Plant & Food Research
Rangahau Ahumāra Kai

RESEARCH BRIEF 13

Effect of slope position on poplar growth

Summary

Trunk diameter data from two wide spaced poplar trials planted in rows, with within row spacing of 10 m, at 20 m apart up a slope are used to provide insights into how slope position affects poplar growth.

Variables that could affect survival and growth on an erodible slope are moisture availability, soil depth, wind exposure, soil nature, microsite, and at later stages, light competition.

Mean reduction in diameter at breast height (DBH) for 18 year old poplar trees at Mapiu site without regard to clone was in the order of 20% from the bottom row to the top row (40 m upslope), from 39.1 cm to 31.0 cm. The intermediate row had a mean DBH of 35.2 cm.

There was no difference in survival between rows with survival overall being 86%.

Mean reduction in diameter at breast height (DBH) for 19-year-old poplar trees at Windwistle site without regard to clone was in the order of 32% from the bottom row to the top row (60 m upslope), though the decrease was not even up the slope.

Our general conclusion is that growth decreases as trees move further upslope, and that this effect is likely to be long-lasting where the trees are planted on a slope with an erosion history.

This report analyses data from two trial sites established in 1999, one on an eroded slope at Mapiu in Waikato, and the other on an uneroded site at Windwistle, Canterbury.

Approach

Mapiu, Waikato

The Mapiu trial site (38°37.5'S, 175°13'E, elevation 414 m) is located on SH4 in Waikato region, just south of Mapiu, and approximately 36 km north of Taumarunui. The trees were planted from poles on a NE facing slope in 1999 in three rows at right angles to the slope, and advancing up the slope. The poles were spaced at 10 m intervals within each row and the rows were 20 m apart. Ten clones are represented in the trial (Table 2), being planted in a random block design, each clone being represented once in each block. The difference in elevation between rows is approx. 13 m. The aspect varies little. A permanent stream flows at the bottom of the slope. The site is grazed but with a developing understorey of native woody vegetation within dying Manuka and blackberry as at 2018. Grazing appears to be mainly by goats currently, though at establishment cattle were the main stock present. Grazing pressure is low.

Tree diameters used for this analysis were measured in 2007, 2013 and 2018.

Windwistle, Canterbury

The Windwistle site (43°31'S, 17°40'E, elevation 280 m) is located on a property on Leaches Road SE of Windwistle on the north bank of the Rakaia River on a SW facing sedimentary slope with no evidence of slip erosion. The paddock is grazed by both sheep and cattle. The slope separates an upper and lower terrace. The poles were planted as per the Mapiu site.

Tree diameters used for this analysis were measured in 2007, 2009, 2012 and 2018.

4 year old trees taken in 2003 showing the rows clearer than in the later picture during the trial at Mapiu

10 year old trees taken in 2009 at the (taken from a different view point)

Findings

Mapiu, Waikato

The slope position influences tree growth (Table 1) with the mean diameter of the trees being greatest lowest on the slope and least for those trees planted highest on the slope. This trend was consistent over time (Table 1).

There was considerable variation in growth between clones (Table 2). While there are exceptions usually explained by the microsite, the general trend can still be observed, regardless of the clone, i.e. the higher up the slope the pole is planted the slower the subsequent growth of the tree will be.

An example of a microsite effect at Mapiu was tree 78, 'Shinsei', growing in a sheltered hollow with a steady seepage of water. Though on the upper slope, this tree had a DBH of 66.9 cm in 2018 and was the largest tree measured. Two other trees (86 'Hororata' and 96 'Geyles') on the upper slope which exceeded 50 cm DBH in 2018, were favoured by their position in a gully that captured runoff and sediment.

