TIMING OF SULPHUR SPRAY APPLICATION FOR CONTROL OF HAZELNUT BIG BUD MITES (*PHYTOPTUS AVELLANAE* AND *CECIDOPHYOPSIS VERMIFORMIS*)

J. WEBBER and R.B. CHAPMAN

Bio-Protection and Ecology Division, PO Box 84, Lincoln University, 7647,
New Zealand

Corresponding author: wjwebber@paradise.net.nz

ABSTRACT

Eriophyoid big bud mites are key pests of hazelnuts throughout the world, although little is known of the identity and impact of the species on New Zealand hazelnut crops. The objective of this study was to determine the efficacy of and optimum timing for sulphur application to control these mites. A field experiment tested the application of sulphur (1.12 g ai/tree) at 3, 62 and 88% accumulated mite emergence from overwintering big buds. The greatest reduction in emerging mite numbers was achieved with an application at 62% emergence. The importance of determining peak mite emergence, the appearance of hazelnut buds and weather conditions to optimise the time to apply control measures are discussed.

Keywords: big bud mites, *Cecidophyopsis vermiformis*, chemical control, hazelnut, *Phytoptus avellanae*, mite emergence, overwintering, degree-days.

INTRODUCTION

At present there is no recognised major arthropod pest of hazelnut (*Corylus avellana* L.) in New Zealand, although the big bud mite species, *Phytoptus avellanae* (Nalepa 1889) (Acari: Phytoptidae) and *Cecidophyopsis vermiformis* (Nalepa 1889) (Acari: Eriophyidae) are causing increasing concern to growers. These eriophyoid mites cause buds to become swollen, fleshy, deformed and pinkish ('big buds') (Jeppson et al. 1975). Injury to buds by big bud mites may cause significant economic loss (Ecevit et al. 1992; Stamenkovic et al. 1997). Bud losses as high as 90% have been reported in the Republic of Georgia (Tavamaishvili 1990) and 80% in England (Massee 1930), but the percentage of infested buds is generally less than 20% for most cultivars (AliNiazee 1998).

In New Zealand, growers have been advised that big bud mites can be controlled without the use of agrichemicals by carefully removing and burning infested buds from the young trees (Hart 1999; Eastmond & Eastmond 2003). This is considered laborious, uneconomic and inefficient (Vidal-Barraquer et al. 1966). The use of chemical sprays for big bud mite is not a common practice of New Zealand growers despite recommendations for spraying with lime sulphur, endosulphan, other systemic insecticides, or a variety of natural and synthetic pyrethroids (e.g. cypermethrin) and low toxicity miticides (e.g. fenpyroximate) (Hart 1999; McNeil 1999, 2000). Recent work in Turkey by Ozman-Sullivan & Akça (2005) found one application of sulphur (80% WP) to be as effective as endosulphan (35% EC) against big bud mites.

Hazelnut big bud mites are difficult to control with chemicals or other methods because they are protected inside the bud. It is only during spring, when the mites are emerging from the old big buds to invade newly developing buds, that chemical control measures are effective (AliNiazee 1980; Petanovic et al. 1989; Childers et al. 1996). However, as these mites can not be seen with the naked eye, it is difficult to determine when this emergence and movement of mites is taking place. If a chemical spray is applied before the peak emergence period many big bud mites remain unaffected inside the big buds,

and if sprays are applied after the peak emergence period many big bud mites will be safely inside the new buds. It is difficult for growers to predict this time because mite and tree phenology vary between localities, seasons and cultivars.

The objective of this research was to determine the efficacy of three spray timings against emerging big bud mites in a hazelnut orchard during spring.

MATERIALS AND METHODS

A field experiment was carried out over a 12 month period during 2005–2006 on 4-year old 'Whiteheart' trees at Oxford Road, Fernhill, Canterbury, that were infested with both *Phytoptus avellanae* and *Cecidophyopsis vermiformis*. The experiment used a row of 48 trees, which was divided into four blocks of 12 trees. Within each block, treatments were randomly allocated to single trees, and there was a buffer tree between each treatment tree to minimise any effect of spray drift. This was adequate given that a low pressure Swissmex knapsack sprayer (Fruitfed Supplies, Christchurch) was used and drift was unlikely in the sheltered conditions in the orchard.

