MONITORING MONTEREY PINE APHID IN HAWKE'S BAY FORESTS

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ABSTRACT

The Monterey pine aphid (*Essigella californica*) was recently found in New Zealand. To examine the seasonal biology and impact of this insect on *Pinus radiata*, aphids were sampled using beating and branch bagging methods over two seasons (October to April), from three forest elevations, and from three tree age-classes in Hawke's Bay forests. Many more aphids were found in 2001–02 than in 2000–01, with numbers peaking in January in 2001 and April in 2002. Few aphids were found from October to December. More aphids were recorded on trees in the medium and old age classes than in the young age class. There was no consistent pattern in aphid numbers in relation to elevation of forests. There was little visual evidence of aphid damage to trees but this does not mean that this aphid does not cause economic damage. Factors influencing the population dynamics of this aphid and sampling methods are discussed.

Keywords: Monterey pine aphid, *Essigella californica*, monitoring, *Pinus radiata*, economic impact.

INTRODUCTION

The Monterey pine aphid (MPA) (*Essigella californica*) was first recorded in New Zealand in 1998 (Carver & Kent 2000; Flynn et al. 2003). The 'natural' range of this insect includes western areas of Canada, USA and Mexico, and possibly Florida (Sorensen 1994). The aphid has recently extended its distribution to include France (Turpeau & Remaudiere 1990), Spain (Seco Fernandez & Mier Durante 1992), Australia (Carver & Kent 2000) and Brazil (Carvalho 2000). While not considered a pest in its natural range, localised damage to pines by MPA has been recorded in France (Turpeau & Remaudiere 1990) and Australia (Carver & Kent 2000). MPA has been found on a number of different *Pinus* species (Carver & Kent 2000; Flynn et al. 2003), but in New Zealand the focus of concern is its economic impact on radiata pine (*Pinus radiata*).

The purpose of this project was to provide background information on MPA, with emphasis on the economic impact on *P. radiata* in Hawke's Bay, New Zealand.

METHODS

Forest sites

MPA was sampled over two seasons (2000–01 and 2001–02) from forests in three areas of the Hawke's Bay region that were selected to provide different forest elevations (Table 1). Within each forest, samples were taken from trees allocated to one of three tree age-classes: 1–10, 11–20 and 21–30 year old trees.

TABLE 1: Details of forest sample sites for Monterey pine aphid in Hawke's Bay.

Elevation	Age class	Forest	Years planted	Approximate elevation	Mean diameter (DBH in m) ¹
Low	Young	Waipatiki	1997	100 m	0.55
	Medium ²	McKinnon	1984	200 m	1.68
	Old	Waipatiki	1974, 75	100 m	2.26
Mid	Young	Gwavas	1997, 98	500 m	0.49
	Medium	Gwavas	1983, 84, 87	400 m	1.24
	Old	Gwavas	1975	500 m	2.11
High	Young	Kaweka	1997	700 m	0.37
	Medium	Kaweka	1983, 84	700 m	1.46
	Old	Kaweka	1976, 77	750 m	1.98

¹Diameter at breast height (DBH) for 16–20 trees per site was measured in April 2002.

²'Bagged' branch samples were taken from this site only in 2001–02.

Aphid sampling

Two sampling methods were used. In both years beating, based on a protocol developed in Australia (Kent & Carnegie 2000) and used in similar research elsewhere (Appleton & Gresham 2003), was used. At each elevation and age class, 16–20 trees were selected. For each tree, six branches were beaten three to five times from ground level over a 365 mm diameter tray. Aphids were counted and categorised as: I (0 aphids), II (1–10), III (11–100) or IV (>100). In 2000–01, samples were taken every month (October–April) with two samples in each of February and March. The January 2001 Gwavas sampling was not undertaken due to inclement weather. In 2001–02 only two samples were taken: the first between 27 February and 1 March (the period of maximum aphid numbers recorded in 2000–01) and the second between 9 and 12 April 2002 (after large aphid numbers were found in 'bagged' branch samples). In 2001–02 all aphids collected (February: all trees per site, April: four–five trees per site) were stored in 70% alcohol and the number of winged adults later counted. Further instar analysis was not attempted as there is an overlap in the characters distinguishing first, second, third and wingless adult instars (J. Wharton, pers. comm.). Putative MPA natural enemies were also counted in 2001–02.

