Poplar cultivation: a comparison of international and national activity

A report for the Forest Growers Levy Trust, New Zealand Poplar & Willow Research Trust, and for the New Zealand Farm Forestry Association

March 2023

Ian McIvor Plant & Food Research

Ian.mcivor@plantandfood.co.nz

Executive Summary

Poplar is grown in Europe, Middle East, Asia, North America, and southern countries of South America as a plantation species for the production of sawn timber and woody biomass. Most cultivation occurs on floodplains. IPC (formerly International Poplar Commission), a subsidiary body of FAO, serves to bring together researchers and practitioners to advance poplar silviculture internationally. As a country member of IPC, New Zealand is a contributor to international knowledge about poplar cultivation, particularly in relation to soil erosion control. Likewise, as a member of IPC New Zealand has access to expertise in poplar cultivation for wood products, bioenergy, bioremediation, and other uses.

Hybrid poplar clones selected from breeding programmes for improved growth rates, disease and pest resistance and wood properties dominate poplar silviculture. The most significant poplar species contributing to these hybrid clones are *Populus deltoides*, *P. nigra*, *P. trichocarpa* and *P. maximowiczii*. Hybrid choice varies with climatic conditions, notably temperature and length of growing season.

The climate in New Zealand is very suitable for poplar cultivation. Growth rates for improved clones of hybrid poplar in New Zealand compare favourably with rates in Europe and North America. Selection of clonal types is also similar, though almost all clones now propagated in New Zealand have emerged from our domestic breeding programme.

Compared with European and North American poplar production and usage, poplar silviculture in New Zealand can best be described as formative and lacks co-ordination. Data on growth rates and clonal suitability is from research trials. Data from commercial poplar silviculture is limited. Currently there is no indicative site suitability map for New Zealand that matches poplar species/clone with region.

The formation of a national body dedicated to all aspects of poplar silviculture (cultivation, milling, processing, marketing) would be a huge step forward, as would the production of a site suitability map matching poplar clones with region across New Zealand.

International Poplar Cultivation

Introduction

The fast-growing species of poplar have been grown for millennia for commodity use, generally for their wood. They were economically important in rural areas because of their ease of propagation and adaptation to areas too wet for farming, e.g., flood plains and along watercourses.

Poplar is grown in Europe, Middle East, Asia, North America and southern countries of South America as a plantation species for the production of sawn timber and woody biomass. Most cultivation occurs on floodplains. Poplar is widely planted in China in plantations and shelterbelts for reducing wind erosion with the secondary benefit of wood production. IPC (formerly International Poplar Commission), a subsidiary body of FAO, serves to bring together researchers and practitioners to advance poplar silviculture internationally. IPC supports member countries in improved practices and encourages extension engagement with non-member countries to sustain rural livelihoods and improve environmental services. New Zealand has been a member country of IPC since 1967.

Poplar plantation development in Europe in the 1950s was facilitated by the intentional introduction of North American clones into European breeding programmes. Although poplars occur in natural stands, these are now conserved and are replaced by plantation poplar using improved hybrid clones.

Poplar plantation development in China has been promoted at national level to combat soil erosion both as very large reforestation programmes and in rural agroforestry initiatives.

Poplar plantation development in North America using improved hybrid clones is replacing harvest of depleted natural stands.

Poplars grow rapidly, propagate readily, and lend themselves to improvement by conventional tree breeding as well as biotechnology; these characteristics make poplars attractive for cultivation in shorter rotations than is feasible for other species. This improvement includes in form, growth rate, timber properties and resistance to pests and diseases.

Hybrid poplars selected for superior form, disease resistance, and growth rate dominate poplar cultivation internationally.

Domestication programmes

Significant domestication programmes occur in many countries in Europe (e.g., Italy, France, Hungary, Germany, Netherlands, Turkey, Russia), in North America, China, Korea, Argentina and Chile. Hybrid clones have been bred, using both native and introduced poplar parental species.