Sulphur was applied as 80% WP (No Fungus Super Sulphur, active ingredient 800 g/kg sulphur, Kiwicare Corporation Limited, Christchurch) at 40 g product/10 litres, as recommended by Ozman-Sullivan & Akça (2005). Each treated tree was sprayed for 30 seconds, which delivered 350 ml/tree (1.12 g ai/tree) and achieved complete coverage. The control trees were sprayed with water only.

Applications were made on 5 September (early), 9 October (on time) and 26 October (late) 2005 which were close to the predicted 2%, 50% and 80% cumulative emergence of the big bud mites in 2004 as determined by accumulated degree-days (DD) above a lower development threshold of 4°C (Webber 2007). It was not always possible to apply the agrichemical on the preferred date due to rain, but applications were made within 1–2 days of the predicted dates.

The number of branches with a diameter greater than 1 cm was recorded, and the number of big buds per tree counted, both before treatment in June 2005 and post treatment in August 2006. The number of big buds per tree was assessed to determine the mite infestation level.

The spring emergence of big bud mites was also monitored. One big bud was selected from each tree within easy arm reach of the outer canopy. Double-sided adhesive tape (12 mm wide; Sellotape® Double Sided Tape, The Sellotape Company, Henkel New Zealand Limited) was applied around the twig 10 mm above the base of the big bud toward the distal end of the twig, following the method used by Oldfield (1969). Both ends of the adhesive tape were sealed with a 19 × 30 mm self-adhesive, white rectangular removable label (Avery Dennison Corporation, Castle Hill, NSW, Australia), which prevented the ends sticking together. The labels were also marked to indicate the edge of the sticky tape closest to the big bud for later analysis when the tapes were removed from the tree. The tapes were first placed on the twigs on 29 August 2005. The tapes were collected every 3 days throughout the mite emergence period ending 22 November 2005. Sticky tapes were also removed from above the big bud prior to spraying for later examination, and fresh sticky tapes were applied at the completion of each spray application.

After collection, each tape was spread on to a microscope slide with the mites on the upper surface, and examined under a binocular microscope (Zeiss, Stemi SR) on a black background at 32× magnification. A 10 × 10 grid (area of one square = 0.14 mm²) was placed in the eyepiece. The number of big bud mites in an area of 6 × 6 squares was counted on the area of tape where the maximum number of mites appeared. The species are difficult to separate morphologically without making slide mounts for microscopic examination therefore they were counted together. Both *P. avellanae* and *C. vermiformis* have been identified in New Zealand (Lamb 1960; Webber 2007).

Statistical analysis

The percentage change in the numbers of big buds per branch (for each tree) pre- and post- spray treatment was calculated. By using these values as the dependent variable, the effect of treatment and the time of application on the percentage reduction of big buds per branch was analysed using two-way ANOVA.

RESULTS

Comparative numbers of big buds pre- and post-spray

Neither the sulphur treatment ($P=0.885$) nor the timing ($P=0.121$) of the spray application had any significant effect on the number of big buds subsequently formed by mite infestation. From pre- to post spray the early treatment with sulphur gave a 2.3% decrease ($\pm 45\%$ SEM) in the number of big buds per branch whereas in control there was an 18.7% ($\pm 39\%$) increase in big buds. The "on-time" treatment gave a 0.8% ($\pm 44\%$) increase compared to a 13.0% ($\pm 44\%$) decrease in big buds in control, and the late treatment resulted in a 57.4% ($\pm 40\%$) increase in big buds, similar to the control where there was a 62.0% ($\pm 40\%$) increase in big buds (SED=44.3%)

Effect of sulphur spray on mite cumulative emergence

The application of sulphur on 5 September (334 DD, predicted 2% emergence) did not reduce the number of big bud mites (Fig. 1a). The application of sulphur on 9 October (503 DD, predicted 50% emergence) and 26 October (615 DD, predicted 80% emergence) effectively reduced the number of emerging and mobile big bud mites compared with the controls (Figs 1b & 1c). The percent emergence of mites on these dates in 2005 (3, 62 and 88%) was always greater than was predicted from 2004 data (2, 50 and 80% in 2004) (Webber 2007).

