# BRONZE BEETLE CONTROL IN AUCKLAND APPLE ORCHARDS

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## SUMMARY

Two replicated field trials showed that bronze beetles (*Eucolaspis brunnea*) in apple orchards were controlled by four sprays of chlorpyrifos (38 g ai/100 litres) beginning with a pre-blossom application, followed by three fortnightly sprays commencing at petal fall. Chlorpyrifos is a suitable replacement for DDT, the most effective insecticide which is now precluded from use by legal and environmental considerations. Four sprays of prothiofos (60-80 g ai/100 litres) also control bronze beetle. Lindane and azinphos-methyl had little effect on field populations. Laboratory bioassays disclosed that apple foliage sprayed with DDT remained highly toxic for 2 weeks, while chlorpyrifos and particularly prothiofos were less persistent.

## INTRODUCTION

The bronze beetle, a native chrysomelid distributed throughout N.Z., is a significant pest of apples (cv. "Granny Smith") only in Auckland. Adult beetles feed on petals and developing fruit. Damaged fruit develop distinctive large raised brown scars which downgrades the fruit at harvest.

Bronze beetles were serious apple pests in the 1930's, regularly mentioned in contemporary monthly advisory columns, and subject to detailed scientific studies (Cottier 1935; Miller 1931). After the second world war, DDT replaced lead arsenate as the major horticultural spray. DDT appeared to give such good control of bronze beetle that the species was no longer an economic concern. Over the last 4-5 years, following the decline of DDT, bronze beetle damage to apples has re-appeared and new methods of control are needed.

## METHODS

### Seasonality of the bronze beetle

Six Auckland apple orchards (Oratia (2), Huapai (2), Wainui (1) and Albany (1)) were surveyed during the 1981/82 and 1982/83 growing seasons. Adult bronze beetles were collected weekly with sweep nets and sticky traps from September to December, then monthly till harvest (early April). The impact of each spray in the MAF programme (based on azinphos-methyl) on the beetle population was observed. Spray data were supplied by the orchardists. The developing apples were sampled, diameter measured and the damage compared with beetle numbers.

### Insecticidal trials

Each season (1981/82, 1982/83), a block of apple trees with a history of bronze beetle damage was selected for an insecticidal trial.

Greater damage was expected on a blackberry infested border of each of the blocks so the trials were designed as randomised block experiments comprising seven strips of ten (1981/82) or eight (1982/83) trees parallel to the infested border. Each strip contained each treatment applied to a single tree. Most insecticides chosen for the trial were already registered for use on apples (Table 1). DDT was included for its historical importance and acephate was used because of the results of Swart, Barnes and Greeff (1976). Individual trees were sprayed with a hand lance to run-off (approximately 10 litres/tree).

**TABLE 1: Chemical and rates of application.**

| Insecticide | Symbol | Formulation | Concentration used (g ai/100 litres) |
|---|---|---|---|
| Acephate | (O) | Orthene 75 WSP | 75 |
| Azinphos-methyl | (G) | Gusathion M 50 WP | 50 |
| Chlorpyrifos | (Lo) | Lorsban 50 WP | 38 |
| DDT | (D) | D-spray 50 WP | 50 |
| Lindane | (Li) | Lindane 50 WP | 50 |
| Prothiofos | (T) | Tokuthion 40 WP | 80 (first spray followed by 60) |

At harvest, the apples on each tree were counted, and the bronze beetle damaged apples examined in the laboratory for size (diam) and number of feeding scars. The data (number of damaged apples/tree) was transformed to logarithms and treatments were compared using the "t" statistic.

*(a) 1981/82 trial (year 1)*

Four insecticides were compared using a standard three-spray treatment (Lo1, Li1, D1, G1) (Table 2). Treatments with the second spray deleted (D3, Li2), with an additional pre-blossom spray (D2, Lo2), or with an additional spray at the end of the standard treatment (G2) completed the experimental programme. The control treatment received no insecticide sprays.

*(b) 1982/83 trial (year 2)*

Four treatments (Lo1, Lo2, D2 and control) were repeated. Lindane and azinphos-methyl treatments were replaced with prothiofos (T) and pre-blossom sprays of DDT (D4) or acephate (E) followed by Lo1 treatments. A further treatment (Lo3) comprising three early sprays completed the programme (Table 2).

