Plant & Food Research
Rangahau Ahumāra Kai

RESEARCH BRIEF 08

Effect of giant willow aphid on growth of young willows

Willow poles planted up the stream

Summary

Two wide-spaced trials were planted on each of two farms in Tararua District to evaluate the effect of sap-sucking *Tuberolachnus salignus*, giant willow aphid (GWA), on 'Tangoio' tree willow growth (Table 1).

In Trial 1 (3 years) 100 experimental willows (50 trees at each farm site) were treated with aphicide (P) to inhibit aphids both in the nursery and in the field, and compared with 100 control willows receiving no aphicide protection (NP). In Trial 2 (2 years) 100 willows in the trial were protected with aphicide in the nursery only, and again compared with control willows not receiving aphicide protection.

The planting material was 3-m poles (planted to 0.8 m depth), spaced at a minimum of 10 m apart, and treated and untreated poles were mixed together in the planting arrangement. Plastic sleeves protected the willows from stock browsing.

In each year of the trials, height and collar diameter were measured for each tree in early January before GWA appeared and at the end of the growing season in June.

Willow trees that received the aphicide protection showed no significant increase in height or collar diameter compared with unprotected trees. The most significant factor affecting willow growth was not sap extraction by GWA but the site where the trees were planted. We concluded that feeding by GWA did not reduce above-ground tree growth in the first 3 years of establishment. We did not quantify below-ground growth, but expect root growth of young wide-spaced 'Tangoio' tree willow will also not be significantly reduced by GWA feeding.

It is likely that young wide-spaced willows can maintain close to normal rates of growth under GWA herbivory pressure, whereas old willows may not be as resilient to the same pressure. We have no data on willow mortality on farms that could confidently be attributed to giant willow aphid.

Trial Period		Poles		
	Site	Poles planted	Treated (P)	Untreated (NP)
2015–18	Farm B	100	50	50
	Farm A	100	50	50
2016–18	Farm B	100	50	50
	Farm A	95	50	45

Table 1. Number of wide-spaced 'Tangoio' willow poles planted at each site in each trial.

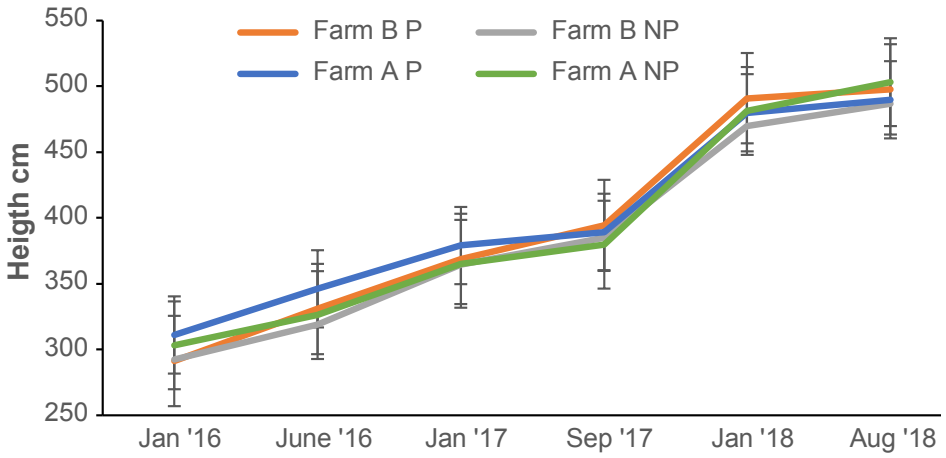

Figure 1. Mean height growth for the willow trees in the 2015 trial to age 3 years. P = chemical protection against *Tuberolachnus salignus*, giant willow aphid (GWA), NP = no chemical protection. Bars are ± 1 s.e.

