

TRACE ELEMENT STATUS OF SELECTED KIWIFRUIT ORCHARD TOPSOILS IN THE BAY OF PLENTY

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Abstract

With growing concerns on potential accumulation of soil trace elements in the Bay of Plenty under kiwifruit land use, 20 topsoils (0-10 cm deep) from kiwifruit orchards in Western Bay of Plenty, Whakatane and Opotiki were sampled by the Bay of Plenty Regional Council in 2012 and were analysed for total recoverable arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn). For Western Bay of Plenty, 12 archived topsoil samples collected by GroPlus in 2009 were retrieved and analysed for comparison with the 2012 samples in order to assess if any significant increase can be detected. The results indicate that for all trace elements, the mean values of the 2012 samples were below the environmental guideline values based on the 2003 NZ Biosolids Guidelines. However, for Cd, 3 out of 20 orchards (15%) exceeded the 1 mg/kg environmental guideline value. One-tailed paired t-tests on the Western Bay of Plenty samples (2009 vs. 2012 samplings) showed no significant increases in the concentrations of As, Cd, Cr, Ni and Pb. However, paired t-tests on the log-transformed values of Cu and Zn indicated significant increases in the concentration of these two trace elements over the 3-year period (one-tailed P values of 0.034 for Cu and 0.026 for Zn).

Introduction

With increasing concerns on potential accumulation of soil trace elements in the Bay of Plenty under kiwifruit land use, particularly the increasing use of copper as a protectant spray for kiwifruit orchards to combat the bacterial disease *Pseudomonas syringae* pv actidinia or Psa (Guinto 2012), the Bay of Plenty Regional Council has initiated a soil sampling programme in 2012 for selected trace elements involving more kiwifruit orchards. Recent work by Benge and Manhire (2011) indicated that there were no obvious correlations between the number of copper applications or the amounts of copper added and soil copper levels, i.e. orchards which applied more copper did not necessarily have higher soil copper levels (and vice versa).

Methods

Twenty topsoils (0-10 cm deep) from kiwifruit orchards in Western Bay of Plenty (12 sites), Whakatane (4 sites) and Opotiki (4 sites) were sampled in March-April 2012 (Figure 1). There were 13 green orchards and 7 gold orchards sampled. Sample sites were georeferenced using a portable GPS unit. The soil samples were submitted to Hill Laboratories, Hamilton for the analysis of arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn). The concentrations were reported as total recoverable metals in mg/kg dry soil (Kim and Taylor 2009). Mean trace element concentrations were compared with New Zealand environmental guideline values for biosolid application to soils (NZWWA 2003). For Western Bay of Plenty, 12 archived topsoil samples collected by GroPlus in 2009 were retrieved and analysed for comparison with the 2012 samples in order to assess if any significant increase can be detected. A one-sided paired t-test was employed to compare the 2009 (before the arrival of Psa) and 2012 Western Bay of Plenty samples. Copper and Zn data were non-normal and were log-transformed prior to analysis. Vine row and alleyway samples were collected separately in 2012 and then bulked prior to analysis. The 2009 archived samples were separate vine row and alleyway samples (Holmes et al. 2012) but after retrieving them from the warehouse they were composited, so sample collections for both years were effectively the same. To prevent the spread of Psa, phytosanitary practices were observed when entering and leaving the orchards as well as during soil sampling (Figure 2).

Results and Discussion

2012 samples

Table 1 shows the mean trace element concentrations from the 2012 samples. The results indicate that for all trace elements, the mean values of the 2012 samples were below the environmental guideline values based on the 2003 NZ Biosolids Guidelines. However, for Cd, 3 out of 20 orchards (15%) exceeded the 1 mg/kg environmental guideline value (viz. two orchards from the Western Bay of Plenty and one orchard from Opotiki). These orchards may have received cumulatively more Cd in the form of impurities from phosphate fertiliser.

2009 vs. 2012 Western Bay of Plenty samples

Table 2 compares the topsoil trace element concentrations of the 2009 and 2012 samples. There were no statistically significant increases in As, Cr, Pb and Ni. For Cd, there was a slight and insignificant decrease in concentration. Copper concentration increased significantly ($P=0.034$) as well as that of Zn ($P=0.026$). An increasing but non-significant trend in the concentrations of these two trace elements in kiwifruit orchards in the Bay of Plenty over a 10-year period was reported by Guinto (2012). The increase in topsoil Cu concentration is most likely due to periodic spraying of Cu-containing compounds in kiwifruit orchards. Ten (10) out of the 12 kiwifruit orchards sampled have received copper protectant sprays since the advent of the Psa disease. The increase in Zn concentration may be due to the presence of Zn as an impurity in applied phosphate fertiliser (Alloway 2008).

