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Control of grass grub in New Zealand yam crops

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Copy 9 of 15

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Contents

1 Executive summary

Soil-borne insects are one of the most troublesome pests for growers of tuber crops. Three pesticides, Confidor 350 SC, Ascend and BioShield™, were applied at the second (last) mounding of New Zealand yam in order to evaluate their efficacy for grass grub control. Unfortunately there was no response to pesticide treatment as grass grub presence was very low in the two blocks used. No detectable residues (<0.01 mg/kg) were found in the Confidor and Ascend treated tubers from samples collected four weeks before harvest and at harvest.

2 Introduction

Crops of New Zealand yam (*Oxalis tuberosa*) often suffer considerable damage from soil-borne insects, such as the whitefringed weevil (*Naupactus leucoloma*) and grass grub (*Costelytra zealandica*), when planted in paddocks that were in grass the year before. Larvae are present in the soil for nine months (January till October) and have been found during yam harvests in May and early June. Insects cause most damage to yam crops from the time new tubers are formed in February until harvest in May (Fenemore 1984).

Insect damage has been recorded in up to 45% of the tubers in the Kimbolton (Manawatu) area (van Epenhuijsen & Koolaard 2001). Tubers damaged by insects cannot be sold or used for seed. Storage rot in stored, damaged tubers subsequently results in the loss of plants after planting, causing empty spaces in the field. As New Zealand yam crops produce many undersized tubers, which cannot be marketed and are not suitable for planting, an effective treatment for grass grubs would increase the economic return of the crop.

Promising results with a late application in February of Confidor 350 SC (ai fipronil) (van Epenhuijsen & Koolaard 2001) for white-fringed weevil were based on the experience that tubers only start to form from February onwards. Adding water via irrigation after treatment is recommended to spread the chemical in the soil because the soil is often very dry in February. The bacterium, *Serratia entomophila,* when incorporated into a prill formulation, also needs free soil water for bacterial inoculum to be distributed throughout the soil profile (O'Callaghan et al. 2002). The novel granular formulation of *Serratia entomophila*, Bioshield™, has demonstrated efficacy against grass grub (Townsend et al. 2004). Ascend is registered for use on potatoes in Australia as Regent 200 SC (ai imidacloprid) where it is sprayed on to the soil surface and incorporated to a depth of 150 mm before the tubers are planted. The purpose of this project was to investigate the efficacy of three pesticides, Confidor 350 SC, Ascend and BioShield™, applied at the second (last) mounding of New Zealand yam in order to evaluate their efficacy for grass grub control.

3 Methods

Two blocks, Block A (Road plot 122) and Block B (Shed plot 106), were used at Almadale Partnership, Kimbolton. The two blocks were planted with different varieties (variety 2 in Block A and variety 3 in Block B) of New Zealand yam at different planting dates. The year before, Block A had been in grass while Block B had been in barley followed by annual ryegrass over winter. In both Blocks A and B, the treatments were laid out in a randomised block experimental design with four replicates. Within each replicate, the four treatments were randomly allocated to one of each of the four plots. Plots consisted of 4 rows, each 10 m long (inter-row distance 900 mm and a plant spacing in-row 400 mm), with approximately 24-26 plants per row. Treatments were applied before the second mounding using a handheld, electric-powered knapsack sprayer fitted out with an application kit (Teejet) (Fig. 1) on 24 February and 11 March.

Figure 1: Applying liquid and granule treatments.

The soil was sprayed at both sides of the approximately 150 mm high plants in each of the four rows. A surfactant (Du-Wett) was added to both Confidor 350 SC and Ascend (Table 1). A pre-test showed that a high rate of Du-Wett did not have phytotoxic effects.

Table 1: Treatments applied.

