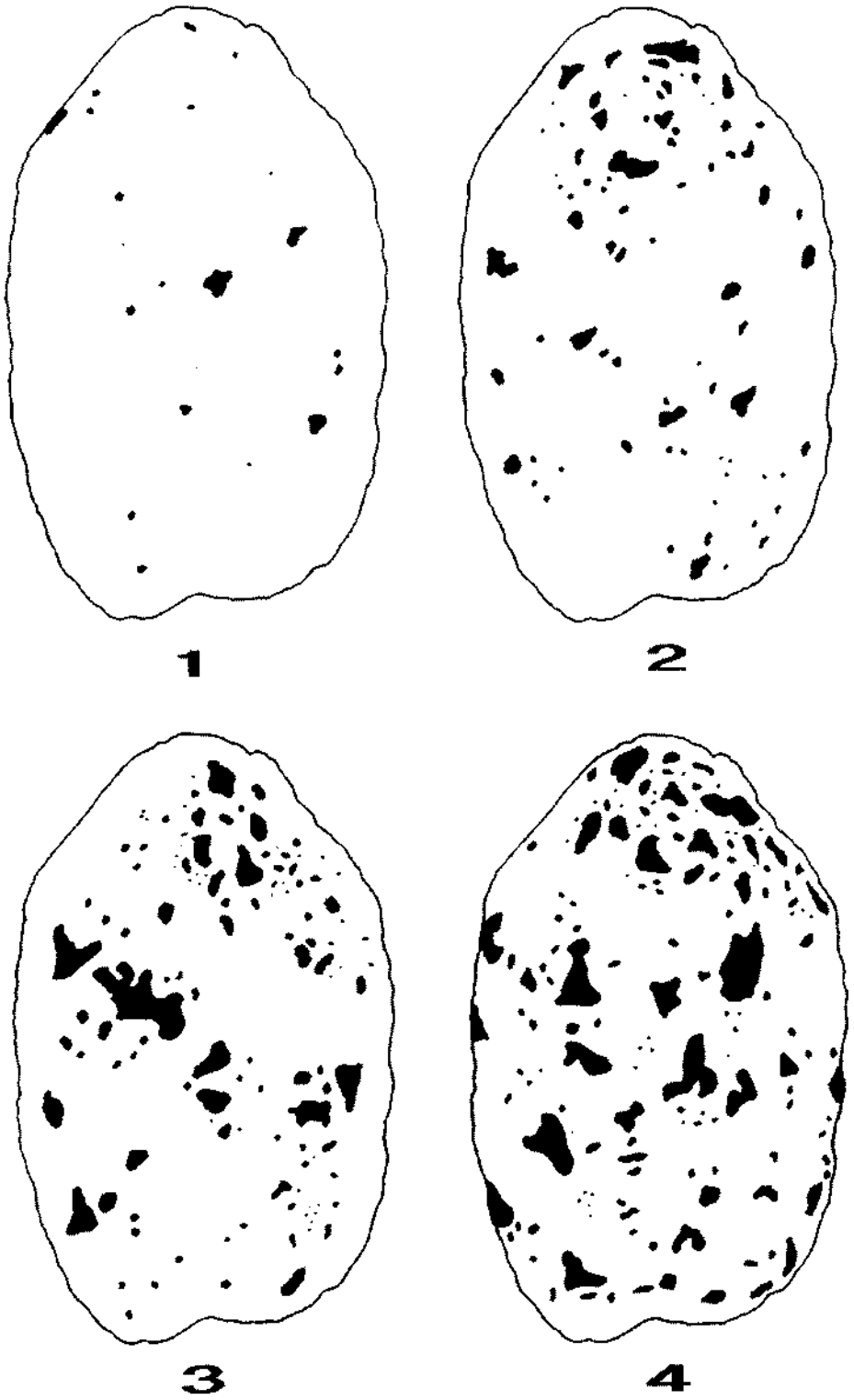
2: single lesion 26 –50mm (or composite of small lesions totalling less than 50mm)

3: single lesion greater than 50mm (or composite of small lesions totalling more than 50mm but not girdling the stem

4: lesion(s) less than 25mm, which is girdling the stem

5: lesion(s) more than 25mm, which is girdling the stem

2. Key for tuber disease assessment.



3. Published articles

Abstract and electronic copy of poster submitted to the 12th Australasian Plant Pathology Conference in Canberra, Sept 1999.

Rhizoctonia article, Potato Australia, September 1999.