Slope position	No of trees at 1999	Mean DBH (cm) 2007	Mean DBH (cm) 2012	Mean DBH (cm) 2018
Lower	30	17.0±6.2	28.5±11.9	37.9±14.0
Middle	30	14.7±5.6	24.8±10.6	33.4±13.3
Upper	40	12.3±6.0	22.1±10.7	31.0±14.1

Table 1. Mean tree diameter (DBH) varies with position on the slope at Mapiu

Clone	slope position	DBH (cm) 2007	DBH (cm) 2012	DBH (cm) 2018
'Geyles'	lower	24.3	40.5	49.5
	middle	18.7	32.1	40.1
	upper	13.4	28.5	40.0
'Shinsei'	lower	22.6	42.2	53.1
	middle	20.4	40.5	53.9
	upper	17.5	35.8	51.2
'Toa'	lower	20.9	35.6	48.8
	middle	18.4	28.5	38
	upper	14.8	20	26.5
'Weraiti'	lower	10.5	16.1	33.8
	middle	12	20.1	29.6
	upper	9.4	14.9	21.3

Table 2 Variation in tree diameter (DBH) with slope position and time for selected clones at Mapiu

10 year old trees in Windwistle taken 2009

20 year old trees in Windwistle taken 2019

Findings

Windwistle, Canterbury

Slope position	No of trees at 1999	Mean DBH (cm) 2007	Mean DBH (cm) 2009	Mean DBH (cm) 2012	Mean DBH (cm) 2019
Lower	19	15.7±3.7	20.0±4.2	26.5±4.8	38.0±6.4
Middle-lower	22	13.0±3.0	17.6±4.1	25.4±5.6	40.2±7.3
Middle -upper	22	12.4±3.4	16.1±4.7	23.2±5.8	36.8±8.3
Upper	20	11.7±2.7	14.5±3.4	19.4±4.1	26.7±6.6

Table 3 Mean tree diameter (DBH) varies with position on the slope at Windwistle

The general trend of diameter decreasing for trees planted higher on the slope is apparent for the Windwistle trial also. The slope was steeper between the mid-upper and upper positions than between the lower and mid-upper positions (19°c.f.12°) and this may have reduced shading for the upper slope as the trees grew taller. This site is protected with evergreen shelterbelts except on the SE side which likely are providing greater benefit to trees higher on the slope as the shelterbelt has grown with the trial.

Clone	Slope position	DBH (cm) 2007	DBH (cm) 2009	DBH (cm) 2012	DBH (cm) 2019
'Toa'	Lower	17.7	22.2	29.3	44.2
	Mid-lower	14.6	17.2	30.1	48.7
	Mid -upper	16.7	22.6	32.8	49.7
	Upper	11.4	15.7	23.2	27.7
'Geyles'	Lower	16.9	21.4	28.3	38.3
	Mid-lower	13.5	20	27.4	42.5
	Mid -upper	13.5	17.7	25.3	38.9
	Upper	9.3	10.7	14.5	20.4
'Weraiti'	Lower	15.8	19.5	26.2	37.9
	Mid-lower	10.6	17.9	28.7	44.2
	Mid -upper	9.0	12.5	21.4	36.4
	Upper	13.3	17.1	21.3	29.1
'Shinsei'	Lower	20.9	25.8	35.8	50.1
	Mid-lower	16.3	21	28.8	46.5
	Mid -upper	14.8	19	26.4	41.8
	Upper	9.0	10.4	14.3	19.5

Table 4. Variation in tree diameter (DBH) with slope position and time for selected clones at Windwistle.

When the data at Windwistle were separated by clone the trend is obscured (Table 4). This is partly explained by variation in the number of reps of each clone at each slope position, the rows at each slope position containing varying numbers of trees and a shading effect lower on the slope. However, it seems likely that the effect of slope is most pronounced when the slope has an erosion history, as at Mapiu.

It becomes more challenging to establish poplar trees the higher up the slope they are planted. This is contributed by decreasing soil depth if the slope is eroded, steeper profile resulting in higher runoff of rainfall and greater light intensity to the slope (higher evaporation), greater exposure to windrun. Slower above ground growth rates are predicted based on these factors, and this study confirms that there is a slope effect on poplar growth.

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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