

Phytoplasma diseases in New Zealand

Lia W. LIEFTING¹, Ross E. BEEVER², Mark T. ANDERSEN³, Gerard R. G. CLOVER¹

¹Biosecurity New Zealand, Ministry of Agriculture and Forestry, Auckland, New Zealand

²Landcare Research, Auckland, New Zealand

³HortResearch, Auckland, New Zealand

Abstract

Five phytoplasma diseases are known in New Zealand. Of these, phormium yellow leaf, strawberry lethal yellows, cordyline sudden decline, and coprosma lethal decline are associated with a single phytoplasma species, '*Candidatus* Phytoplasma australiense'. The fifth, poinsettia branch-inducing phytoplasma is the only exotic phytoplasma.

Key words: '*Candidatus* Phytoplasma australiense', phormium yellow leaf, strawberry lethal yellows, cordyline sudden decline, coprosma lethal decline, poinsettia branch-inducing phytoplasma.

Introduction

The geographical isolation of New Zealand and, at least in recent times, the strict quarantine measures in place for the importation of plant material and possible plant pathogen vectors has limited the number of exotic phytoplasmas that have become established in New Zealand. Five phytoplasma diseases are known in New Zealand with four of them associated with, the at least predominantly indigenous '*Candidatus* Phytoplasma australiense' (table 1). While this phytoplasma has also been reported from boysenberries showing boysenberry decline disease, this disease has a fungal aetiology (Wood *et al.*, 1999). '*Ca. P. australiense*' has also been associated with a number of diseases in Australia including Australian grapevine yellows and papaya die-back (Liefting *et al.*, 1998) as well as diseases in a range of other hosts (Streten and Gibb, 2006). Based on *tuf* gene sequence analysis, three subgroups have been recognised in '*Ca. P. australiense*', one found only in New Zealand, one found only in Australia, and one found in both New Zealand and Australia (Andersen *et al.*, 2006). Phylogeographic analysis suggests this latter group is exotic in either Australia or New Zealand. Of the two subgroups of '*Ca. P. australiense*' found in New Zealand, a 3.6 kb plasmid has been sequenced from both (Liefting *et al.*, 2006) and the entire 959 kb genome has been sequenced from one of them (Liefting *et al.*, unpublished). We briefly describe the phytoplasma diseases presently known in New Zealand.

Phormium yellow leaf

Phormium yellow leaf (PYL) disease was first recognised in 1908 and subsequently became an important limiting factor for the fibre industry based on the native monocotyledonous plant, *Phormium tenax*. Symptoms include intense yellowing of older leaves and vascular damage in the rhizome, followed by plant collapse and death. PYL is also known from the second indigenous species, *P. cookianum*. The flax planthopper *Oliarus atkinsoni* Myers is confirmed as a vector of the disease (Cumber, 1953; Liefting *et al.*, 1997). The phytoplasma aetiology of this disease was first recognised using electron microscopy (Ushiyama *et al.*, 1969). DNA sequence studies placed this phytoplasma in the stolbur group, sequence heterogeneity between the two copies of the 16S rRNA gene was demonstrated (Liefting *et al.*, 1996), and a sensitive nested-PCR detection method has been developed (Andersen *et al.*, 1998a).

Strawberry lethal yellows

Strawberry lethal yellows (SLY), known from the early 1970s, was associated with phytoplasmas using electron microscopy (Patel and Milne, 1985). Subsequently the phytoplasma was identified as '*Ca. P. australiense*' (Andersen *et al.*, 1998b). Symptoms include plants growing flatter to the ground, purpling of older leaves, reduced leaf size, yellowing of younger leaves, and sometimes plant death.

Table 1. Phytoplasma diseases recorded in New Zealand.

Common name	Species	Phylogenetic group	Plant host
Coprosma lethal decline	' <i>Ca. P. australiense</i> '	Stolbur group (16SrXII)	<i>Coprosma robusta</i> <i>Coprosma macrocarpa</i>
Cordyline sudden decline	' <i>Ca. P. australiense</i> '	Stolbur group (16SrXII)	<i>Cordyline australis</i> <i>Cordyline banksii</i>
Phormium yellow leaf	' <i>Ca. P. australiense</i> '	Stolbur group (16SrXII)	<i>Phormium tenax</i> <i>Phormium cookianum</i>
Poinsettia branch-inducing	-	X-disease group (16SrIII)	<i>Euphorbia pulcherrima</i>
Strawberry lethal yellows	' <i>Ca. P. australiense</i> '	Stolbur group (16SrXII)	<i>Fragaria</i> × <i>ananassa</i>

Cordyline sudden decline

During the late 1980s, large numbers of cabbage trees (*Cordyline australis*), began dying in the North Island and upper South Island of New Zealand. After intensive study (Beever *et al.*, 1996), a phytoplasma was detected by electron microscopy and PCR, and shown to be '*Ca. P. australiense*' (Andersen *et al.*, 2001). Cordyline sudden decline (CSD) results in the rapid death of affected plants within months of first external symptoms becoming apparent. Symptoms include vascular discolouration and leaf yellowing followed by leaf desiccation and eventual plant collapse.

Coprosma lethal decline

Coprosma lethal decline (CLD), affecting species of the native shrub genus *Coprosma*, is the most recent disease associated with '*Ca. P. australiense*' (Beever *et al.*, 2004). Symptoms seem to be dependent on the particular species involved, and include abnormal interveinal chlorosis and yellowing of leaves, abnormal leaf reddening, slowing of growth, and shoot dieback.