CONTROL OF *RHIZOCTONIA* ON POTATOES

K.W. Davies, T.J. Wicks, and B.H. Hall
South Australian Research and Development Institute, GPO Box 397, Adelaide SA 5001.

INTRODUCTION

Black scurf, caused by the fungus *Rhizoctonia solani*, is a serious disease of potatoes worldwide. The fungus causes rotting of stolons as well as reductions in yield and marketability due to cracked, irregular shaped and blemished tubers.

Amistar (Azoxystrobin 500g a.i./Kg) is a new broad spectrum fungicide that has shown to be effective against a range of horticultural pathogens in Europe and the USA (1). Experiments were undertaken to assess the control of *Rhizoctonia* with Amistar applied in furrow or to the soil surface. This was compared to the seed treatments Maxim® (Fludioxonil 100g a.i./L) and Monceren® (Pencycuron 250g a.i./L).

MATERIALS AND METHODS

One pot trial and a field trial were set up on the Lenswood Research Centre, 30km east of Adelaide. A second field trial was carried out on a commercial growers property at Narrung, 150km SE of Adelaide. All trials used cv. Coliban, with *Rhizoctonia* sclerotes present on 100% of seed used in the pot trial, and 28% of seed in the field trials. Treatments were applied in a randomised complete block design, field trials with 6 replications of 2 rows by 10m and the pot trial with 8 pots per treatment.

Application: Seed treatments were applied in a volume of 100ml to 10Kg batches of tubers to ensure complete coverage. For in furrow applications, fungicides were applied at 625L/Ha onto the seed and surrounding soil immediately prior to burial. Post emergent treatments were applied to the soil surface using 1250L/Ha, followed by 2500L/Ha of water to ensure the fungicide was leached into the soil.

Lenswood field trial: Monceren (600ml/T seed) and Maxim (250ml/T seed) applied to seed tubers were compared to Amistar applied as an in furrow spray at 56, 112 & 224g/Ha. The trial was planted on 29/1/99, into ground previously not grown to potatoes, and harvested on 11/6/99.

Pot trial: Seed tubers were planted, two per 15L pot of sterile soil, on 19/1/99 and harvested on 3/6/99. The same chemicals, rates and application methods as the Lenswood field trial were used.

Narrung field trial: This trial was planted on 22/2/99, in infected soil, and harvested on 5/7/99. Monceren was applied in furrow at 1.5L/Ha, and Amistar at 448g/Ha applied as a soil treatment at emergence, 3 weeks later and at flowering.

Assessment: All tubers from the pot trial and 100 tubers per replication in the field trials were assessed for presence of sclerotia using a 0-4 scale later converted to give a severity rating, ranging from 0-100 for each treatment (2).

RESULTS

In the Lenswood trials, both the incidence and severity of *Rhizoctonia* were lowest when Monceren and Maxim were applied as seed treatments and the highest rate of Amistar applied in furrow (Figs 1&2).

In the Narrung trial, Monceren was effective as an in furrow treatment whereas Amistar applied as a soil treatment had little effect on *Rhizoctonia* (Fig 3).

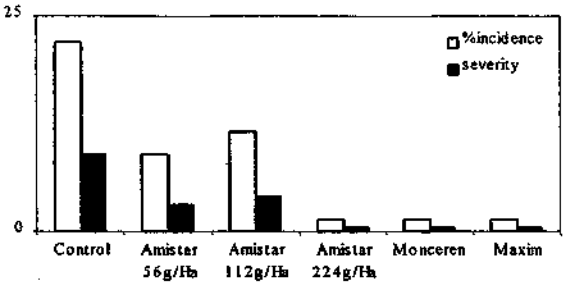


Figure 1. Incidence (%) and severity rating of *Rhizoctonia* – Lenswood field trial.

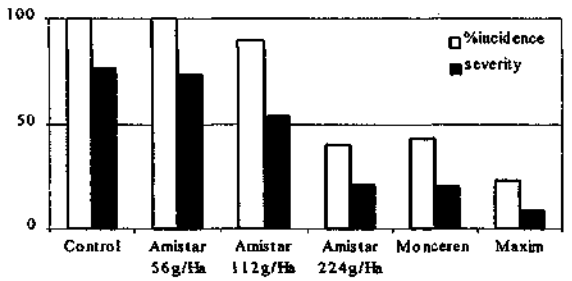


Figure 2. Incidence (%) and severity rating of *Rhizoctonia* – Lenswood pot trial.