Hybrid poplars grown commercially (Table 1) include intraspecific clones of *Populus nigra, P. deltoides, P. tremula, P. ciliata*, and others; and interspecific clones of *Populus deltoides x nigra, P. trichocarpa x nigra, P. maximowiczii x nigra, P. deltoides x maximowiczii.* Clone selection depends on local considerations such as soil type, rainfall, disease and pest risk, commercial requirements.

Table 1. international clonal selections used in commercial poplar cultivation (a full list can be found in 'Poplars and willows: trees for society and the environment' edited by JG Isebrands and J. Richardson https://www.fao.org/3/i2670e/i2670e.pdf)

Region	Country	Clones propagated commercially in plantations
Europe	France	Intra- and interspecific clones of *P. nigra, P. deltoides, P. trichocarpa*
	Italy	Mostly clones of *P. xeuramericana* and *P. deltoides*
	Spain	Mostly clones of *P. xeuramericana*
	Hungary	Mostly clones of *P. xeuramericana*
North America	Canada	Mostly clones of *P. xcanadensis, P. trichocarpa*
	USA	Intra- and interspecific clones of *P. nigra, P. deltoides, P. trichocarpa, P. maximowiczii.* Clone selection is determined by geographical region.
South America	Argentina, Chile	Mostly clones of *P. xcanadensis*
Asia	China	Clones of *P. xcanadensis, P. simonii, P. cathayana*
	India	Mostly introduced clones of *P. deltoides*
Australasia	New Zealand	Mostly clones of *P. xeuramericana,* also hybrids with *P. trichocarpa* and *P. yunnanensis*

Note: *P. xcanadensis* is synonymous with *P. xeuramericana.* Usage differs between regions.

Cultivation

Requisite soil and climate conditions

The most suitable sites are floodplain areas and lowland areas with soils characterised by good fertility and water availability. The most appropriate soils are deeper than 0.5 m, permeable, with good water availability, characterised by sandy-silt or sandy-clay texture, with a uniform profile and a pH from subacid to mildly alkaline. The most widely cultivated poplar species require annual average rainfall of not less than 700 mm, with average annual temperature between 8.5 ◦C and 17 ◦C.

Planting material and density of planting

Dimensions and densities of planting material typically used in EU countries is shown in Table 2. The short rotation crops are grown for biofuel and the longer rotation crops are grown for timber, wood chips, veneer and packaging products.

Table 2. Typical material choice and planting practice in Europe

Intention	Material	Planting depth	Planting density (stems /ha)
Short rotation	cuttings 25-35 cm in length, one-year-old live stakes 1.5-2 m	20-30cm 80-120 cm	10,000-15,000
Longer rotation	one-year-old live stakes 1.5-2 m two-year-old live poles 2-3 m	80-120 cm 120 cm or more	150-330

Planting depth is frequently much greater (several metres) to reach the water table. Almost all plantings are on level/almost level and usually cultivated ground.

Pruning

Pruning operations are usually carried out during dormancy. Pruning is done in three lifts and to 6-7 m. Sometimes less vigorous branches are left in each whorl to contribute to the next growth phase and pruned in the next lift.

Growth rates and yields

This section will only cover longer rotation production and will provide data for plantation poplar from various EU countries, Canada, and United States. Growth rates are reported variously, as DBH increment, as biomass/ha, as above ground carbon/ha, as volume/ha, as volume/tree. Stocking rates are not always supplied in commercial reports. Clones vary between countries and within countries.

Figure 1. Rural landscape in the Po valley, Italy with intensive poplar culture in a floodplain area (photo courtesy Guiseppe Nervo CREA)

Europe

In EU the poplar cultivated area is about 900,000 hectares where France Spain Hungary and Italy are the main countries.

The information below was supplied by Guiseppe Nervo from a report published in 2020 co-funded by the European Commission within the Horizon 2020 Programme.

The largest area of poplar culture in Europe is in the Po valley floodplain in northern Italy. The report uses data from the Po valley as representative of poplar culture in other EU countries (Spain, France, Hungary) where poplar is grown in well-watered floodplains.

