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Annual monitoring of cicadas and spiders to indicate kiwifruit orchard health

Introduction

Cicadas and spiders are being monitored by ARGOS as potential indicators of ecosystem health in three different types of NZ kiwifruit orchards - KiwiGreen Hayward ('Green'), KiwiGreen Hort16A ('Gold') and Organic Hayward ('Green Organic'). We have been counting the number of cicada exuviae (shells) and spider webs in every ARGOS orchard in the Bay of Plenty region (10 of each type) every summer since 2004. Ecologists must repeatedly measure for years before they can be sure that initial differences in abundance and variety of animals between farming systems persist, and whether numbers are trending up, down or staying about the same.

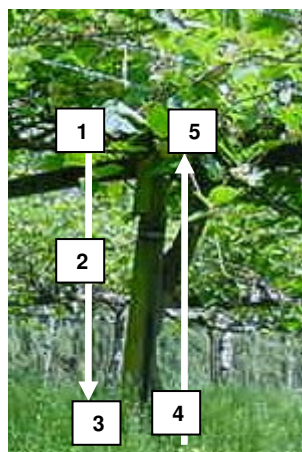
Vines in the centre row of each of three randomly selected blocks in each orchard were sampled on one day each summer. For cicadas, we counted the shells left on vines (a result of the pupae 'moulting' into winged adults). However, most of their lifecycle is spent under the ground (Fig. 1) and so we think cicadas may be greatly affected by soil conditions and soil management.

Results

Over three consecutive years, Green and Green Organic orchards on average had more cicada shells than Gold orchards, but the difference was particularly pronounced in 2005 (Figure 2, top). Gold orchards also averaged fewer spider webs with Green and Green Organic orchards containing similar numbers (Figure 2, bottom), but this time the difference was particularly pronounced in 2004. We do not yet know why the differences fluctuate between years. Differences might be seen between orchard types in some years (e.g. drier years), but not others if say soil was on average moister in Organic compared to KiwiGreen orchards, and if soil moisture affected cicada survival and emergence.

We are pleased with our choice of cicadas and spiders as indicators – monitoring their numbers is quick and therefore inexpensive

Figure 1: Life cycle of the cicada (in kiwifruit).



1. Female lays eggs in vine and dies soon after. Eggs hatch.
2. 'Nymphs' drop to the ground.
3. Nymphs live underground feeding on roots.
4. After several years, nymphs tunnel to surface, crawl up vines and shed skins to become adults.
5. Adults mate during summer.

and it can be done consistently so that we can be sure figures will be comparable over long periods. By the look of our first three years' results, they also give reasonably consistent patterns between orchard types. However, in view of the variation in the size of the difference between years, and fluctuations in the overall populations, it is obvious that we will have to keep on monitoring for at least another 5 years before we can determine trends or even be certain of the average difference between the orchard types.

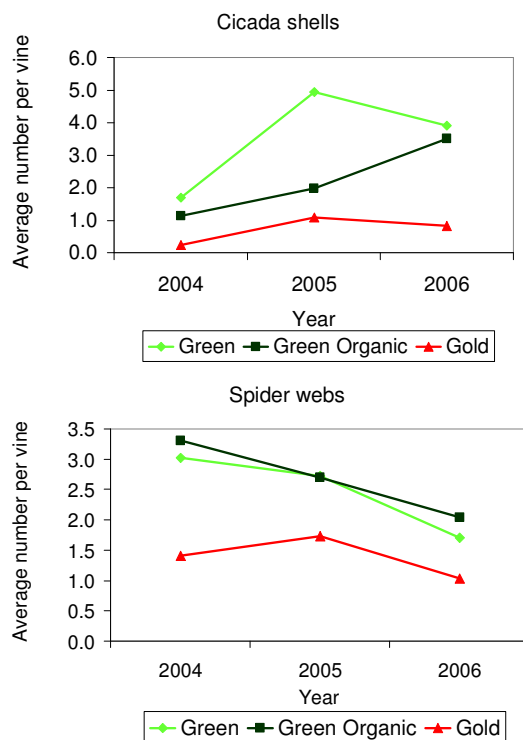


Figure 2: Abundance of cicada shells (top) and spider webs (bottom) in different kiwifruit production systems.

An important part of the ARGOS study design is its 'longitudinal' aspect – we want to know whether as time goes on the diversity and abundance of animals and plants (its 'biodiversity') on different types of orchards starts to converge to become more similar; or whether biodiversity diverges, becoming more different. We always thought of ARGOS as a 20-year research project, so we are hoping that the orchardists and funding supports us for this long haul to really get to the bottom of long

term ecological changes. Ecological monitoring requires patience and stubborn determination!

Conclusions

Consistent differences in the number of cicadas and spiders between Green Organic, Green and Gold orchards are emerging. We are also monitoring earthworms and birds as other potential long-term indicators of orchard environmental health. 'Indicator' species can only really tell a story about environmental health if we can also determine what affects them – what are changes in indicator species a symptom of? – what could cause any observed decline? – what are the consequences for orchard ecosystems? So this sort of indicator species monitoring is intended as a type of 'proxy' - an early warning system and a learning tool to index bigger issues of orchard management. ARGOS's environment team in the first 2-3 years has concentrated on finding out what plants and animals are present and how they vary between orchards. We will now focus mainly in researching why differences occur.

You can read more about the choice of spiders and cicadas for ecological monitoring in ARGOS Research Notes 3 and 5. The types of cicadas present are described in ARGOS Research Note 23.

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