**TABLE 2: Experimental insecticidal treatments and resulting bronze beetle damage to apples at harvest (see Table 1 for chemical symbols and rates).**

| | Stage at which applied | | | | | Apple damage | |
|---|---|---|---|---|---|---|---|
| Treatment | Pink | Petal Fall | +2 weeks | +4 weeks | +6 weeks | 81/82 % | 82/83 % |
| D1 | — | D | D | D | — | 1.0 cd | — |
| D2 | D | D | D | D | — | 0.3 d | 3.1 d |
| D3 | — | D | — | D | — | 1.6 bc | — |
| D4 | D | Lo | Lo | Lo | — | — | 8.4 bc |
| Lo1 | — | Lo | Lo | Lo | — | 1.6 bc | 9.7 bc |
| Lo2 | Lo | Lo | Lo | Lo | — | 0.7 d | 7.1 cd |
| Lo3 | Lo | Lo | Lo | — | — | — | 9.2 bc |
| E | O | Lo | Lo | Lo | — | — | 14.0 ab |
| T | T | T | T | T | — | — | 9.9 bc |
| Li1 | — | Li | Li | Li | — | 2.6abc | — |
| Li2 | — | Li | — | Li | — | 2.4 ab | — |
| G1 | — | G | G | G | — | 3.0 a | — |
| G2 | — | G | G | G | G | 3.0 a | — |
| Control | — | — | — | — | — | 2.2 ab | 18.4 a |

**Bioassay for persistence of toxicity**

The persistence of the toxicity of chlorpyrifos, DDT and prothiofos was assessed in a laboratory bioassay. Fruiting spurs (branchlet, leaves and developing fruit) were collected from sprayed trees or unsprayed control trees. The first sample was collected on 10.11.82, 13 days after the second (petal-fall) application. The third spray was then applied and a second sample of fruiting spurs obtained the same day (0 days). The final sample was collected 8 days later (18.11). Immediately after sampling, groups of 30 beetles were enclosed in large plastic bags with a spur and assessed 24 h later for numbers of dead, moribund and live beetles. The experiment was replicated six times for the 0 and 13 days samples or one to three times for the 8 days sample. Data was analysed (ANOVA) following an arc-sine transformation.

## RESULTS AND DISCUSSION

**Seasonality of the bronze beetle**

Adult bronze beetles were first captured on blossom, feeding on flower petals till petal fall when they began to damage the developing apples. Damage increased very rapidly, then appeared to decline, possibly due to preferential abscission of insect damaged fruit (Murneek 1933). The last beetles were captured in mid-December.

In the first year of the survey only one of the five commercial orchards was heavily attacked. Our reports of large numbers of beetles 1-2 days after the post-blossom application of lindane and later azinphos-methyl convinced the grower that a new insecticide was required. Two applications of chlorpyrifos greatly reduced the numbers of beetles in our samples for the remainder of the season.

**1981/82 Insecticide trials**

Most of the damage in the first years trial at Oratia was concentrated in the rows nearest the blackberry infested border. The trial design provided two trees sprayed with each treatment within the heavily damaged area.

DDT was the most effective insecticide. Comparison of treatments with identical spray intervals (G1, Li1, Lo1, D1) revealed a sequence of decreasing damage, though only D1 was significantly different from the control ($p < 0.05$) (Table 2). Pre-blossom application of DDT (D2) further decreased damage (D2 was signicantly different from control, $p < 0.001$). When the interval between sprays was increased to four weeks (D3) damage increased and was not significantly different from control.

Chlorpyrifos gave good control only when a pre-blossom spray (Lo2) was included (Table 2) (Lo2 was significantly different from the control $p < 0.01$).

Lindane and azinphos-methyl treatments (Li1, Li2, G1, G2) were not significantly different from the control. This confirmed our earlier observations from commercial orchards that these materials were not suitable for bronze beetle control.

**1982/83 Insecticide trials**

The experimental block at Huapai received tenfold the damage observed in the previous season at Oratia. Despite this large difference, three of the four treatments common to both trials were damaged in similar proportions (D2: Lo2: control = 3: 7: 20, Table 2). D2 and Lo2 were the best treatments in both years. The Lo1 treatment was significantly different from the control only in 1982/83 ($p < 0.01$). Omission of the last chlorpyrifos spray (Lo3) increased damage, but not to a statistically significant extent. Prothiofos (T) was significantly less effective than DDT (D2) ($p < 0.05$) but could not be statistically distinguished from Lo2. Treatments combining two insecticides (D4, E) were less or no more effective than either of the insecticides used alone (D2, Lo2). None of the new treatments offered an improvement on D2 and Lo2.

