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Insecticides and host plants for New Zealand yam (Oxalis tuberosa)

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1 Executive summary

Insect damage to New Zealand yam tubers results in a high percentage of unmarketable tubers. The grass grub and the white fringed weevils are major pests of this crop and cannot be controlled with the insecticides registered in New Zealand. Yam tubers damaged by insects are not only unmarketable but, are likely to rot quickly when planted out as seed tubers.

We carried out two field trials to examine the effect of three insecticides (applied at different dates and times) on populations of grass grubs and white fringed weevils in yam crops.

Treatment with Confidor against grass grubs produced good results, especially when applied late.

Oats were found to be good hosts for the white fringed weevil in the pot plant greenhouse trial. Only one adult was found in the potted ryegrass plants. A late treatment for the control of white fringed weevil in the field was not effective.

2 Introduction

In autumn 2000, yam tubers were checked at harvest for insect damage on seven properties in the Manawatu. From 1.4 to 45% of the tubers were damaged, (van Epenhuijsen, unpublished data) mainly by the grass grub (*Costelytra zealandica*) and by the white fringed weevil (WFW) (*Graphognathus leucoloma*) on a property in Ashhurst. Insect damage affects not only the "saleable" yield, but reduces the quality of the seed tubers in storage, resulting in rots. Although other soil pests are also found in yam (Carpenter et al. 2000), insects such as wire worms and cutworms were not present in high enough numbers to cause significant damage to crops at these sites. A few wire worm larvae were found when plants were uprooted to assess insect damage.

In 2000 wireworm traps consisting of perforated plastic containers were filled with soaked wheat (Parker 1996) and placed both in the South Island and Manawatu but did not catch any wireworms.

Tubers damaged by grass grub are often seen in soil that has previously been in grass. Insecticide treatments are seldom applied. Application of an insecticide to a yam crop should occur soon after the last ridging because after that plants cover the field surface, making access to the crop very difficult with a tractor.

In February tubers start to form and if the soil temperature remains high enough, grubs will damage the tubers even into the normally colder months.

A pot trial was also carried out to identify preferred hosts of these two insect pests. Plants tested were clover, oats and rye grass.

3 *Pest status*

3.1 *Grass grub*

Damage by grass grub causes much deeper holes than the damage by the WFW. Early damage by WFW can deform the tubers and slow their growth (Fig. 1).

Adult grass grubs main emergence and flight period is from October until mid December. Females mate as soon as they emerge and lay their eggs close to the emergence point. Hence infestations tend to remain localised. Larvae are present in the soil for nine months and can be found close to the surface in large numbers during the yam harvest in May and even early June, if the temperatures are not too low. The main insect damage to crops other than yam occurs from November to February, but since yam tubers are not formed before February, damage to them will occur later—up to harvest (Fenemore 1984).