Planting densities for conventional stands (Figure 1) range from 250 to 270 trees ha^{-1}. Diameters at breast height (DBH) at age 10 for poplar in the Po valley without irrigation are within the range 25-35 cm, with clones not improved for disease resistance (notably clone I-214) having a mean growth 6-8 cm below improved clones.

Poplar clone productivity as volume average in the Po valley is approx. 225 $m^3 ha^{-1}$ (180-270 $m^3 ha^{-1}$). Clonal choice is a significant variable in productivity. Average production of all clones obtained in different localities in Po valley ranged between 175 and 300 m^3 per hectare. Location is a significant variable in poplar productivity.

United States

About 16 to 20 thousand hectares of eastern cottonwood (*P. deltoides*) were planted in the lower Mississippi between 1961 and 1980 (Krinard and Johnson, 1980). They reported yields from trial plots of various spacings after 15 years of 285 to 330 $m^3 ha^{-1}$. DBH after 15 years were in the range 40-45 cm. Survival ranged from 25% at the closest spacing (1.2 m x 2.7 m) to 76% at the widest spacing (4.8 m x 5.4 m).

Gardiner et al. (2022) reported gains in biomass sequestration of 96 tonnes per hectare at year 10 at 3.7 m x 3.7 m spacing (730 stems per hectare or sph), with tree level above-ground biomass being 40 kg. This is a high stocking rate for timber production, though the end-use hinted at large-diameter products.

Krinard (1976) reported on mean diameter growth of young cottonwoods at two sites (Catfish, Georgetown) in the Mississippi delta (Table 3). Spacings were 5.4 m x 5.4 m (343 sph) at Catfish and 6 m x 6 m (278 sph) at Georgetown.

Table 3. Mean height and diameter of plantation cottonwoods at Catfish and Georgetown, Mississippi.

Site	Year	Mean Height m	Mean Diameter cm
Catfish	2	6.1	7.5
	3	9.4	13.7
	4	Not measured	17.6
Georgetown	2	8.2	10.7
	3	11.9	16.7
	4	Not measured	20.8

Silvics of Forest trees of the US Agriculture Handbook 654 (1990) quotes heights of individual trees of 13 m at age 3 and more than 30 m at age 9, and in one plantation unpruned trees at wide spacing averaged 29 cm DBH at age 5. Yields reported in this handbook were 138.6 $m^3 ha^{-1}$ total volume at age 4 with 2,700 stems per hectare (~2 m x 2 m spacing). Timber plantations are thinned to 6 m x 6 m at this age.

Further data published in 1975 for cottonwood plantations in the Mississippi delta are presented in table 4.

Table 4. Mensuration characteristics of the studied cottonwood (*P, deltoides*) plantations in 1975.

Location	Age (yrs)	Initial planting density (sph)	Planting density at measurement (sph)	Mean DBH (cm)	Mean height (m)	Basal area (m^2/ha)
Catfish	4	756	665	14.1	11.7	10.0
Leavenworth	6	756	670	18.1	17.0	16.5
Catfish	9	1345	295	22.4	19.8	10.9
Fitler	9	1345	287	25.3	24.3	14.1
Fitler North	12	1345	243	27.2	27.3	13.7
Fitler South	12	1345	184	28.7	28.2	11.8
Warren	15	1060	158	29.8	30.5	10.5
Warren	16	1345	125	35.3	34.0	11.7

These data give a good indication of growth rates of *P. deltoides* in the Mississippi delta.

Figure 2 provides growth data for plantation poplar growing on private land in Wisconsin and Minnesota. The land is typically flat or gently sloping with good drainage. The codes for the various hybrid genomic groups listed in the figure are DN = *P. deltoides x nigra,* NM = *P. nigra x maximowiczii,* NC = *P. trichocarpa x deltoides x deltoides.* (Data courtesy of Ron Zalesny, USDA, Rhinelander, Wisconsin, USA).

These clones are more representative of clonal selections cultivated in Europe and New Zealand

Height growth range from 0.65 – 1.6 m/year and diameter increase from 0.3 – 2.4 cm/year. Above ground biomass (bole, branches) per tree could not be derived from the biomass data since planting densities at the various locations were not available.