DISCUSSION

Reducing the number of overwintering big bud mites emerging from big buds has been the main objective of studies aimed at refining control methods for these pests. Many authors (e.g. Vidal-Barraquer et al. 1966; Beber 1994; Stamenkovic et al. 1997; Ozman-Sullivan & Akça 2005) relate a recommended optimum time at which to apply a chemical control to the time of first emergence of big bud mites, the time of peak emergence or a stage in the new growth of the hazelnut. However, these vary due to the differences in cultivars and mite ecology (Ozman-Sullivan & Akça 2005). Hence, information from overseas cannot be applied to the control of big bud mites in New Zealand as both the cultivars and the growing environment differ.

This field experiment did not show any reduction in the number of big buds from one year to the next after treatment with sulphur spray at any spray timing. This may in part be explained by the difficulty in accurately predicting the percent cumulative emergence of mites using degree-days alone. Early spraying was ineffective because the big bud mites were still inside the old big buds and the chemical did not penetrate into the big buds. When the spray was applied at 62% emergence, it is likely some big bud mites were already safely inside many of the new buds. At 88% mite emergence all of the new buds had developed sufficiently to be infested; it was far too late in the emergence period to effectively apply an agrichemical.

Ozman-Sullivan & Akça (2005) found control of big bud mites to be generally ineffective when spraying took place before the peak emergence period. Although many authors recommend the application of a chemical at peak emergence, this may be difficult in practice as the 'peak' can be difficult to determine due to the fluctuation in mite emergence in response to other environmental conditions and to rainfall delaying spray application. In this field experiment, a decrease in the number of emerging big bud mites only resulted from the application of sulphur spray at 62% emergence (87% decrease) and later in the emergence period (88% emergence) (86% decrease). Further data are needed to improve the predictive power of accumulated degree days to achieve optimal spray timing.

Webber (2007) describes two models based on accumulated heat sum, which provide a reasonable prediction of the start of emergence and a satisfactory means of determining the approximate accumulated percent emergence of the big bud mites. However, independent data are required for further refinement and to validate the models.

Although the peaks of emergence in hazelnut big bud mites can be difficult to predict, this is not the case with the lifecycle events of other mites (e.g. the European red mite, *Panonychus ulmi* (Koch) (Broufas & Koveos 2000)). This accumulated heat unit method

FIGURE 1: The number of big bud mites/big bud/3 days (smoothed over 6 days) after (a) early (5 September 2005, 3% emergence; 334 degree-days; SED=9.6), (b) on time (9 October 2005, 62% emergence, 503 degree-days; SED=16.3) and (c) late (26 October 2005, 88% emergence, 614 degree-days; SED=8.2) spray applications on sulphur-treated and control trees. Arrows indicates date of spray applications.

has also been shown to be satisfactory for predicting the emergence of the blackcurrant gall mite (*Cecidophyopsis ribis* (Acari: Eriophyidae)), particularly for the first and 5% emergences (Cross & Ridout 2001).

The size and appearance of the developing new bud can also provide an indication as to the time that the emerging big bud mites can enter the new bud. Control should be applied before buds measure 0.5×0.5 mm (width $\times$ height), are enclosed within the axil and have a rounded tip or, when 50% accumulated mite emergence has occurred, whichever occurs first (Webber 2007). Consideration could also be given to adding a surfactant to the spray mix to improve sticking, and to the application of a second spray, especially if rain or high temperatures occur after spraying.

ACKNOWLEDGEMENTS

We thank the property owners for their assistance and participation in this project. Funding for this research was provided by Lincoln University and the Hazelnut Growers Association of New Zealand.

