AGRICULTURE RESEARCH GROUP ON SUSTAINABILITY

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Evaluation of the bait-lamina test for assessing biological activity in soils on kiwifruit orchards

Introduction

The Agriculture Research Group On Sustainability (ARGOS) is investigating the environmental, economic and social consequences of farming in NZ. As part of its programme, ARGOS is seeking cost-effective and repeatable methods for tracking long-term changes to soils on farms and orchards. This is important because sustainable farming systems depend on maintaining or enhancing soil health. One potential tool is the bait-lamina test. This involves monitoring the rate at which artificial bait is removed from a plastic strip ("probe") that is inserted into the soil. While this has been used overseas in forest ecosystems, agroecosystems and in the field of ecotoxicology, it has not been used to the same extent in New Zealand. This research note presents the results of a pilot trial carried out by ARGOS on kiwifruit orchards in the 2004/05 summer.

Sample sites

ARGOS is comparing the three main production systems in the kiwifruit sector, i.e. KiwiGreen Hayward ('Green'), KiwiGreen Hort16A ('Gold') and Organic Hayward ('Organic'). KiwiGreen is the integrated management system used for growing kiwifruit in NZ. The main study was carried out on 10 clusters of orchards in the Bay of Plenty. Each cluster contains one of each of the three different types of orchard being studied in close proximity to each other. On each orchard, sampling occurred at nine permanent soil monitoring sites (SMS) which are randomly located. At each SMS, sampling occurred under the vine leaders (within-row) and in the alleyways (between-row).

In addition to the main study, a transect study was carried out on one cluster of orchards to determine variability across orchard blocks and with distance from shelterbelts. Transects ran north to south and east to west across blocks.

Figure 1: Bait-lamina probes used for assessing biological activity in the soil of kiwifruit orchards.

Bait-lamina probes

We used plastic probes that were 160 mm long, 6 mm wide and 1 mm thick. Each had 16 small holes (just a few millimeters in diameter) drilled at 5 mm intervals to a depth of 80 mm. The holes were filled with

a cellulose-based bait. The probes were inserted vertically into the soil (Figure 1) so that the upper hole lay just beneath (2 mm) the soil surface. Probes were later removed from the soil and each hole was scored by eye according to the proportion of bait removed, i.e. one if the bait was completely removed, 0.5 if the bait was partially removed, and zero if the bait was intact.

Results

Baits in the probes were removed extremely quickly (99% gone in five days). We found no evidence that Organic or KiwiGreen orchards had different overall average rates of bait removal, i.e. when the entire sampling depth was considered. However, Organic orchards had slightly faster bait removal deeper in the soil, 80 mm below the surface (Figure 2). Although this difference was highly statistically significant, it is doubtful that it is ecologically important except as a potential indicator of increased soil biological activity at greater depths (>80 mm). Overall, soil biological activity under the leaders (within-rows) was not significantly different to that in the alleyways (between-rows). However, in the top 40 mm of soil, there were indications that the activity was higher under the leaders in the Organic and Gold orchards.

In the transect study, we found that soil biological activity was lower adjacent the shelterbelts compared to in the kiwifruit blocks (Figure 3). The reasons for this are unclear but maybe the soil close to shelterbelts was more sheltered from rainfall which occurred during sampling. There was no evidence that soil biological activity was any different on the edges of kiwifruit vine blocks compared to in the middle of blocks.

Conclusions

The lamina bait test is inexpensive, rapid and repeatable and high statistical power can be achieved from the extensive replication possible. It shows excellent promise as a bio-assay of soil biological activity to monitor and compare the sustainability and ecological resilience of soil managed under different farming systems. Its primary disadvantage is it can not inform researchers on what is removing the baits. The rapid removal of bait-lamina (and covering of the holes in the probes with soil) reduced the power in our data to detect differences. Future experiments would need to be repeated over much shorter time periods and at deeper levels in the soil before optimum long term soil health monitoring protocols can be designed.

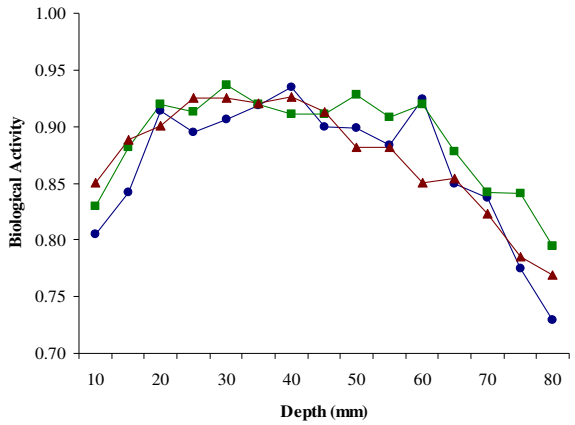

Figure 2: Changes in the biological activity of the soil in Green (●), Organic (■) and Gold kiwifruit orchards (▲), with depth.

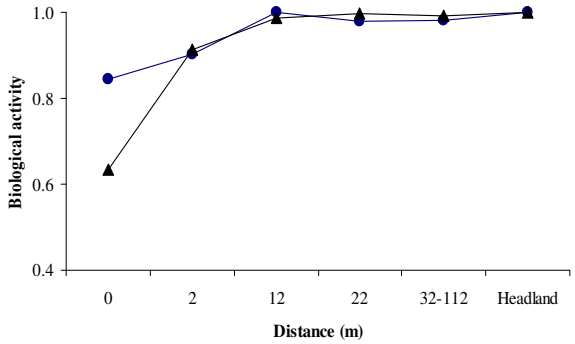

Figure 3: Changes in the biological activity of the soil in kiwifruit orchards with increasing distance from shelterbelts, for transects running in a east to west direction (●) and a north to south direction (▲).

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