The second sampling method (2001–02 only) consisted of removing and bagging branches within tree canopies. Monthly samples (October 2001 to June 2002 inclusive) of 12 trees were undertaken in the McKinnon forest (low elevation and medium age class) because this site had the highest number of aphids in year 1. Two branches (500–600 mm long) were cut from each tree at about two-thirds up the height of the tree. Branches were placed separately in large labelled autoclave bags and sealed in the tree, taking care that disturbed aphids fell into the open bag. The bagged sample was stored at 4°C for up to 5 days before the branches were removed and beaten over a large white plastic bin. All aphids and potential parasitoids and predators were collected and counted and placed in 70% alcohol and the number of winged aphids later counted.

Aphid beating scores and bagging counts were summarised descriptively. Formal analysis methods were considered but due to the data quality and clarity of the patterns the analytical effort required was not judged to be worthwhile.

Canopy evaluation

To examine the impact of MPA on tree health, a score based on a visual assessment of the level of canopy defoliation was recorded (Kent & Carnegie 2000). This was done for trees in all age and elevation classes in the foliage beat samples. Current year and previous year's foliage was taken into account in accordance with the protocol. Estimated foliage loss was classed as: I (0% defoliation), II (25%), III (50%), IV (75%) and V (100%). Foliage scores were averaged for each site.

RESULTS

2000–01

No aphids were collected in 'beat' samples in October and November at any site, and only one from December 2000. In January and February 2001 (Table 2) some aphid population scores of II and III were recorded from low and mid elevations. At this time the average number of aphids per site never exceeded two and the largest number from a single tree was 20. There were very few aphids recorded in March and April (Table 2). There tended to be more aphids in the medium tree age class compared to the young and old age classes. Very few aphids were recorded from the high elevation sites (Table 2) and then only in January and April. No defoliation or discoloration of foliage was observed on any trees on any sampling occasion.

2001–02

In late February 2002 most aphid scores from 'beat' samples were either I or II (I: 87, II: 80, III: 13 and IV: 0). The average number of aphids per site never exceeded 7.6 ($SD < 8.0$) and the largest number from a single tree was 30. At the second 'beat' sampling in mid April, overall aphid scores had increased appreciably (I: 37, II: 81, III: 53 and IV: 10). With the exception of the young tree age class (I: 24, II: 33, III: 3 and IV: 0), there were relatively few scores of I. Most medium and old age classes had scores of II or III (I: 13, II: 48, III: 50 and IV: 10), with most of score IVs being recorded for the trees at the low elevation. The greatest numbers of aphids collected were from medium (mean: 31.8 aphids per tree, $SD = 45.4$) and old (59.0 aphids per tree, $SD = 37.0$) trees at the low elevations and the medium (34.5 per tree, $SD = 28.1$) tree age at the high elevation. Means for other samples did not exceed 7.6 aphids per beat sample ($SD < 8.2$). The greatest number of aphids caught from a single beat sample was 189 from a medium aged tree in the low elevation site.

Very few (means < 0.42 aphids per tree, $SD < 1.0$) aphids were collected from the 'bagged' branch samples at the low elevation, medium aged site from October 2001 to February 2002. Numbers of aphids increased in March (2.4 aphids per tree, $SD = 3.1$) with maximum numbers recorded in April (7.0 aphids per tree, $SD = 13.4$). The May 2002 sample was not carried out and there were few aphids in June (0.41 aphids per tree, $SD = 1.1$).

Winged MPA never exceeded 3.5% of total number of aphids in the 'beat' samples. Only one lacewing was collected from beat samples in February (mean = 0.006, $SD = 0.08$ for all samples) but the numbers increased in April (mean = 0.16, $SD = 0.62$ for all samples). Few other natural enemies (predators or parasites) except spiders were collected. Very few winged aphids or lacewings were observed in the 'bagged' branch samples.

Canopy defoliation score values were mostly I or II and the averages were below 1.1 ($SD < 0.47$) for young and medium tree classes and 1.9 ($SD < 0.34$) for the old class.

DISCUSSION

There was little visual evidence of MPA damage to trees in this study or other recent New Zealand studies (Appleton & Gresham 2003), but this does not necessarily indicate that this aphid does not cause economic damage to *Pinus radiata*. Phloem feeding insects can deplete carbohydrate reserves of trees, affecting their long-term growth and survival. Trees may appear unaffected by some insects when conditions are favourable and impacts may only become apparent under conditions of environmental stress, such as drought (Vranjic & Ash 1997; Day & Cameron 1997; Smith & Schowalter 2001). Long term research is required to assess whether current and future infestation levels of MPA in New Zealand forests are capable of reducing tree health.

The size of MPA populations varied considerably between years and locations. In associated research many more aphids were found in Bay of Plenty forests than Hawke's Bay forests in both years, and more aphids were found in both areas in 2001–02 compared to 2000–01 (Appleton & Gresham 2003). Greatest numbers were recorded in April 2000 and 2001 in Bay of Plenty and April 2002 in Hawke's Bay. Kent & Carnegie (2000) recorded peak MPA numbers in February and March 1999 in New South Wales.

