THE INSECT PEST COMPLEX OF *ACTINIDIA ARGUTA* KIWIFRUIT

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ABSTRACT

The key insect pests of *Actinidia arguta* kiwifruit were determined by monitoring tagged fruit bunches for insects and insect damage in six orchard blocks from fruit set in November 2007 until harvest in February 2008, and by examining samples of picked fruit at harvest. The proportion of fruit damaged by leafroller feeding increased throughout the entire growing season and live caterpillars were present on picked fruit at harvest. Greenhouse thrips damage to fruit was noticeable from mid January. Armoured scale insects and mealybugs were recorded on the fruit from December, but most infestations occurred during the month prior to harvest. Leafrollers and greenhouse thrips are the key production pests, while leafrollers, greedy scale and some mealybug species are potential quarantine species. All three commercial *A. arguta* cultivars grown in the Bay of Plenty are susceptible to the key pest species. **Keywords:** *Actinidia arguta* kiwifruit, leafrollers, greenhouse thrips, armoured scale insects, mealybugs.

INTRODUCTION

Actinidia arguta kiwifruit or 'NZ KiwiBerry' is a relatively new commercial fruit crop. There are three main cultivars grown for export in New Zealand: Takaka Green, K2D4 and Marju Red. Unlike other commercial kiwifruit, *A. arguta* vines produce small fruit (5-20 g) with smooth edible skins in bunches of up to 20 fruit. The majority of plantings are in the Bay of Plenty between Katikati and Opotiki.

As with any new export product, the New Zealand KiwiBerry industry is facing a number of challenges, including significant production losses due to insect pests. Packhouse records from three consecutive seasons showed that a number of growers experienced fruit losses of 20% or more as a result of insect damage (G. Oliver, Kiwi Produce Ltd., pers. comm.). Further losses occurred following fumigation of exported produce in response to quarantine interceptions. A crop protection programme incorporating appropriately timed applications of insecticides that do not leave unacceptable residues on the fruit is seen as critical to reduce losses due to insect pests, and to facilitate the growth of the New Zealand KiwiBerry industry.

In 2007 a survey of *A. arguta* production sites in the Bay of Plenty region was completed to identify the mites, insects and fungal pathogens associated with the fruit at harvest (McKenna et al. 2007). Records from this survey identified a number of potential pest species including leafrollers, thrips, armoured scale insects and mealybugs. In this study the timing of crop infestation by these insects and the key damage periods was investigated, as the basis for the development of pest management strategies for use on commercial *A. arguta* plantings.

METHODS

Six blocks of *A. arguta* in the Bay of Plenty were used for this study, two each of Takaka Green, K2D4 and Marju Red. Four blocks were located in Pongakawa and two in Te Puke. All blocks contained mature vines trained on a pergola structure. The blocks received standard commercial vine husbandry except that no pesticides were applied to the trial areas.

In each block, ten fruit bunches on each of ten randomly selected vines were tagged and the number of fruit per bunch counted. Tagging occurred at fruit set on 12 November 2007 for the blocks located in Pongakawa, and on 28 November 2007 for the blocks located in Te Puke. Tagged fruit bunches were checked under a 10x OptiVISOR® at fortnightly intervals from fruit set until harvest on 13 February 2008 for the presence of insects and insect damage. In particular, fruit were checked for live leafroller caterpillars and caterpillar damage, thrips and thrips damage, armoured scale insects and mealybugs. Leafroller and thrips damage was categorised as light (superficial damage < 0.5 cm²) or severe (superficial damage > 0.5 cm² and any penetrating damage). Fruit with severe damage are unsuitable for sale. Any live caterpillars found feeding on the fruit were identified to genus or species using differences in head capsule colour and body appearance (Steven 1990). Caterpillars or thrips were not removed from their feeding site.

At harvest on 13 February 2008, all fruit bunches were picked and examined in the laboratory under a binocular microscope for the presence of insects and insect damage. Damage was categorised as per the *in situ* checks. Any live caterpillars found were placed in plastic tubes containing artificial diet (Singh 1983), and reared in the laboratory at ambient temperature. Initial visual identifications were confirmed after moth emergence using adult morphological characteristics.

