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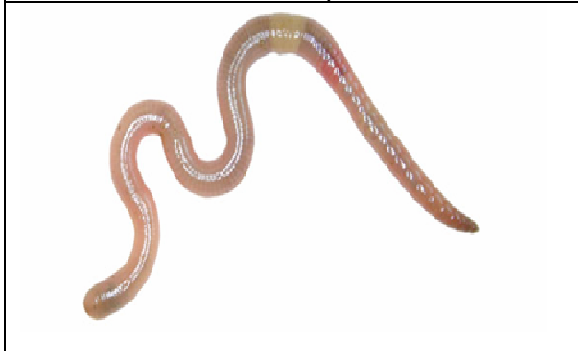
Earthworms in kiwifruit orchards

Introduction

The Agriculture Research Group On Sustainability (ARGOS) is investigating the environmental, economic and social outcomes of different farming systems in NZ. In the kiwifruit sector, the three main production systems are being compared i.e. KiwiGreen Hayward ('Green'), KiwiGreen Hort16A ('Gold') and Organic Hayward ('Green Organic'). Twelve orchards are being studied under each system giving a total of 36 orchards.

One of the indicators being used by ARGOS to identify management impacts is earthworms. These provide an indication of the biological, chemical and physical fertility of a soil and are important for incorporating and breaking down organic matter, making the nutrients available to plants. In addition, burrowing earthworms mix soil and improve soil aeration and drainage. Here we present the density of earthworms found across the ARGOS orchards.

Figure 1. *Aporrectodea caliginosa* (adult), a common earthworm species in NZ soils.

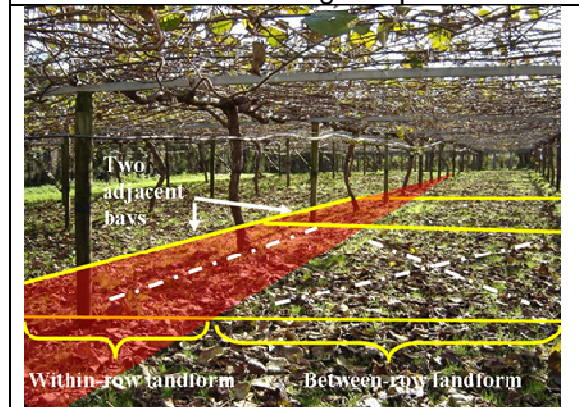


Methodology

Soil monitoring sites

In 2004, nine soil monitoring sites (SMS) were randomly located in each orchard – three in each of three blocks. An SMS is effectively 2 adjacent bays occupying a total area of about 4 - 5m (width) by 8 – 10m (length) (Figure 2). At each SMS, sampling occurred both within-row (under the leader) and between-row (middle of the bay) giving a total of 18 samples per orchard.

Figure 2. An individual soil monitoring site in an ARGOS kiwifruit orchard showing the two landforms being compared.



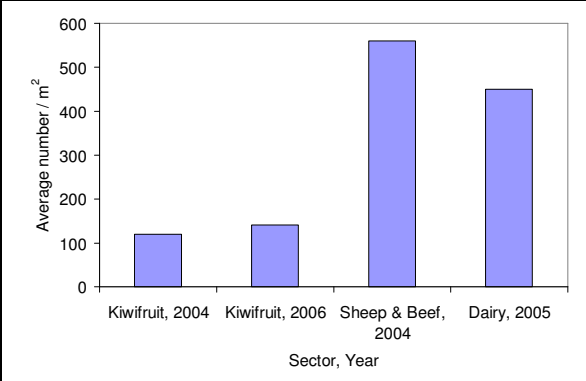
Counting and weighing

At each SMS, a small hole was dug approximately 15cm x 15cm (the width of a small spade) and 30cm deep. The removed soil (and sward where present) was placed on a tarpaulin and carefully hand-sorted for worms which were all counted and weighed (part worms were included). After sorting, the soil was returned to the holes. Sampling occurred in winter (June/July) prior to fertiliser applications.

Results

The average density of earthworms across both years was about 130 per square meter (about 3 per hole). This was much lower than the numbers found in other farming sectors because their returns of organic matter are much larger (Figure 3). For each production system, the average number did not differ significantly between years.

Figure 3. Average density of earthworms found in each of the farming sectors in the ARGOS programme.



In both years, Green Organic orchards had on average significantly more earthworms than both Green and Gold (Table 1, Figure 4). It is not known if the differences were ecologically significant but they could have contributed to differences in soil quality.

Table 1. Average number of earthworms found per hole in ARGOS kiwifruit orchards.

	2004	2006	Overall
Green	2.0	2.8	2.4
Green Organic	3.4	4.4	3.9
Gold	2.6	2.3	2.4
Overall	2.7	3.2	2.9

On average, significantly more worms were found between-rows (Figure 5). This is likely to be due to greater organic matter there as opposed to under the leaders where herbicides have been used on many of the orchards (the difference between landforms was higher for Green and Gold which suggests a herbicide effect).

Figure 4. Average density of earthworms found in ARGOS kiwifruit orchards. Within each year, bars with letters in common are not significantly different at the 5% level.

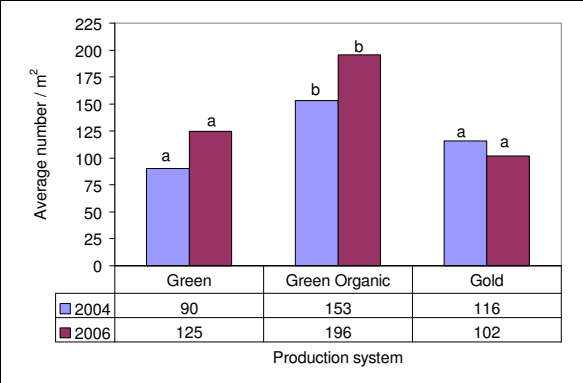
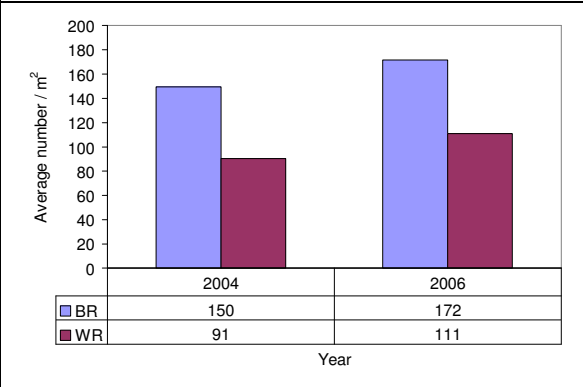


Figure 5. Average density of earthworms in ARGOS kiwifruit orchards within-row (WR, under the leaders) and between-row (BR, middle of bay). Within each year, the differences shown are significant at the 5% level.



Conclusion

This research has demonstrated clear differences in earthworm density between kiwifruit production systems and within orchards. ARGOS will continue to monitor earthworm dynamics in order to assess the longitudinal impacts of management on soil quality.

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