The data demonstrate that growth rates are a product of genotype -environment interactions and can vary significantly between geographically close locations with different soils and drainage.

Canada

A hybrid poplar crop manual for the Canadian prairie provinces (prepared by Cees Van Oosten, Silviconsult Woody Crops Technology Inc.) gives very comprehensive information on all aspects of poplar silviculture. Poplar silviculture is quite recent in Canada since harvesting of poplar has been of natural forests. Many hybrid poplar clones are offered, including hybrids of *P. deltoides x nigra* and *P. maximowiczii x nigra* but also including hybrids of native poplar species absent in New Zealand. Expected height growth rates are >1 m per year for fast growing clones and 0.8 – 1.0 m per year for moderate growing clones. Of the eighteen commercial clones on offer 7 were ‘fast growing’ and 11 were ‘moderate growing’. Yield expectations are not included in the manual. Yields would be much lower than in New Zealand because of the shorter growing season.

Crop rotations for saw logs are 20-30 years and planting densities are 625-816 sph. Expected DBH at harvest is in the order of 22-24 cm, with a wood volume of 0.22 – 0.27 m^3/tree and a saw log % of 70 – 80%.

China

China accounts for 83% of the world's productive poplar plantations. Cultivation practices largely follow European practices with adaptations to the length of plating material for deeper water tables in desert regions. Improved cultivars of *P. deltoides*, and *P. x euramericana* from North America and Europe were the mainstay of Chinese poplar cultivation but more recently there has been incorporation of native poplar species into breeding programmes for evaluation in desert regions.