TABLE 2: Numbers of samples in each aphid score category (I=0 aphids, II=1–10, III=11–100 and IV=>100) from ‘beat’ samples from three elevations and three tree age classes in Hawke’s Bay forests in 2001 and 2002¹.

Month	Age class	2001				2002			
		I	II	III	IV	I	II	III	IV
Low elevation									
January	Young	14	6	0	0	-	-	-	-
	Medium	2	13	5	0	-	-	-	-
	Old	9	9	2	0	-	-	-	-
February	Young	15	5	0	0	19	1	0	0
	Medium	6	13	1	0	12	8	0	0
	Old	17	3	0	0	13	7	0	0
April	Young	20	0	0	0	10	9	1	0
	Medium	20	0	0	0	0	4	12	4
	Old	20	0	0	0	0	4	11	5
Mid elevation									
January	Young	-	-	-	-	-	-	-	-
	Medium	-	-	-	-	-	-	-	-
	Old	-	-	-	-	-	-	-	-
February	Young	15	4	1	0	4	15	1	0
	Medium	13	7	2	0	7	10	3	0
	Old	12	6	2	0	7	12	1	0
April	Young	19	1	0	0	4	14	2	0
	Medium	20	0	0	0	3	15	3	0
	Old	20	0	0	0	5	9	6	0
High elevation									
January	Young	20	0	0	0	-	-	-	-
	Medium	19	1	0	0	-	-	-	-
	Old	19	1	0	0	-	-	-	-
February	Young	20	0	0	0	10	8	2	0
	Medium	20	0	0	0	1	13	6	0
	Old	20	0	0	0	14	6	0	0
April	Young	20	0	0	0	10	10	0	0
	Medium	18	2	0	0	0	4	15	1
	Old	20	0	0	0	5	12	3	0
Average	Young	17.9	2.0	0.1	0	9.5	9.5	1.0	0
	Medium	14.8	4.5	1.0	0	3.8	9.0	6.5	0.8
	Old	17.1	2.4	0.5	0	7.3	8.3	3.5	0.8

¹Note that samples from October to December 2000 and late February to March 2001 are not included because very few aphids were found. When samples were taken on two dates in February and April 2001 the earlier sample is provided in this table. Between 16 and 20 trees were sampled at each site in 2002. Figures in italics are adjusted to give a figure for 20 trees.

Winter temperatures (Day & Crute 1990), natural enemies (Crute & Day 1990), crowding (Crute & Day 1990), host plant quality (Kidd et al. 1990) and quantity (Parry 1969), and water stress (Major 1990) have been implicated as important factors influencing the population dynamics of some conifer aphids. It seems unlikely that natural enemies or emigration were important factors affecting MPA in this study because of the small number of natural enemies and the small number of winged adults found. Cold winter (and spring) temperatures may be important as smaller numbers of MPA were found at colder, higher elevation sites in Hawke’s Bay in 2000–01 and in Bay of Plenty in 2000–01 and 2001–02 (Appleton & Gresham 2003). However, some of the greatest aphid numbers in Hawke’s Bay in 2001–02 were found at the high elevation, medium aged class forest.

In general, few aphids were collected from the young tree age class. Similar results have been recorded in Bay of Plenty (Appleton & Gresham 2003) and Australia (Powell 2001). Powell found that older trees were most affected by the aphid, generally from the time of first thinning. Appleton & Gresham (2003) recorded more aphids in mid-age trees than in old trees but this difference was not so obvious in the current study, where the highest number of aphids was found in the older trees at the low elevation site in 2001–02. Appleton & Gresham (2003) found a trend for greater aphid numbers at lower elevations in the Bay of Plenty. In Hawke's Bay there were generally more aphids at low elevations in 2000–01 but this was not the case in 2001–02. Some of the highest aphid numbers were found at the high elevation, medium aged site in April 2002.

Trees with branches that could be reached from ground level for beat samples were usually found at the forest edge, on the side of forest tracks or in forest clearings and did not reflect the 'normal' growth pattern of forest trees without lower branches. An attempt was made to circumvent this problem by using a tree climber to take bagged samples about two-thirds of the way up the tree canopy. However, this climbing method was costly and few aphids were caught in relation to sampling time. Appleton & Gresham (2003) subsequently found that aphids were randomly distributed throughout the height of the tree canopy. Beating branches at ground level appears to be the most cost-effective method for surveying MPA in forests.

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