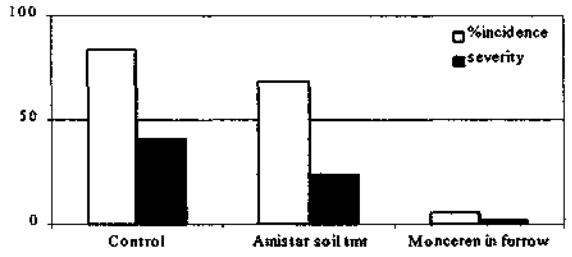


Figure 3. Incidence (%) and severity rating of *Rhizoctonia* – Narrung field trial.

CONCLUSION

These results show that Amistar has great potential for the control of *Rhizoctonia* on potatoes, equal to that of Monceren and Maxim. Monceren provided excellent control of *Rhizoctonia* when applied in furrow, indicating that this application method should also be evaluated when testing new chemicals, as it is widely used by growers.

REFERENCES

1. Dacol, L., Gibbard, M., Hodson, M.O. & Knight, S. (1998). Azoxystrobin : development on horticultural crops in Europe. *The Brighton Conference Pests and Diseases Conference Proceedings*. **3**: 843-8.
2. Wicks, T.J., Morgan, B. & Hall, B. (1996). Influence of soil fumigation and seed tuber treatment on the control of *Rhizoctonia solani* on potatoes. *Aust. J. of Exp. Agric.* **36**: 339-45.

SARDI

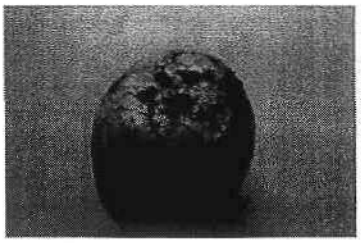
South Australian Research and Development Institute

CONTROL OF *RHIZOCTONIA* ON POTATOES

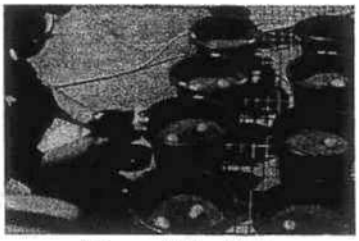
K.W. Davies, T.J. Wicks, and B.H. Hall

Black scurf, caused by the fungus *Rhizoctonia solani,* rots stolons and reduces yield and marketability due to cracked, irregular shaped and blemished tubers.

Amistar® (Azoxystrobin 500g a.i./Kg) is a new strobilurin fungicide that has shown to be effective against a range of horticultural pathogens. Experiments were undertaken to assess the control of *Rhizoctonia* with Amistar applied in furrow or to the soil surface compared to the seed treatments Maxim® (Fludioxonil 100g a.i./L) and Monceren® (Pencycuron 250g a.i./L).

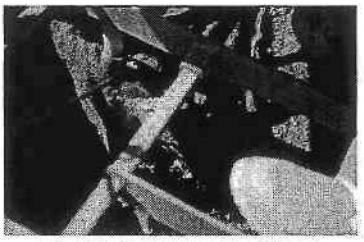


Rhizoctonia sclerotia on a potato tuber

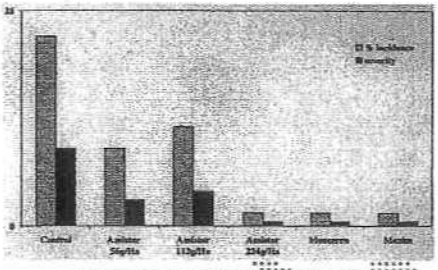


Infurrow application of Amistar
Lenswood pot trial

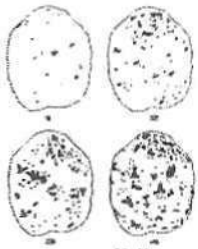
Application of fungicide as a seed treatment



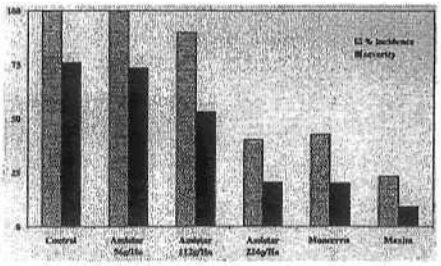
Infurrow application of fungicide - field trials



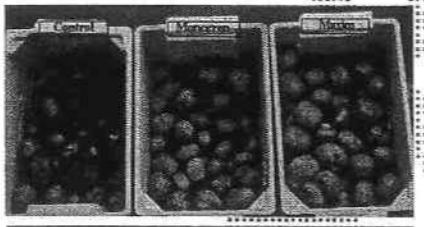
Incidence (%) and severity rating of *Rhizoctonia*
Lenswood field trial