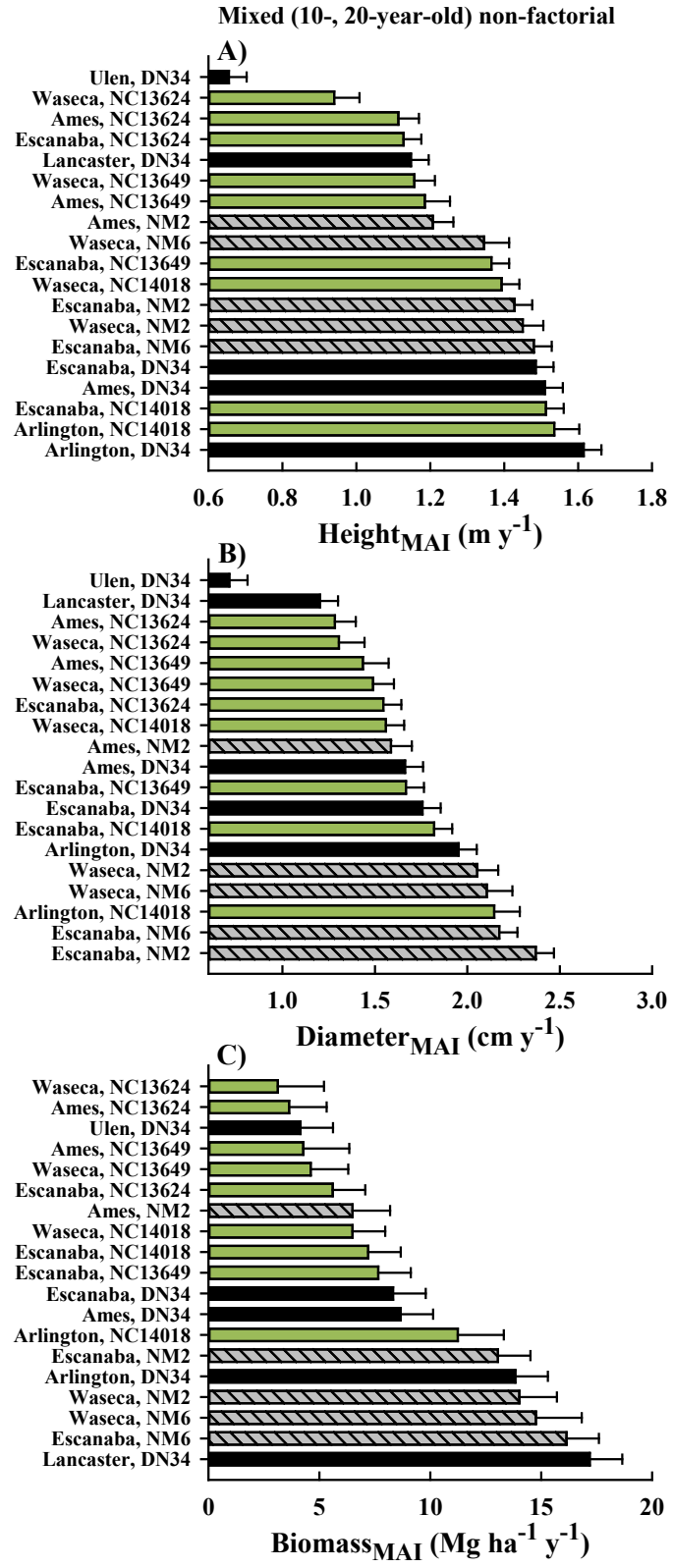


Figure 2. Mixed age (10-year-old, 20-year-old) mean annual growth rates for a range of clones and sites throughout Wisconsin and Minnesota, North-Eastern United States

Pests and Diseases

Worldwide, the most damaging disease is leaf rust, caused by species and races of *Melampsora* **fungus** that cause premature leaf fall and reduce growth. Leaf rust can also predispose highly susceptible trees to other biotic and abiotic damaging agents. Other fungal diseases are *Marssonina* leaf spot and blight, which in susceptible clones also causes premature leaf fall, *Venturia* leaf and shoot blight, bronze leaf disease caused by the fungus *Apioplagiostome populi* and *Septoria* leaf spot and canker. These fungal diseases reduce tree growth and may subject severely affected trees to secondary damaging fungi and insect pests. Hypoxylon (*Entoleuca mammata*) cankers are very damaging and most commonly reported in P. tremuloides. Cankers can girdle and kill branches and main-stem cankers can produce dieback, stem breakage or kill trees.

Of **bacterial** diseases, Xanthomonsas populi has been a priority pathogen for resistance breeding in poplars for many years in Europe. The poplar canker disease caused by this bacterium is common in Europe but not known to be present in North America. Pseudomonas syringae is a ubiquitous bacterium with numerous varieties and pathovars. *P. syringae* strains can cause dieback in plantations exposing the affected trees to secondary pests and diseases.

Insect pests having commercial impact on poplar cultivation attack leaves, buds and young sheets, and stems. Wood boring insects are the most damaging, drilling tunnels and galleries in the trunk or branches, interrupting sap flow, causing cracks in bark and leading to wood necrosis. The Asian longhorn beetle, *Anoplophora glabripennis*, now present in North America and Europe is particularly destructive because it attacks healthy trees. Larvae bore into trunks and large branches, severely damaging the structural integrity of the wood and eventually killing the tree. Up to 300 insect and mite species are recorded as damaging to native poplars, though a lesser number are reported as damaging in plantation poplars.

Control measures for diseases and pests in poplar plantations include m monitoring using pest traps, phytosanitary measures, silvicultural management (maintaining and improving vigour of the trees) and biological control using parasitoids.

(For further information see Poplars and willows: trees for society and the environment, chapters 8, 9).

Source material

Berlin M, G Nervo, S Bergante et al. 2020. Performance models for poplar clonal FRM and deployment guidelines. Project co-funded by the European Commission within the Horizon 2020 Programme (2014-2020)

Bisoffi S, Gullberg U. (1996). ***Poplar breeding and selection strategies***. In Biology of Populus and its Implications for Management and Conservation. Eds. R.F. Stettler, H.D.J. Bradshaw, P.E. Heilman and T.M. Hinckley. NRC-CNRC, Ottawa, pp 139–158

Broadfoot WM. 1960. Early growth of planted cottonwood on delta soils. Mississippi State University Agricultural Experiment Station Information sheet 677.

Cao QV and KM Durand 1991. Site index curves for eastern cottonwood plantations in the lower Mississippi delta. South J. Appl. For. 15(1):28-30.