Treatment	Application rate (product/ha)	Additive (300 ml/ha)	Number of residues samples	Residue test
Confidor 350 SC	1.111 L	Du-Wett	4	Imidacloprid
Ascend	0.5 L	Du-Wett	4	Fipronil
BioShield ™	30 kg*	-	0	-
	40 kg**	-	0	-
Untreated control	-	-	4	-

*Plot A **Plot B

A third treatment was BioShield™ applied at 30 kg/ha in the first block (A) and 40 kg/ha in the second block (B). Quantities of 27 g and 36 g for each row were placed in small 45 ml plastic jars with holes (diameter 10 and 14 mm) in the lid and spread at walking speed while shaking the jar horizontally (Fig. 1).

The two blocks were harvested within one week of each other. Two 8 m lengths of row in the middle were harvested by hand digging for Block B (23 June) and by machine for Block A (29 June). All yams were washed and graded at Crop & Food Research, Palmerston North.

Combined residue samples (500–900 g) were taken from the remainder of the rows on 26 May (approximately 4 weeks before harvest) for the 4 plots of Confidor and Ascend and the untreated control. These samples were then stored within 2 hours at -18°C. Planned extra samples were not taken 6 weeks after harvest.

At the time of application, some rows were partly covered with black nightshade (*Solanum nigrum*) that was removed from Block A but left in two plots in Block B. Rainfall data were collected over the growing season.

We did not collect grass grub larvae from the Bioshield™-treated rows to find out whether certain life stages had been less affected by this treatment and which life stage survived the treatment.

The mean weights and mean numbers of insect-damaged tubers were statistically compared between the treatments using one-way randomised block ANOVA.

4 Results

Harvested yams from the manual harvested plot were hand washed at Crop & Food Research. This required less effort than washing the yams from the machine-harvested block, which were mixed with weeds, soil, and stones. In both blocks rot was found and greyish soggy spots were seen. Cracked tubers (Fig. 2) were found in four plots in one replicate in Block A. It is unknown if they came from more than one plant in one plot. In Block A some bird and rodent damage (Fig. 2) was found in tubers exposed on the top of mounds that had been partly washed away by rain.

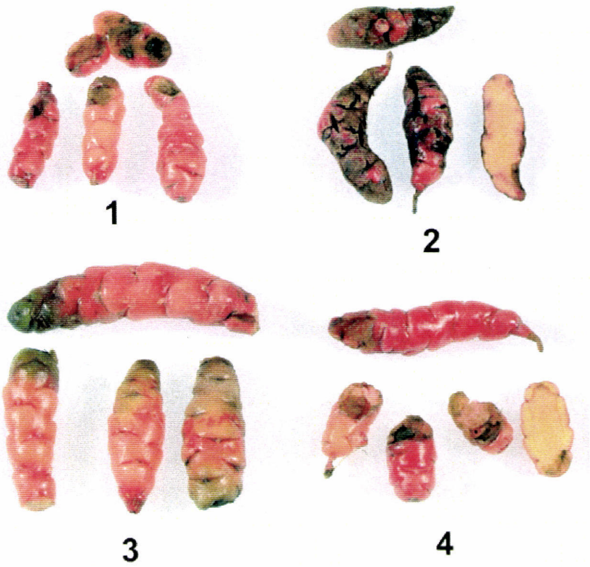

Figure 2: Unmarketable tubers: 1. Grass grub damage; 2. Odd cracked tubers; 3. Field rot; 4. Bird and rodent damage.

The extent of damage to the tubers by insects (Fig. 2) was very low and sometimes very difficult to distinguish from damage caused by birds and rodents.

Grass grub larvae were not found at harvest because the temperatures were too low.

There were no significant differences in the mean weights of insect-damaged tubers between the four treatments in Block A (Road) ($P = 0.31$) (Table 2) but in Block B (Shed) the treatments did have different effects ($P = 0.07$). The mean weight of tubers in the Ascend treatment that were damaged by insects was only 18% of that of the Control (Table 3).