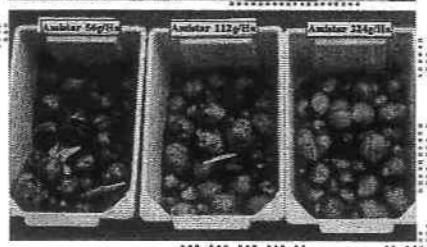


Rhizoctonia assessment scale



Incidence (%) and severity rating of *Rhizoctonia*
Lenswood pot trial

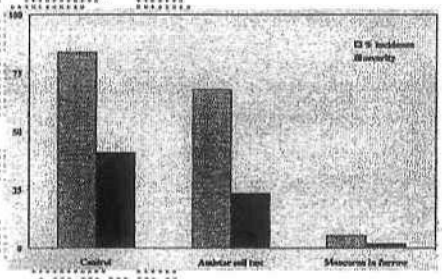




Tubers harvested from pot trial

These results show that Amistar at 224g/Ha has great potential for the control of *Rhizoctonia* on potatoes, equal to that of Monceren and Maxim. Monceren provided excellent control of *Rhizoctonia* when applied in furrow, indicating that this application method should also be evaluated when testing new chemicals, as it is widely used by growers.

We thank HRDC, the Potato Industry, Crop Care and Novartis for funding this work, and the potato growers and staff who assisted with the field trials.



Incidence (%) and severity rating of *Rhizoctonia*
Narrung field trial

Understanding *Rhizoctonia*

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Damage caused by the fungus *Rhizoctonia solani* is common in potato crops world wide resulting in reduced yields and poor quality tubers. The black scurf symptom (reddish-black crusty structures on the skin that cannot be washed off) has become a major problem for the washed, fresh market and seed potatoes growers alike.

Research around the world on rhizoctonia canker and black scurf spans several decades but there is still much to be learnt about this mysterious fungus.

What sort of damage can *Rhizoctonia* do

Rhizoctonia affects the underground parts of potato plants. Damage to sprouts, stems and stolons appear as reddish brown to grey depressed lesions or cankers and sprouts, stems and stolons may be pruned. This process can be repeated several times on sprouts with successive re-sprouting below the damaged area.

Above ground symptoms include slow or patchy emergence, reduced stem numbers and stunting of individual plants several weeks after emergence. In mature plants, symptoms include yellowing or reddening of foliage and cupping of the leaves (rosette symptom). Plants may wilt and die. In extreme cases, particularly after hot dry weather, several plants in an area can wilt and die leaving bare patches in the crop.

Plants with stem damage remain green long after the rest of the crop has dried off. They typically have short, thickened stems with small green-reddish aerial tubers in the leaf axils. Severely affected plants can produce large numbers of very small tubers or one or two very large tubers.

If tubers are infected at initiation, the resulting potatoes can have patches of russetting on the skin, cracking, deep russetted pits, dimple ends or blind eyes. The black scurf symptom develops on mature tubers. As a potato crop dies off and tubers mature, chemicals produced by the tuber stimulate the fungus to form survival red, black crusty structures called sclerotia.

Where does the disease come from

Rhizoctonia can be both seed borne and soil borne. The fungus survives on decaying organic debris in soil and on the roots and stems of volunteer potatoes. Sclerotia and fungal threads on the skin of seed potatoes are also a source of disease in new crops. The relationship between the amount of sclerotia and fungal threads on seed and the severity of damage in the crop is not known. More research is needed to determine the black scurf threshold for seed-borne infection.

What about other hosts? The fungus can colonise the underground parts of many different plant species without causing damage. The question is whether these hosts can maintain populations of the fungus without potatoes being present? We have some more work to do to determine if our rotation systems, particularly pastures, reduce or support populations of *Rhizoctonia*.

Rhizoctonia is a complex organism with a number of different strains. Three strains known to infect potatoes around the world also occur in traditional potato cropping areas in Australia. However, it seems that some native strains may be infecting potatoes in new areas never previously cropped to potatoes. Until we know which strains occur in our cropping systems and their respective impact on potato production, we will not be able to accurately predict disease risk in the different cropping areas.