Results are presented as the mean ($\pm$ standard error of the mean (SEM)) percentage of fruit with insects or insect damage at each check date and at harvest.

RESULTS AND DISCUSSION

Leafrollers

Most leafroller damage to *A. arguta* fruit appears as a superficial brown scarring on the fruit skin. In some instances the fruit may become distorted if heavy feeding has occurred when the fruit are young. It is sometimes difficult to distinguish leafroller feeding damage from other skin marking such as wind rub on *A. arguta*, especially when the damage is old and well healed. Only damage that we were certain was due to leafroller feeding was recorded.

Leafroller larvae and damage levels varied from block to block (Fig. 1), but the percentage of fruit with leafroller damage consistently increased from fruit set in November 2007 through to the end of January 2008. Live caterpillars were found in fruit bunches at each date: 26 were *Ctenopseustis* sp. (brownheaded leafroller), 12 were *Cnephasia jactatana* (black-lyre leafroller) and 2 were *Planotortrix* sp. (greenheaded leafroller). All species are endemic to New Zealand and are classified as quarantine pests in all export markets.

At harvest on 13 February 2008, the percentage of fruit with leafroller damage was similar in each block with one exception: the 'Takaka Green' block at Te Puke had approximately five times more damage than any other block (Table 1). This block was immediately bordered by a slope covered in a number of plants that are known hosts of leafrollers (e.g. macadamia nut trees, avocados, blackberry). This is likely to have been a key factor in the high incidence of damaged fruit.

There was evidence of fresh feeding damage in all blocks at harvest, and associated with this, 15 caterpillars were found on the fruit: 8 *Ctenopseustis* spp., 6 *C. jactatana* and 1 *Epiphyas postvittana* (lightbrown apple moth) (Table 1). This result confirms that not only is there potential for economic crop losses due to leafrollers, but there is a significant risk of live leafrollers in harvested fruit, which could lead to phytosanitary issues in export markets.

FIGURE 1: The percentage of *Actinidia arguta* kiwifruit damaged by leafrollers during the 2007-08 growing season at the six monitoring sites. The number of live caterpillars found at each monitor date is indicated by bars, with actual values given in numerals. Error bars are SEM. Note that the scale of the Y-axis varies widely between the six plots.

TABLE 1: The percentage of unsprayed Takaka Green, K2D4 and Marju Red kiwifruit with leafroller caterpillar damage at harvest on 13 February 2008 (mean ± SEM), the number of live leafrollers found at harvest and the number of fruit per bunch (mean ± SEM).

	Percentage fruit damage			No. of live leafrollers	No. fruit per bunch
	Total	Severe	Fresh		
Takaka Green, TP ¹	37.2 ± 5.0	23.1 ± 4.1	1.6	1	8.6 ± 0.3
Takaka Green, PK ²	7.9 ± 1.9	1.7 ± 0.6	0.1	0	11.3 ± 0.6
K2D4, PK Block 1	4.6 ± 1.3	0.9 ± 0.4	0.1	1	11.8 ± 0.4
K2D4, PK Block 2	8.1 ± 1.5	5.1 ± 1.1	0.2	1	11.3 ± 0.5
Marju Red, PK	5.4 ± 1.6	0.8 ± 0.2	0.1	0	9.2 ± 0.6
Marju Red, TP	7.8 ± 2.3	4.4 ± 1.3	0.2	12	8.8 ± 0.6

¹TP = Te Puke ²PK = Pongakawa.

Thrips

Thrips feeding damage on the fruit appears as a superficial silver or bronze scarring on the skin. *Heliothrips haemorrhoidalis* (greenhouse thrips) were collected from fruit, confirming this species as responsible for the observed damage.

Thrips and thrips damage were first recorded on the fruit in early January, but at very low levels (≤0.5%) and in two blocks only: K2D4 (Pongakawa Block 2) and Takaka Green (Te Puke). Thrips damage was more prevalent during the harvest assessment of picked fruit, with the level of severe damage reaching 10.0% (Fig. 2). This indicates that the peak thrips damage period is mid January to February.