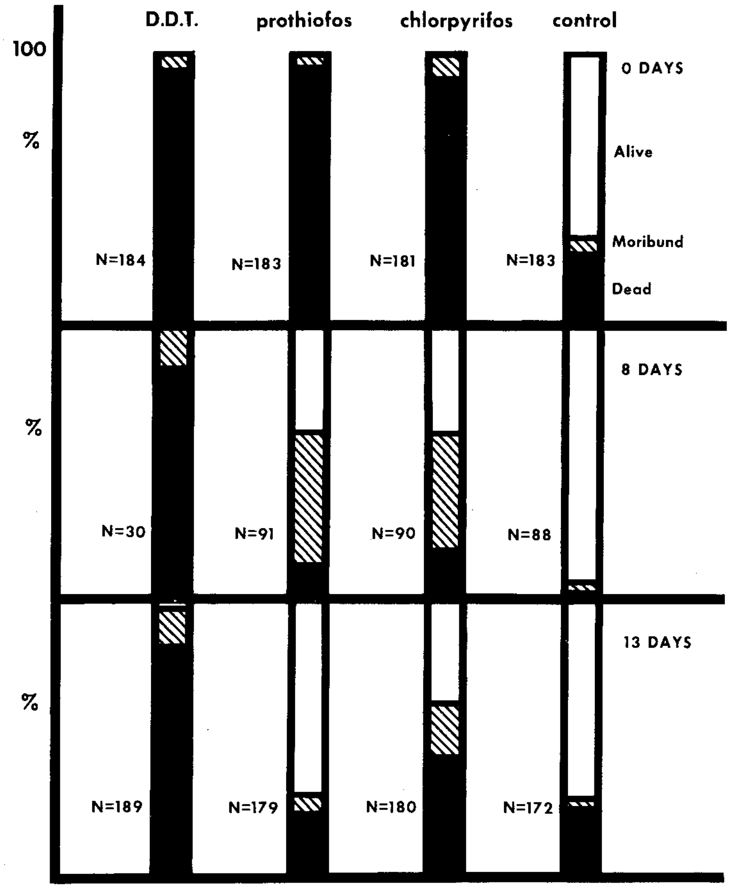


**Fig. 1: Effect of insecticide deposits aged for 0, 8 and 13 days in the field on the mortality of groups of bronze beetles in the laboratory.**

**Bioassay for persistence of toxicity**

The three insecticides that had demonstrated effectiveness in the field were subjected to a laboratory bioassay. Almost as many beetles (97%) were killed or immobilised by contact with 13 day old deposits of DDT as were affected by freshly sprayed fruiting spurs (100%) (Fig. 1). Fresh deposits of prothiofos and chlorpyrifos were very toxic but after 8 days toxicity declined and many of the beetles were only immobilised not killed by 24 h exposure to these materials (Fig. 1). Thirteen day old deposits of chlorpyrifos were still significantly affecting beetles a week later ($p < 0.01$) but mortality from 13 day old prothiofos deposits was indistinguishable from that in the untreated controls. The bioassay suggests that fortnightly applications of DDT would maintain complete protection over the developing fruit, each subsequent spray adding to the toxic deposit on the tree. Fortnightly applications of chlorpyrifos or prothiofos would maintain a partial cover, with periods where the fruits were vulnerable to attack. Four weeks apparently elapsed before similar windows of vulnerability appeared in the DDT programme (similar damage was found in the D3 and Lo1 programme in 1981/82).

**The new bronze beetle control programme in use**

Our tentative conclusions from the 1981/82 trial were incorporated into the MAF apple spray schedules. During the 1982/83 season we followed the beetle population and damage levels in two orchards that planned to use the new recommendations. Orchardist A adhered closely to our chlorpyrifos programme (Fig. 2). Insect numbers remained low throughout. Damage peaked at 5% in early December. After preferential drop of damaged fruit, damage levels of 0-3% were recorded in the months leading up to harvest compared with 15% (lindane and azinphos-methyl spray programme) the previous season.

In orchard B (Fig. 3) chlorpyrifos was applied at pre-blossom and a week after petal fall. Beetle numbers rose notably during this interval, though the sweep net and sticky trap samples showed that the second chlorpyrifos spray counteracted this rise. Azinphos-methyl, used subsequently appeared to have had less effect on the bronze beetle populations and we estimated that 12% of the apples in this area of the orchard were damaged at harvest. Most of this damage was inflicted during the period of rapid fruit growth.