Poinsettia branch-inducing phytoplasma

It is widely known that the free-branching morphotype of poinsettia (*Euphorbia pulcherrima*) is caused by poinsettia branch-inducing phytoplasma (Lee *et al.*, 1997). This free-branching morphotype produces many axillary shoots and red flowers, which are commercially desirable traits. This phytoplasma was first detected in New Zealand in 2002, although it had probably been established long before this date. To date, the phytoplasma has not been found in association with any other plant hosts, and no insect vector has been identified (Lee, 2000). It is probably spread (predominantly, if not exclusively) through cutting propagation, in which case it poses little biosecurity threat to other plants.

References

- ANDERSEN M. T., BEEVER R. E., GILMAN A. C., LIEFTING L. W., BALMORI E., BECK D. L., SUTHERLAND P. W., BRYAN G. T., GARDNER R. C., FORSTER R. L. S., 1998a.- Detection of Phormium yellow leaf phytoplasma in New Zealand flax (*Phormium tenax*) using nested PCRs.- *Plant Pathology*, 47: 188-196.
- ANDERSEN M. T., BEEVER R. E., SUTHERLAND P. W., FORSTER R. L. S., 2001.- Association of '*Candidatus Phytoplasma australiense*' with sudden decline of cabbage tree in New Zealand.- *Plant Disease*, 85: 462-469.
- ANDERSEN M. T., LONGMORE J., LIEFTING L. W., WOOD G. A., SUTHERLAND P. W., BECK D. L., FORSTER R. L. S., 1998b.- Phormium yellow leaf phytoplasma is associated with strawberry lethal yellows disease in New Zealand.- *Plant Disease*, 82: 606-609.
- ANDERSEN M. T., NEWCOMB R. D., LIEFTING L. W., BEEVER R. E., 2006.- Phylogenetic analysis of '*Candidatus Phytoplasma australiense*' reveals distinct populations in New Zealand.- *Phytopathology*, 96: 838-845.
- BEEVER R. E., FORSTER R. L. S., REES-GEORGE J., ROBERTSON G. I., WOOD G. A., WINKS C. J., 1996.- Sudden decline of cabbage tree (*Cordyline australis*): Search for the cause.- *New Zealand Journal of Ecology*, 20: 53-68.
- BEEVER R. E., WOOD G. A., ANDERSEN M. T., PENNYCOOK S. R., SUTHERLAND P. W., FORSTER R. L. S., 2004.- '*Candidatus Phytoplasma australiense*' in *Coprosma robusta* in New Zealand.- *New Zealand Journal of Botany*, 42: 663-675.
- CUMBER R. A., 1953.- Investigations into yellow-leaf disease of *Phormium*. IV. Experimental induction of yellow-leaf condition in *Phormium tenax* Forst. by the insect vector *Oliarus atkinsoni* Myers. (Hem., Cixiidae).- *New Zealand Journal of Science and Technology*, 34: 31-40.
- LEE I.-M., 2000.- Phytoplasma casts a magic spell that turns the fair poinsettia into a Christmas showpiece.- *Plant Health Progress* [online], doi:10.1094/PHP-2000-0914-01-RV.
- LEE I.-M., KLOPMEYER M., BARTOSZYK I. M., GUNDERSEN-RINDAL D. E., CHOU T.-S., THOMSON K. L., EISENREICH R., 1997.- Phytoplasma induced free-branching in commercial poinsettia cultivars.- *Nature Biotechnology*, 15: 178-182.
- LIEFTING L. W., ANDERSEN M. T., BEEVER R. E., GARDNER R. C., FORSTER R. L. S., 1996.- Sequence heterogeneity in the two 16S rRNA genes of *Phormium* yellow leaf phytoplasma.- *Applied and Environmental Microbiology*, 62: 3133-3139.
- LIEFTING L. W., ANDERSEN M. T., LOUGH T. J., BEEVER R. E., 2006.- Comparative analysis of the plasmids from two isolates of '*Candidatus Phytoplasma australiense*'.- *Plasmid*, 56: 138-144.
- LIEFTING L. W., BEEVER R. E., WINKS C. J., PEARSON M. N., FORSTER R. L. S., 1997.- Planthopper transmission of *Phormium* yellow leaf phytoplasma.- *Australasian Plant Pathology*, 26: 148-154.
- LIEFTING L. W., PADOVAN A. C., GIBB K. S., BEEVER R. E., ANDERSEN M. T., NEWCOMB R. D., BECK D. L., FORSTER R. L. S., 1998.- '*Candidatus Phytoplasma australiense*' is the phytoplasma associated with Australian grapevine yellows, papaya dieback and *Phormium* yellow leaf diseases.- *European Journal of Plant Pathology*, 104: 619-623.
- PATEL N. P., MILNE K. S., 1985.- About strawberry viruses.- *New Zealand Fruit Produce Journal*, 6: 4-9.
- STRETEN C., GIBB K. S., 2006.- Phytoplasma diseases in subtropical and tropical Australia.- *Australasian Plant Pathology*, 35: 129-146.
- USHIYAMA R., BULLIVANT S., MATTHEWS R. E. F., 1969.- A mycoplasma-like organism associated with *Phormium* yellow leaf disease.- *New Zealand Journal of Botany*, 7: 363-371.
- WOOD G. A., ANDERSEN M. T., FORSTER R. L. S., BRAITHWAITE M., HALL H. K., 1999.- History of boysenberry and youngberry in New Zealand in relation to their problems with boysenberry decline, the association of a fungal pathogen, and possibly a phytoplasma, with this disease.- *New Zealand Journal of Crop and Horticultural Science*, 27: 281-295.

Corresponding author: Lia LIEFTING (e-mail: lia.liefting@maf.govt.nz), Biosecurity New Zealand, Ministry of Agriculture and Forestry, PO Box 2095, Auckland 1140, New Zealand.