When comparing the results for the mean number of insect-damaged tubers, the pattern was the same as for the mean weights. In Block A (Road) (Table 2) there was no significant difference between the treatments ($P = 0.61$), but in Block B (Shed) there was a tendency for the treatments to have significantly different effects ($P = 0.07$). Again, the mean number of insect-damaged tubers in the Ascend treatment was only 21% of that in the Control (Table 3).

The untransformed data are given in Tables 2 and 3.

Table 2: Mean weight (g) and number of insect-damaged tubers in Block A.

Treatment	Medium (25-50 mm)	Large (>51 mm)	Insect-damaged	Number of damaged tubers
Ascend	9548	4868	110	7
BioShield TM	8838	5638	180	7
Confidor 350 SC	10185	6582	465	10
Untreated (Control)	8752	4260	195	11
5% LSD			424	7.9

Table 3: Mean weight (g) and number of insect-damaged tubers in Block B.

Treatment	Medium (25-50 mm)	Large (> 51 mm)	Insect damaged	Number of damaged tubers
Ascend	3885	12605	73	3
BioShieldTM	3665	11008	265	9
Confidor 350 SC	4195	12380	223	9
Untreated (Control)	3235	10688	413	14
5% LSD			245	7.6

There were no statistically significant differences in the yield among the four treatments.

In the road side block, the yield of medium-sized yams (25-50 mm tubers) was not significantly different (P=0.68), the yield of large-sized yams (>51 mm tubers) was not significantly different (P=0.32), and the total yield of both medium and large-sized yams was not significantly different (P=0.36).

In the shed side block, the results were similar to the road side block. The yield of medium-sized yams was not significant (P=0.49), the yield of large-sized yams was not significantly different (P=0.75), and the total yield of both medium and large-sized yams was not significantly different (P=0.61).

Some badly deformed, cracked tubers were found in all four plots of one replicate in Block A. Blackening was restricted to surface layers, which were shrunken or shrivelled. Deep fissures/cracks were mostly longitudinal, with progressive development from the distal end to the stolon attachment. The internal appearance after the tubers were cut open confirmed the presence of pigmented patches of anthocyanins on the surface.

Residue levels at 4 weeks before and at harvest were not detected in the Confidor and Ascend treated tubers. Therefore no tuber samples were collected 6 weeks after harvest.

Rainfall in the week after the treatments was sufficient for the treatments to work i.e. over 12 mm (Appendix II).

5 Discussion

We originally planned to use 15 kg/ha of Bioshield™, but a much higher rate (30 and 40 kg/ha) was advised (Richard Townsend pers. comm.) and applied after consultation with the grower. The economic returns from more marketable tubers by using a higher rate of BioShield™ are "likely" to cover the higher cost of increased insecticide rates.

Adequate soil moisture levels or rainfall after treatment enhanced the effect of all treatments. When insecticide applications are most needed, soil moisture is often very low. However, applying insecticides at the second moulding and before the plants are too big for applying treatments. In our trial, none of the treatments was significantly more effective because insect levels were too low for any practical treatment effects to be evident.

Subsequent information was received from the farm manager that in two blocks near the Shed site (Block B) a lot of grass grub damage had been found. This illustrates how difficult it is to plan field trials that rely upon insects being present.

Yams are prone to rot if tubers are left too long in soil after the tops are killed off by frosts between the second week of May and the second week of June.

An increase in 'cracked' tubers was noticed by the grower this year.

There is no label claim for use in yams for Confidor and Ascend. Residue data from this trial indicates that these materials, applied at the time and rates given for this trial, are well within the default Minimum Residue level (MRL) of 0.1 mg/kg.

The danger exists that the minor 'cracks' in some tubers at harvest are not detected and tubers may be used again for planting, possibly increasing the number of unmarketable tubers in the following year. The fungus cultured from the diseased cracked tubers was Cylindrocarpon root rot *Nectria radicicola* (= *Cylindrocarpon destructans*). Probably soil or environmental conditions or cultivar susceptibility favoured this infection (Mark Braithwaite pers. comm.).

An increase in fungal disease in tubers is likely in wet soil in winter.