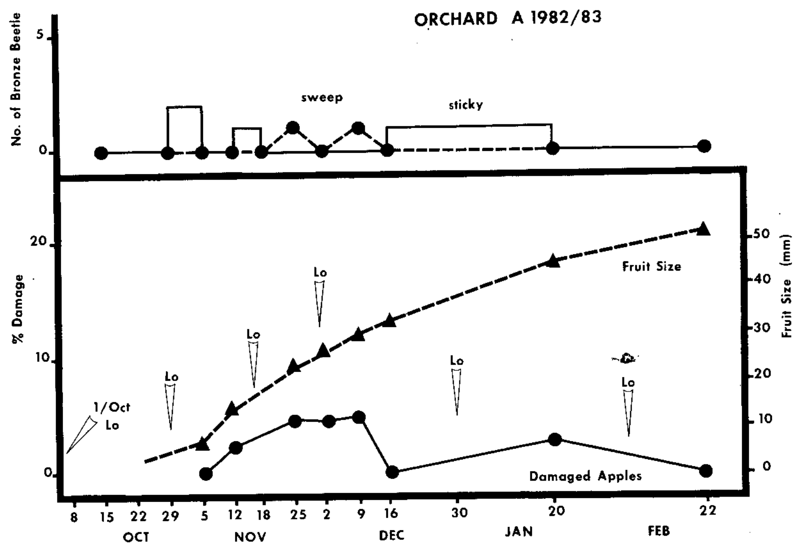


**Fig. 2: Bronze beetle numbers measured by sweep and sticky traps and the resulting apple damage in an orchard adhering closely to the recommended Lo2 programme (see text).**

## CONCLUSIONS

Two years of trial data and one year's experience under commercial conditions indicates that a programme of chlorpyrifos beginning with a pre-blossom spray followed by three sprays at fortnightly intervals begun promptly at petal fall will give good control of bronze beetle. Owners of blocks subject to very heavy damage should consider shortening the spray interval to 10 days, as our bioassays have demonstrated limited persistence for chlorpyrifos.

Though no contemporary literature exists, we conclude that the introduction of DDT to New Zealand apple orchards caused the disappearance of bronze beetles after the second world war.

The use of chlorpyrifos is compatible with integrated mite control.

Azinphos-methyl should replace chlorpyrifos from mid-December till harvest to prevent codling moth damage.

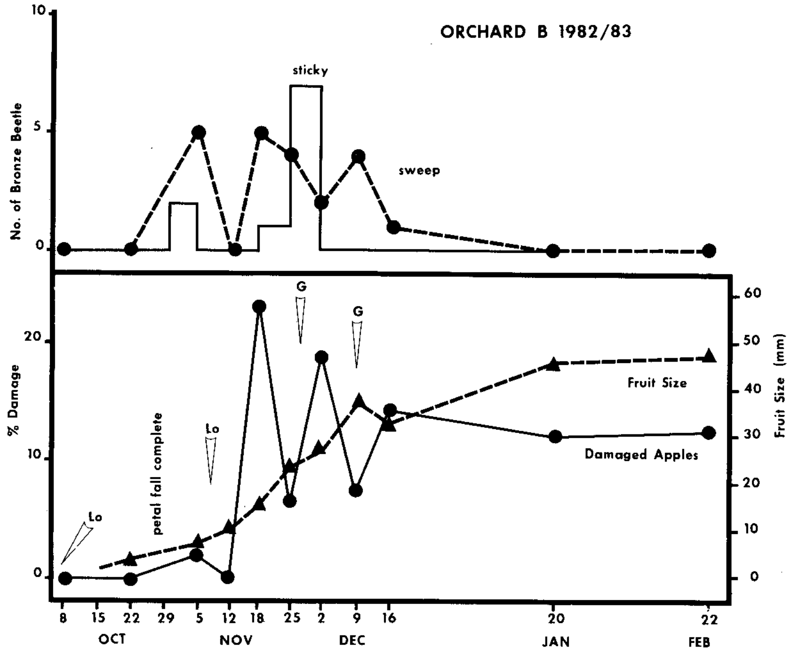


Fig. 3: **Bronze beetle numbers measured by sweep and sticky traps and the resulting apple damage in an orchard not adhering closely to the recommended Lo2 programme (see text).**

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## REFERENCES

Cottier, W., 1935. Experiments on the control of the bronze beetle (*Eucolaspis brunnea*). *N.Z. J. Sci. Technol. 17:* 433-453.

Miller, D., 1931. Bronze beetle. Report on control experiments using chemical spray. *N.Z. J. Sci. Technol. 13:* 34-36.

Murneek, A.E., 1933. The nature of shedding of immature apples. University of Missouri Research Bulletin No. 201.

Swart, P.L., Barnes, B.N. and Greeff, H.J., 1976. Snoutbeetles (kalanders) on apple trees: Preliminary evaluation of candidate insecticides for their control. *The Deciduous Fruit Grower 26:* 308-312.