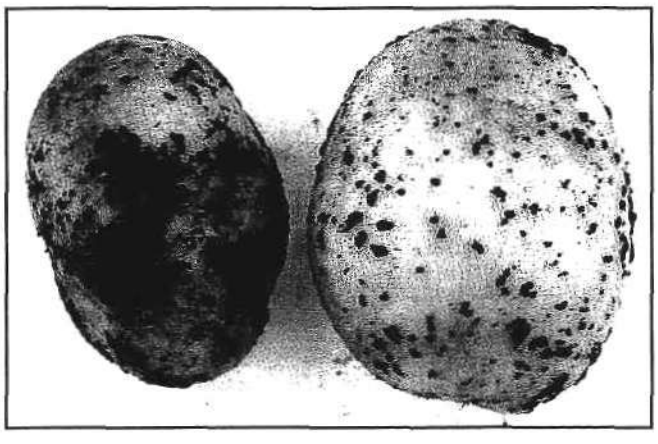
Conditions that favour the disease

Infection of sprouts and stems is most likely under low temperatures and humid soil conditions. For much of its time *Rhizoctonia* colonises the underground parts of the potato plants without causing symptoms. However, when plant growth is slow, due to cold or other stress factors, the fungus is able to infect and cause cankers. Sclerotia (black scurf) on the tuber skin develop under cool, humid conditions. The development of black scurf is slower after mechanical vine kill than after chemical vine kill.

Stem canker and black scurf appear to be particularly severe in nutrient poor, sandy soils. This is perhaps because *Rhizoctonia* has less competition from other soil microbes under these conditions and because damaged plants are less able to cope with stress in these environments.

Can *Rhizoctonia* be controlled with chemicals

Registered chemical treatments (applied to seed tubers just before or at planting) of seed with black scurf can give good control of early sprout damage and black scurf on the daughter plants and tubers. This shows that seed borne *Rhizoctonia* is an important source of infection in the crop. However, these treatments will be no more effective than planting disease free seed. Research shows that some of the disease that develops on plants and tubers is also due to the *Rhizoctonia* that inhabits the soil.



Soil fumigation with chemicals such as Metham can reduce the severity of stem canker and black scurf but is only of benefit if disease free seed or chemically treated seed is planted in the treated soil.

Prevention and management of *Rhizoctonia* canker and black scurf

Although there is still a lot to learn about this disease, there are a number of steps that can be taken to minimise the risk.

- Avoid growing potatoes in short rotations (i.e. less than one crop in every three years).
- Plant only clean seed.
- If there is a risk that seed carries even low levels of black scurf, apply a registered *Rhizoctonia* seed treatment.
- Ensure that sprouts emerge quickly after planting to minimise the risk of damage.
  - warming seed before planting (above 15°C)
  - ensuring that seed is sprouted (do not plant dormant seed)
  - planting no more than 5 cm deep
  - don't plant in cold, wet soils
  - harvest tubers as soon as possible after vine death to reduce the risk of severe black scurf
  - try to avoid stress in crops by ensuring, adequate nutrition and adequate and even irrigation of the crop.

What do we still need to learn about this disease

There is much to learn about *Rhizoctonia* in the unique environment and cropping systems in which potatoes are grown in Australia. A better understanding of the different strains of *Rhizoctonia* in new and traditional cropping systems and the role of the different rotation crops play in the survival of the fungus will help towards predicting disease outbreaks and developing more effective management strategies.

Acknowledgements

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Fresh potatoes from Elders

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Elders, known for its involvement in the animal industries (wool, stock selling), has moved into horticulture with a significant involvement in potatoes. Elders has become the head licensee for several potato cultivars from the UK based Caithness Potato Breeders Ltd. (CPB) group.

Elders formally signed an agreement with CPB in December last year allowing it the full marketing rights for CPB bred potatoes in Australia. This arrangement means that Elders will be testing and multiplying several potato cultivars over the next three years when there will be enough seed for commercial planting.

CPB potatoes generally have low to medium dry matter, set a high number of tubers for high yield potential and size evenness, and have been tested in UK markets which are similar to Australia. The most well known potato from the CPB program is *Nadine* which is doing well in Western Australia and increasing in popularity as a premium washed potato from South Australia. *Nadine* is being trialed in several areas along the east coast of Australia to see if this cultivar will be a washed or brushed potato for local fresh markets.

Plant Breeders Rights (PBR) protects licensees such as Elders who develop and manage supply of potatoes by creating a legal way of controlling who can get PBR protected potatoes and to collect licensing fees. Licensing fees are used to cover the costs of developing and managing the supply of new potato cultivars and reinvest in future potato cultivars.

Of course, the potato would need to have some special features to make it attractive for the market chain in the first place. This naturally means that there will be aggressive searching and testing of new potatoes for the Australian fresh potato industry so the industry will look quite different in 5-8 years time. ■