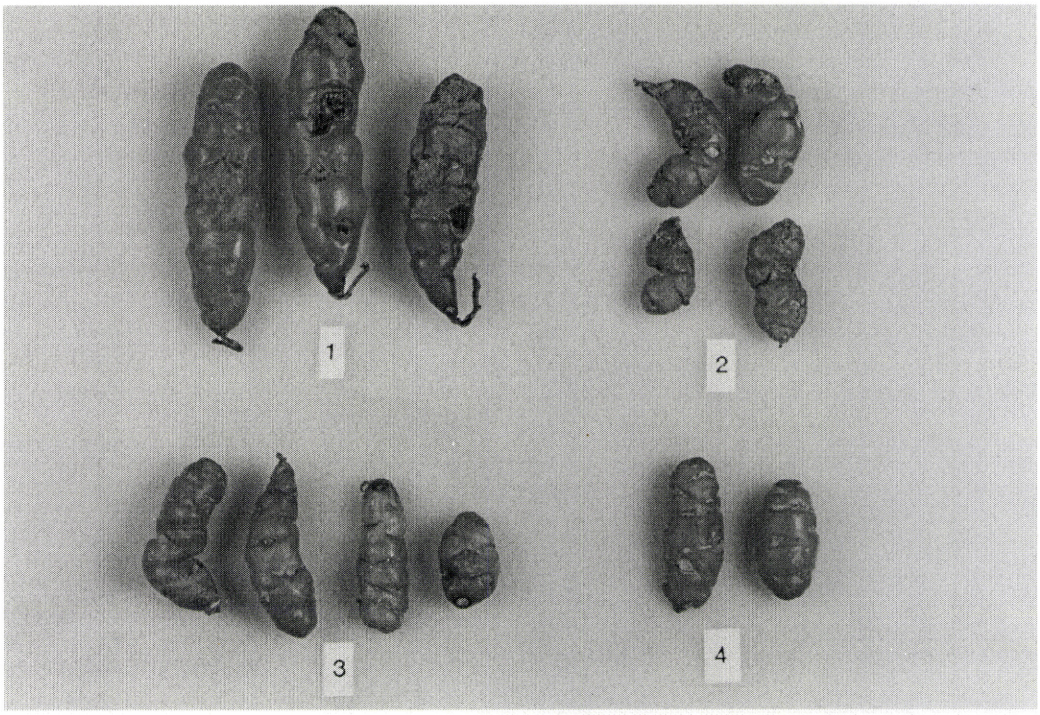

Figure 1: Damaged and deformed New Zealand yam by: 1. grass grub 2. early damage by white fringed weevil larvae 3. unknown light brown spots 4. healthy tubers.

Figure 2: White fringed weevil larvae feeding on New Zealand yam tubers.

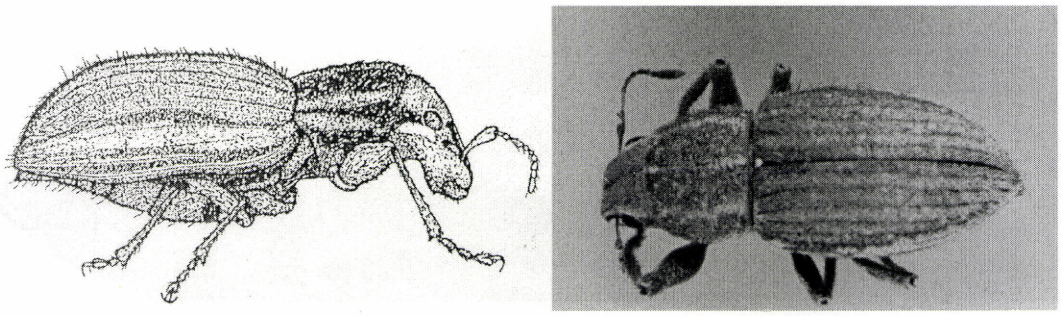

Figure 3: White fringed weevil adults.

3.2 White fringed weevil

White fringed weevil (WFW) larvae (Fig. 2) feed on a wide variety of plants, while the grey and white striped flightless adults (Fig. 3) are nocturnal, moving around only at night or on overcast days. During the daytime, growers are not likely to observe and thus recognise them since they are often obscured between the plants. Adults do not like grasses and cause only little damage to clover leaves in particular. Host plants of the WFW are listed as barley, brassicas, clovers, lucerne, pasture, potatoes, pumpkins, ryegrass, wheat, tomatoes and many common weeds (Scott 1984). Pasture legumes (clovers and lucerne) are favoured hosts (Scott 1984). Reproduction of WFW is by parthenogenesis—males are not required. Most eggs hatch in autumn and the larvae stage can take up to 20 months. Thus, larvae of all sizes can be found at most times of the year, and a short active treatment is not effective. WFW larvae in paddocks seem to thrive if weeds and clover are present. Oats also host WFW (Osborne pers. comm).

This report describes the results of a main trial in Kimbolton, to which insecticide treatments were applied early and late in the season, a small trial in Ashhurst where one insecticide was applied in a late treatment, and observations on WFW host preferences on grass, clover and oats in a greenhouse.

4 Materials and methods

The insecticides used are not registered for yams and must be applied when a considerable amount of rainfall is expected. Such conditions are common in late summer. Application of such an amount of water (13 mm on the day after treatment) by irrigation is not practical.

4.1 Main trial

The trial at Kimbolton on grass grub damage in yams involved two application dates (15 November and 14 February) and three chemicals—six treatments in total (Table 1). The crop previously grown on the site was carrots, and the trial site was surrounded by mature grassland. There were four blocks (replicates) of six plots (one for each treatment) in the trial which was laid out as a randomised block design. Fourteen tubers were planted 15 cm deep in each plot of one row, and ridged after the chemicals were applied in the early application. The total weight of 14 tubers per replicate varied from 299 to 306 g. The planting distance was 400 mm, and the rows were 900 mm apart.