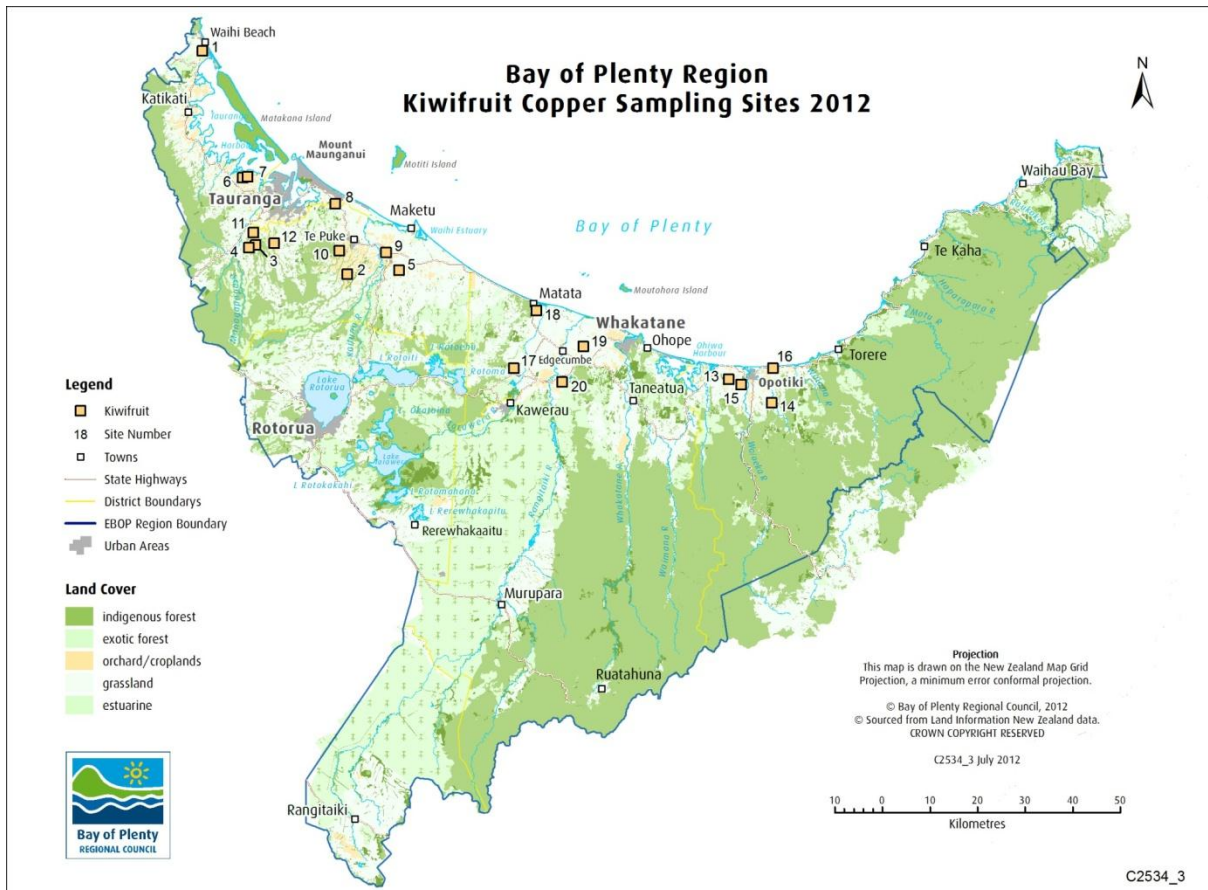


Figure 1. Kiwifruit trace element sampling sites in the Bay of Plenty, 2012.



Figure 2. Phytosanitary practices were observed during soil sampling.

Table 1. Mean topsoil trace element concentrations of 20 kiwifruit orchard sites in the Bay of Plenty, 2012.

Element	Mean (\pm SE) (mg/kg)	Guideline value (mg/kg)	No. of sites exceeding guideline value	Percentage of sites exceeding guideline value
Arsenic	6.2 (0.4)	20	0	0
Cadmium	0.69 (0.05)	1	3	15
Chromium	6.8 (0.5)	600	0	0
Copper	34.8 (4.0)	100	0	0
Lead	4.7 (0.6)	300	0	0
Nickel	7.2 (0.8)	60	0	0
Zinc	72.5 (6.6)	300	0	0

Table 2. Comparison of topsoil trace element concentrations (mg/kg) from the Western Bay of Plenty in 2009 and 2012.

Element	Year		<i>P</i> value (One- tailed t -test)	Guideline Value (mg/kg)
	2009 (n=12)	2012 (n=12)		
Arsenic	5.8	6.1	0.110 ns	20
Cadmium	0.86	0.74	0.060 ns	1
Chromium	6.6	7.0	0.196 ns	600
Copper	35.4	39.2	0.034 *	100
Lead	4.0	4.9	0.095 ns	300
Nickel	8.1	8.5	0.162 ns	60
Zinc	72.1	80.8	0.026*	300

Conclusion

Topsoil trace element concentrations in 2012 for Bay of Plenty kiwifruit orchards were below environmental guideline values. Cu and Zn concentrations increased over a three-year period (2009-2012). Continuous monitoring of these trace elements should be done to prevent potentially negative ecological effects in the future.

References

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