Height (cm)							
Site	Treatment	Jan '16	June '16	Jan '17	Sep '17	Jan '18	Aug '18
Farm B	P	291±20	331±24	369±50	395±60	491±95	498±104
Farm B	NP	292±20	319±27	365±31	385±37	470±58	487±62
Farm A	P	311±22	346±33	379±50	389±60	480±102	490±107
Farm A	NP	303±21	326±27	365±47	380±58	481±110	503±111
Collar diameter (mm)							
Site	Treatment	Jan '16	June '16	Jan '17	Sep '17	Jan '18	Aug '18
Farm B	P	47.5±6.0	56.5±7.3	50.9±10.0	61.2±11.0	71.6±20.0	77.8±25.2
Farm B	NP	49.6±6.4	57.7±6.9	54.7±7.3	55.0±7.8	73.5±14.7	79.0±16.9
Farm A	P	48.4±5.1	55.3±5.4	49.2±7.5	54.7±10.4	67.2±20.8	70.2±22.4
Farm A	NP	50.5±5.3	56.0±5.2	49.7±6.1	54.2±9.0	62.3±14.4	71.6±19.5

Table 2. Variation in height and collar diameter for protected and unprotected willow trees in the 2015 trial. Values are means ± SD; P = chemical protection NP = no chemical protection (control).

Mean heights were similar for P and NP treatments (Figure 1, Table 2) and similar between sites. There was greater variation in collar diameter (Table 2), contributed to by challenges in measuring at the same stem location at each sampling period. However, the general trends were similar, with no significant differences between P and NP treatments.

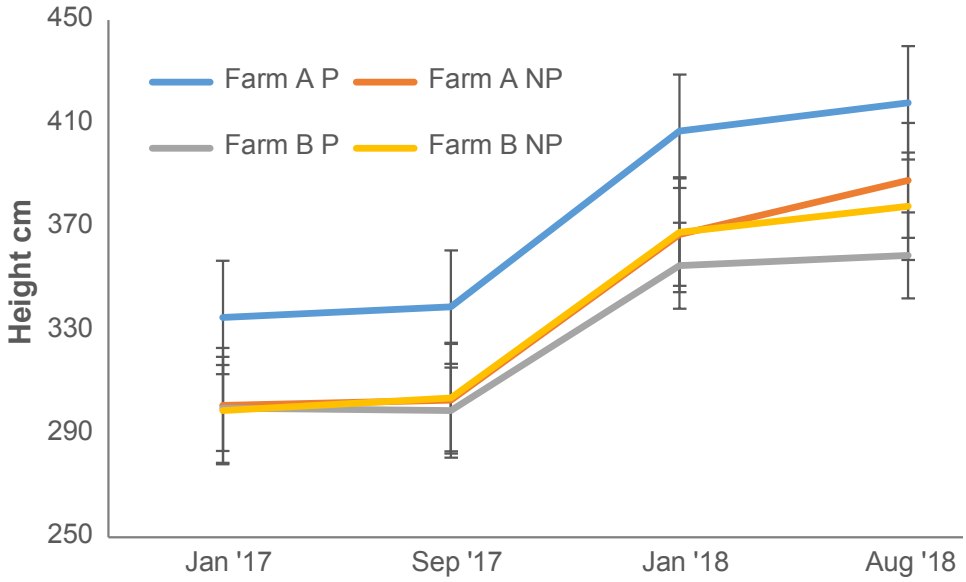

Figure 2. Mean height growth for the willow trees in Trial 2 to age 2 years. P = chemical protection against *Tuberolachnus salignus*, giant willow aphid (GWA), NP = no chemical protection. Bars are ±1 s.e.

GWA colonisation in Trial 2 was similar to that in Trial 1, with larger colonies found on the larger trees and the least vigorous trees having low numbers present. There was considerable variation in height growth between sites and treatments (Figure 2, Table 3) with the P trees being taller at Farm A but not at Farm B.

Height (cm)					
Site	**Treatment**	**Jan '17**	**Sep '17**	**Jan '18**	**Aug '18**
Farm A	P	335±26	339±25	407±64	418±75
	NP	301±30	303±33	367±70	388±64
Farm B	P	300±23	299±37	355±51	359±51
	NP	299±21	304±28	368±55	378±60
Collar diameter (mm)					
Site	**Treatment**	**Jan '16**	**June '16**	**Jan '17**	**Sep '17**
Farm A	P	48.5±7.4	48.5±7.2	49.2±8.8	51.1±8.8
	NP	48.1±4.8	46.3±5.4	45.5±5.9	48±6.8
Farm B	P	46.2±6.2	45.9±5.8	47±14.1	51.5±8.0
	NP	47.4±4.3	47.3±5.0	51.8±7.2	53.2±7.3

Table 3. Variation in height and collar diameter for the protected and unprotected willow trees in Trial 2 to age 2 years. Values are means ± SD; P = chemical protection in the nursery only, NP = no chemical protection (control).