REFERENCES

- AliNiazee MT 1980. Filbert insect and mite pests. Corvallis, Agricultural Experiment Station Oregon State University. 13 pp.
- AliNiazee MT 1998. Ecology and management of hazelnut pests. Annual Review of Entomology 43: 395-419.
- Beber K 1994. Studies on migration of big bud mite (*Phytoptus avellanae* Nal.) in northeastern Slovenia. Acta Horticulturae 351: 625-629.
- Broufas GD, Koveos, DS 2000. Threshold temperature for post-diapause development and degree-days to hatching of winter eggs of the European red mite (Acari: Tetranychidae) in Northern Greece. Environmental Entomology 29(4): 710-713.
- Childers CC, Easterbrook MA, Solomon MG 1996. Chemical control of eriophyoid mites. In Lindquist EE, Sabelis MW, Bruin J ed. Eriophyoid mites – their biology, natural enemies and control. Elsevier Science, Amsterdam. Pp. 695-726.
- Cross J V, Ridout M S 2001. Emergence of blackcurrant gall mite (*Cecidophyopsis ribis*) from galls in spring. Journal of Horticultural Science & Biotechnology 76(3): 311-319.
- Eastmond M, Eastmond C 2003. A hazelnut farming story. http://www.lifestyleblock.co.nz/articles/275_hazelnuts.htm (accessed 18 May 2004).
- Ecevit O, Kececi S, Tuncer C, Yanilmaz AF, Isik M 1992. Dogu karadeniz bolgesi fndk bahcelerinde zarar Eriophyoidea (Acarina, Actinedida) akaralar uzerinde calismalar. [Studies on Eriophyoidea (Acarina, Actinedida) of hazelnut groves in the east Black Sea region]. [Abstract]. Proceedings of the second Turkish National Congress of Entomology. Adana, Turkey. 28-31 January 1992. Pp. 671-681.
- Hart R 1999. Hazel – *Corylus avellana*. New Zealand Tree Crops Association Inc., Motueka. New Zealand. 11 pp.
- Jeppson LR, Keifer HH, Baker EW 1975. Mites injurious to economic plants. University of California Press, Berkley, USA. 614 pp.
- Lamb KP 1960. A check list of New Zealand plant galls (zoocecidia). Transactions of the Royal Society of New Zealand 88: 121-139.
- Massee AM 1930. On some species of gall-mites (Eriophyidae) found on *Corylus avellana* L. Bulletin of Entomological Research 21: 165-168.
- McNeil DL 2000. Nut crop chemical requirements. Health in a shell, 36, 9-13.
- McNeil DL. 1999. Walnuts, chestnuts and hazelnuts; a compilation of general information, New Zealand situation and New Zealand research results. Lincoln University, Christchurch, New Zealand. 80 pp.
- Oldfield GN 1969. Diversity and host plant specificity. In: Lindquist EE, Sabelis MW, Bruin J ed. Eriophyoid mites – their biology, natural enemies and control. Elsevier Science, Amsterdam. Pp. 199-216.

- Ozman-Sullivan SK, Akça İ 2005. Efficiency of pesticides against big bud mites [*Phytoptus avellanae* Nal. and *Cecidophyopsis vermiformis* Nal. (Acarina: Eriophyoidea)] on hazelnut. *Acta Horticulturae* 686: 393-399.
- Petanovic R, Dobrivojevic K, Boskovic R 1989. Zivotni ciklus i rezultati suzbijanja leskine grinje *Phytoptus avellanae* Nal. (Acarida: Eriophyoidea). [Life-cycle of the hazelnut big-bud mite *Phytoptus avellanae* (Nal.) (Acarida: Eriophyoidea) and results of its control]. [Abstract]. *Zastita Bilja* 40(4): 433-441.
- Stamenkovic S, Milenkovic S, Pesic M, Mitrovic M 1997. Population dynamics, harmfulness and control of *Phytoptus avellanae* (Nalepa) in Western Serbia. *Acta Horticulturae* 445: 521-526.
- Tavamaishvili LE. 1990. The chief pests of hazelnut in subtropical western Georgia and their control. [Abstract]. *Subtropicheskie Kul' tury*, 5: 119-125.
- Vidal-Barraquer R, Gil Moreno de Mora J, de Sivatte M, Miquel J 1966 *Phytoptus avellanae* Nal. y otras eriofidos del avellano. [*P. avellanae* and other Eriophyids on hazel]. [Abstract]. *Boletin de Pathologia Vegetal d'Entomolgia* (Madrid) 29: 133-235.
- Webber JD 2007. Phenology of hazelnut big bud mites in Canterbury and implications for management. M. Appi. Sci. thesis, Lincoln University, Lincoln, New Zealand. 126 pp.