Four plants (guard plants) on both sides of each plot were uprooted and assessed for damage and rot on 27 June. The remaining six plants in the middle of the plot were harvested on 31 May and assessed for yield and insect damage.

Treatments, application dates and water supplied are described in Table 1. A light rainfall followed this late treatment application.

Table 1: Insecticides - their rates, time of application and water supplied.

Treatment[1]		Application date	Rate (row)	Water supplied
1.	Confidor 350 SC	Early (14/2)	1 ml/10 m	6 mm
2.	Yates Soil insect killer	Early (14/2)	4.5 g/m^2	13 mm
3.	Thimet 20G	Early (14/2)	7.5 gram/5.6 m	6 mm
4.	Confidor 350 SC	Late (15/11)	1 ml/10 m	–*
5.	Thimet 20G	Late (15/11)	22.4 g/5.60 m	6 mm
6.	Untreated (water)	Early (14/2)	-	6 mm

[1]Confidor contains 350 g/kg imidacloprid, Thimet contains 200 g/kg phorate and Yates insect killer contains 50g/kg Diazinon.

On 14 February tuberisation had not begun and few stolons had formed. The soil was very wet after a weekend with approximately 100 mm of rain in the Kimbolton area.

The first (early) application, of Confidor 350 EC, was applied by spraying the solution over the formed ridges. Rain was forecast to fall over the next few days. At the second (late) application of Confidor more water was supplied to the ridges after application. Thimet was spread into a wide furrow which was slightly covered with soil before the tubers were planted and then ridged up afterwards.

On 14 February many empty spots in the plots with 6 plants were replanted with plants approximately 100 mm tall taken from adjacent rows. Treatments 2, 3 and 5 were applied at different times in a 30 mm wide trench on the ridge. Ridging up was done for the second and last time and plants were spreading out.

4.2 Small trial

In Ashhurst, the trial comprised four treated and four untreated plots, each containing six plants (planted by the farmer). The treatment was Thimet 20G. It was first applied on 28 February. In the later application Thimet was applied by adding 3.2 g over each 2.5 m length of a row.

4.3 Host plant pot trial

On 7 November a trial was conducted at Crop & Food Research in which 4-litre plastic pots were planted with either young clover seedlings or sown with oat or rye grass seed. Forty WFW grubs were collected from the field between 15 and 21 December and were divided equally amongst 4 pots per plant species. The pots were placed in cages in a greenhouse. All sizes of larvae were equally represented in each pot.

The pots were placed in trays. The overflow of surplus water in the trays was covered with netting to prevent the emerging adults from drowning. Stakes were placed against the pots so that adults that fell out could climb back into the plastic pots. On 15 December 90 WFW larvae were dug up from the adjacent plot in soil and tubers and divided among the pots. During the growing season, all other plants/weeds in the pots other than the potted plants were removed. The larger larvae weighed between 0.15 and 0.19 g while smaller specimens were between 0.06 and 0.11 g. The average weight was 0.15 gram varying from 0.09 to 0.12 g.

5 Results

5.1 Main trial

The emergence of red yams is often uneven (David Halford pers. comm.) and the percentage of rotted seed tubers can be surprisingly high. It is well known that emergence of red yam plants is often bad. In our trial, many empty spots had to be replanted with plants from the main field before the first application of spray was carried out.

Only 2 grass grubs and 5 cutworms were found in 24 x 6 plants at the first assessment in Kimbolton.

Table 2: Percentage of all tubers that were clean (undamaged), small tubers that were clean, and large tubers that were clean. Mean yield at harvest for the various insecticides.

	Percentage			Weight (g)	
Treatment	Clean total	Clean large	Clean small	Small clean tubers	Large clean tubers
1. Confidor E*	64.2	55.3	71.5	944.0	1464.0
2. Yates E	53.8	57.3	51.6	559.0	1647.0
3. Thimet E	47.9	39.2	54.6	907.0	1322.0
4. Confidor L*	75.9	78.1	74.7	1171.0	2934.0
5. Thimet L	40.6	36.3	44.1	527.0	1319.0
6. Untreated	28.4	24.2	31.0	449.0	774.0
LSD 5% (df=18)	31.9	31.0	35.1	786.0	1893.6

*E = Early or L = Late application.