Growth in collar diameter was variable, contributed to by challenges in measuring at the same stem location at each sampling time. There was ~33% increase in height and <10% increase in collar diameter over the 2 years.

Trial		Collar Jan 2018	Collar Aug 2018	Height Jan 2018	Height Aug 2018
	Source of variation	*p*	*p*	*p*	*p*
1	Site	**0.004**	**0.022**	0.99	0.78
	Protection	0.70	0.71	0.44	0.97
	Site x protection	0.23	0.99	0.41	0.40
2	Site	**0.031**	0.53	**0.05**	**<0.001**
	Protection	0.20	0.27	0.34	0.70
	Site x protection	0.15	0.14	**0.002**	**0.011**

Table 4. Analysis split by collar diameter and height for trees in Trials 1 and 2. p values in bold are significant at the 5% level (p=0.05). The Site effect has been adjusted for treatment differences, and the treatment effect for Site difference. Treatment = aphidicide spray.Values are means ± SD; P = chemical protection in the nursery only, NP = no chemical protection (control).

There was no significant gain in willow growth by the end of the trials associated with aphicide application. The siting of the willow pole affected growth more than feeding by GWA did.

Comments

GWA has a remarkable capacity to colonise new sites and almost all trees at a site. All untreated trees in this study except for two had GWA on them or evidence that GWA colonies had been attacking the stems. Colonisation of the willows in our study by GWA was due to natural dispersal mechanisms only.

In the first year of Trial 1 growth was greater for those willow trees where GWA were able to feed and breed unchecked, i.e. no chemical protection. However, after two and three years of the trial, feeding by GWA did not significantly reduce height or collar diameter growth of the unprotected (control) willows, i.e. early differences were no longer apparent.

Protection from GWA boosts stool growth in the nursery. However, there was no evidence for increased growth from the protected poles once in the field.

Land movement and stock trampling both had significant effects on the immediate surroundings of the trees. Any soil movement tended to pile up around the tree trunk; stock trampling also pushed up the soil around the trunk. Both these effects meant errors arose with time when measuring collar diameter, since not all trees were affected equally. Consequentially, measures of collar diameter beyond the first growing season in the pastoral environment were of limited analytical value. Height was not affected to the same extent, so retained analytical value.

Giant willow aphid on 2-yr pole

Other growth patterns of young 'Tangoio' willows showed up in the trials. Most height growth occurs in the early part of the growing season, while stem diameter growth occurs later in the growing season. Sugar flows up to new shoots and leaves early in the growing season, and down to the trunk and roots in late summer and autumn. Late summer and autumn is the period when GWA populations increase rapidly, capitalising on the downward flow. There appears then to be a perfect synchronisation of aphid population growth with tree physiology. The effect of GWA feeding on the willow root system is still to be clarified. However, the biggest trees hosted the greatest numbers of GWA, and it is likely the biomass of the root system is proportional to the above-ground biomass. Willow roots continue to grow between leaf fall and the emergence of new leaves in spring; however, there is no published information on whether, or how, GWA feeding alters seasonal or annual growth of new roots in willows.

Older tree willows (Salix fragilis, S. alba) in river systems in the Horizons Region appear to be adversely affected by several seasons of exposure to GWA feeding (G Kuggelijn, personal communication). More data are needed to determine whether these trees are dead or declining, and whether the cause is GWA alone, or GWA in combination with other factors such as age, disease, possums and/or Old Man's Beard (Clematis vitalba). Individual willows harbouring GWA over winter may be more susceptible, since they may be exposed to more generations over the season.

Liquid and crystallised sap excreted by feeding giant willow aphids

It is likely that young and vigorous wide-spaced willows can maintain close to normal rates of growth under GWA herbivory pressure, whereas old willows may not be as resilient to the same pressure. We have no data on willow mortality on farms that could be confidently attributed to GWA.

For more information

This is one in a series of research briefs about Poplars and Willows that can be found at poplarandwillow.org.nz

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