The inclusion of BioShield™ and Ascend was made to screen as many potential control methods as possible.

Application of treatment in yam is hampered by the fact that after the field is covered with the crop, spray cannot enter the soil without damaging the crop. In the past we have applied a chemical into the furrow, Phorate but it was not effective in a previous yam trial (van Epenhuijsen & Koolaard 2001) and instead we chose to apply a chemical at the last and final mound. Whenever one of the treatments is being applied in future it is important to realise that weed cover might affect the treatments by preventing the chemical from reaching the soil. When black nightshade is expected to establish, a herbicide treatment might have to applied for this weed.

6 Conclusion

The two trial sites had a very low grass grub population and so no practical conclusions can be drawn on the efficacy of Confidor, Ascend and BioShield™ for grass grub control in yams. We recommend a repeat of this experiment but at a heavily infested site, preferably one that has been in pasture in the previous year. The grass grub population should be checked before the trial is established.

7 Acknowledgements

Ascend was supplied by BASF New Zealand Ltd, Confidor by Bayer CropScience, and BioShield™ by Ballance Agri-Nutrients Ltd. Du-Wett was supplied by Elliott Chemicals Ltd. Peter Lang of Spraying Systems NZ Ltd gave advice on spraying equipment and Richard Townsend (AgResearch) on the application of BioShield™. David Halford and Clint Smythe of Almadale Partnership carried out all cultural practices, gave assistance during the trial and supplied the rainfall data. Ian Mandahl also provided help during the trial. Further assistance from Julian Heyes, Don Brash and Mark Braithwaite (MAF's Biosecurity and Diagnostic Centre) is also acknowledged.

8 References

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Appendices

Appendix I. Residue results.

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Laboratory No: 383176
Date Registered: 7/07/2005
Date Completed: 19/07/2005
Page Number: 1 of 2

The results for the analyses you requested are as follows:

Sample Type: Biological Materials, Vegetable

Sample Name	Lab No	Fipronil (mg/kg as rcvd)
1 4wks Confidor Shed	383176/1	< 0.01
2 4wks Confidor Road	383176/2	< 0.01
7 Hvst Confidor Shed	383176/3	< 0.01
8 Hvst Confidpr Road	383176/4	< 0.01
5 4wks Untreated Shed	383176/9	< 0.01
11 Hvst Untreated Shed	383176/10	< 0.01

Note: "<" = No residues were found above this detection limit.

Sample Type: Biological Materials, Vegetable

Sample Name	Lab No	Imidacloprid (mg/kg as rcvd)
9 Hvst Ascend Shed	383176/5	< 0.01
10 Hvst Ascend Road	383176/6	< 0.01
3 4wks Ascend Shed	383176/7	< 0.01
4 4wks Ascend Road	383176/8	< 0.01
5 4wks Untreated Shed	383176/9	< 0.01
11 Hvst Untreated Shed	383176/10	< 0.01

Note: "<" = No residues were found above this detection limit.

Summary of Methods Used and Detection Limits

The following table(s) gives a brief description of the methods used to conduct the analyses for this job.
The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Substance Type: Biological Materials

Parameter	Method Used	Detection Limit
Fipronil	Ethyl acetate extraction, SPE cleanup, analysis by GCMS-SIM	0.01 mg/kg as rcvd
Imidacloprid	Methanol extraction, SPE cleanup, analysis by LCMS	0.01 mg/kg as rcvd

Analyst's Comments:

These samples were collected by yourselves and analysed as received at the laboratory.

Samples are held at the laboratory for one month (where appropriate) after reporting of results. After this date they are discarded unless otherwise advised by the submitter.

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Colin Malcolm, BSc
Pesticides Client Manager

Appendix II. Rainfall (mm) from 14 February (10 days before the first treatment) till May.

Month	Day	Rainfall
February	14	15
	15	8
	28	12
March	6	9
	11	15
	24	18
	30	23
April	2	1
	5	2
	14	13
May	6	55
	27	42