The mean percentage of clean tubers in the untreated control (28.4%) was much lower than in the other treatments. Confidor L had the highest percentage (75.9%) followed by Confidor E (64.2%); both were significantly higher than the untreated control. The other treatments gave percentages somewhere in the middle, but not significantly different from either the control or the Confidor treatments.

The percentage of large tubers that were clean (without insect damage) was lowest in the untreated control (24%) and highest for Confidor L (78%)—significantly better than in the untreated control and Thimet treatments. Confidor E and Yates E had moderate percentages of large clean tubers.

For the percentage of small tubers that were clean, the Confidor E and L were again the best two treatments by far—significantly better than control.

The mean plot yields of small clean tubers from Confidor E and L and Thimet E treatments were by far the highest (more than double that of the control). Thimet L and Yates yielded relatively poorly. The untreated control also had by far the lowest average plot yield of large tubers. Confidor L's yield was much higher than all the others, but was significantly higher than the control only, since there was a large degree of variability in the plot yields. All other treatments yielded, on average, about double that of the control, and half that of Confidor late.

Table 3: Mean percentages of clean tubers and of large clean tubers (out of total number of tubers), and mean plot yield in grams, in a late season application of Thimet against white fringed weevil in Ashhurst.

Treatment	Percentage clean tuber	Percentage large clean tubers	Mean plot yield (g)
1. Water control	76.3	13.1	1992
2. Thimet	73.6	10.6	1406
Significance level for comparison of treatment means (df=6)	*P*=0.522	*P*=0.533	*P*=0.123

5.2 *Small trial*

There was no significant difference between Thimet and the untreated control in any of the measures used (Table 3). The control had a 40% higher mean plot yield of clean tubers, but the difference was not significant at the 5% level. Only one WFW was found during the harvest at Ashhurst.

5.3 *Host plant pot trial (Table 4)*

WFW beetles that emerged from the potted plants were counted periodically between 29 January and 18 April, and live beetles were released into the cages again. The number of beetles indicated the total number of weevils that were reared successfully out of the released grubs. Five came from the oats while only one came from the potted ryegrass. When the pots were emptied on 18 April the soil was also checked for WFW larvae. Two large grubs were found in the pots with clover, four medium sized grubs were found in the pots with oats, and none were found in the ryegrass.

Aphids entered the cages of this trial, probably during the hand watering in mid April, causing clover plants to die.

Table 4: Number of adults weevils emerged from the release of 24 grubs in potted clover and oats and ryegrass.

	Number of adults		
Date of observation	Clover	Oats	Ryegrass
29/1	2*	2*	1
9/2	0	1*	0
15/2	0	1	0
21/2	2	1	0
15/3	1	3*	0
6/4	0	2	0
18/4	0	1	0
Total beetles dead	3	5	1

* alive and released again

6 Conclusion and recommendation

6.1 Insecticide treatments

Insects can cause considerable damage to an already labour-intensive crop in which a crop rotation with grass is not helpful if the grass crop contains many broadleaf weeds and clover.

The lack of rainfall in summer, the time when insecticide applications are recommended, reduces the potential efficacy of chemical treatments.

The late treatment with Thimet for WFW control was no more effective than the untreated control. For grass grub control, the Confidor late application gave a significantly higher percentage of clean small tubers which are either the late-formed tubers or the knobs on the earlier produced larger tubers. Confidor in a late application gave significantly higher proportions of large clean tubers than the untreated control.

Where seed tubers are likely to be damaged by insects, an early applied insecticide treatment could result in fewer weak or dead plants at planting time, but the application probably does not prevent later damage in the season.

6.2 Host plant pot trial

Oats seems to be another good host plant for the WFW and in a rotation will not reduce WFW population. Application of an effective pesticide and some pest monitoring in the form of large pitfall traps could help in determining when to apply a chemical to control the adult population of WFW. Application should occur on an overcast day, or early in the evening. We saw only one weevil coming out of the potted ryegrass plants, but a low number was expected since this is not a preferred host plant. This lone weevil probably came from one of the larger grubs that were released, and might not have needed to feed before pupating.

6.3 Recommendation

Confidor should be registered for use on yams for the control of grass grub and is likely to be most effective when applied late in the season.

7 Acknowledgements

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