Although fruit damage levels were variable among blocks, the three highest levels occurred in one block of each cultivar. Observed differences in damage levels are therefore more likely to reflect local pest pressure, as opposed to differences in cultivar susceptibility.

FIGURE 2: The percentage of *Actinidia arguta* kiwifruit infested with thrips damage, armoured scale insects and mealybugs at harvest on 13 February 2008. Error bars are SEM.

Armoured scale insects

Two species of armoured scale insects have previously been recorded on *A. arguta* fruit: the non-actionable *Hemiberlesia lataniae* (latania scale) and the quarantine pest *Hemiberlesia rapax* (greedy scale) (Mauchline & Hill 2005; McKenna et al. 2007). The two species are closely related and similar in appearance. To distinguish between the species, microscopic examination of slide-mounted mature specimens is required (Morales 1988). It was confirmed that all scale insects found on the fruit throughout the monitoring period and at harvest were *Hemiberlesia* sp., but because only immature stages were found, they were not able to be identified to species level.

Scale insects were first recorded in mid December when three first instar scale insects were found on Marju Red fruit at Pongakawa. These insects were almost certain to be first generation offspring from mature scale insects resident on the vine wood (Blank et al. 1996; Hill et al. 2008), as there were no alternative host species in the near vicinity of the block from which infestations might arise, e.g. scale insect-susceptible shelter belts (Jamieson et al. 2006). Scale insects were recorded in four blocks during the January checks of tagged fruit, but at low levels only (0.2% to 0.8%).

At harvest, scale insects were found on fruit from all blocks, with infestation levels ranging from 0.1% to 5.8% (Fig. 2). These levels, while not particularly high, could potentially increase markedly in the future if scale insect populations were left unchecked to build up on the vine wood, especially as *A. arguta* fruit appears at risk of infestation from the first (ca October to January) as well as the second (ca February to May) scale insect generations (Blank et al. 1996; Hill et al. 2008).

Mealybugs

The first mealybug was found in mid December 2007 in the K2D4 Pongakawa Block 1. Further mealybugs were recorded during the checks of tagged fruit bunches in January, but only in K2D4 Pongakawa Block 1 (three mealybugs) and Takaka Green, Te Puke (one mealybug).

At harvest, mealybugs were present on fruit from all blocks, with infestation levels ranging from 0.1% to 2.2% (Fig. 2). Two adult mealybugs were identified as *Pseudococcus longispinus* (long-tailed mealybug), but the remainder of the insects were juvenile and unable to be identified to species level.

Although mealybug infestation levels were not high, they are of concern, as some mealybug species are quarantine pests in a number of markets (McKenna et al. 2007). Little is known about the phenology and ecology of mealybugs in kiwifruit orchards, including whether fruit infestations are a result of mealybug dispersal from adjacent shelter trees or whether mealybugs feed and breed on the vines themselves. However, it does appear that most fruit infestation occurs in the latter part of the growing season.

Other insects

A number of other insects were recorded on the fruit throughout the season, including several species of mites, fungal feeding beetles and psocids. These insects do not damage the fruit and are not quarantine pests, and are therefore not of primary concern. *Scolypopa australis* (passionvine hopper) and *Amphipsalta zelandica* (cicada) were present in high numbers in the Te Puke blocks, and as a consequence of their feeding on the vines, 18.8% of the Takaka Green and 57.2% of the Marju Red fruit were found to be contaminated with sooty mould at harvest. Both insects can be found in high numbers in some kiwifruit blocks in some seasons (Allison et al. 1998; Logan & Connolly 2005).

CONCLUSIONS

These results confirm that leafrollers (primarily brownheaded and black-lyre leafrollers) and greenhouse thrips are the key production pests of *A. arguta* in New Zealand, while leafrollers, greedy scale and some mealybug species are potential quarantine pests. All *A. arguta* cultivars grown in the Bay of Plenty are susceptible to each pest species, but the incidence of live insects and the occurrence of damage can vary markedly from block to block according to local pest pressure. A pest management programme that gives due consideration to the key pest species and the periods when most fruit infestation and fruit damage occur will be required to protect the crop against economic damage and to prevent market access issues.

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