Cao QV and KM Durand 1991. A growth and yield model for improved eastern cottonwood plantations in the lower Mississippi delta. South J. Appl. For. 15(4):213-216.

Colbert KC, DR Larsen and JR Lootens 2002. Height-diameter equations for thirteen midwestern bottomland hardwood species. North. J. Appl. For. 19(4):171–176.

Dahal B et al. 2022. Aboveground biomass equations for black willow (*Salix nigra* Marsh.) and eastern cottonwood (*Populus deltoides* Bartr. ex Marsh.). Trees, Forests and People 7 (2022) 100195

FAO (2016). ***Poplars and Other Fast-Growing Trees - Renewable Resources for Future Green Economies Synthesis of Country Progress Reports.*** 25th Session of the International Poplar.

Gardiner E. et al. Early dynamics of carbon sequestration relative to spacing of a eastern cottonwood planting. Presentation to VII International Poplar symposium Novisad, Serbia 2022

Krinard RM and RL Johnson 1980. Fifteen years of cottonwood plantation growth and yield. South. J. Appl. For. 4(4): 180-185.

Krinard RM and EC Burkhardt 1984. Growth through 13 years of two pruned cottonwood plantations spaced for sawtimber production. South. J. Appl. For. 8(4): 221-223.

Larocque GR 1999. Performance and morphological response of the hybrid poplar DN-74 (*Populus deltoides × nigra*) under four different spacings on a 4-yer rotation. Annals of Forest Science 56 (4)

Mohn CA and RM Krinard. Volume tables for small cottonwoods in plantations. US Forest Service Research Note c. 1984.

Poplars and willows: trees for society and the environment. FAO 2014. Eds JG Isebrands and J Richardson. ISBN 978-9251071854

Van Oosten C. 2006. Hybrid poplar crop manual for the Prairie Provinces. Saskatchewan Forest Centre.

Van Oosten C 2008. Crop density for hybrid poplar in the Prairie Provinces. WESTERN Journal APPLIED. FORESTRY. 23(4) 2008

Poplar cultivation in New Zealand

Introduction

New Zealand imported improved hybrid and species poplar clones from Europe and United States up till the 1980's, and a breeding programme begun in the late 1960's continues. Hybrid clones commercialised in the breeding programme have been selected for superior form, disease resistance, vigour and regional adaptability.

There is research knowledge of survival, growth rates and rust disease resistance for poplar clones bred and grown in New Zealand

While timber production has not been prioritised, there is some research knowledge of wood density, and commercial knowledge of milling, treatment and usage.

Most poplars seen in the New Zealand landscape were planted for soil conservation or as shelterbelts, with limited management and no expectation of using the trees for timber at any stage. Data on the land area dedicated to commercial production of plantation poplar have never been published. However, there are large areas of close-spaced poplar growing alongside rivers in Canterbury, and smaller areas of close-spaced poplar on private land. Smaller close-planted experimental poplar stands are scattered across both islands. These poplar plantations are mostly unmanaged and unharvested. Some managed stands have been harvested and sold as logs for export and local use, e.g., 'Kawa' poplar in Northland. Again, data are limited.

Growth rates for New Zealand poplar

Table 5. Tree girth, mean wood volume per tree and mean wood volume per hectare for differing planting densities of 'Kawa' poplar in a nelder plantation at Tangiteroria near Dargaville, Northland.

Plot	stems per hectare	mean DBH cm	mean wood volume V m^3	V/ha m^3 / ha
1	70	57.5	3.08	215.5
2	84	52.6	2.58	216.8
3	102	48.9	2.26	230.5
4	126	46.9	2.10	264.4
5	156	46.6	2.02	315.9
6	188	42.1	1.58	296.2
7	237	39.3	1.44	341.6
8	287	36.4	1.24	355.4
9	343	33.1	1.02	350.8
10	434	30.8	0.88	383.9
11	517	29.3	0.80	415.52
12	625	27.5	0.72	450.36
13	772	38.7	1.40	1084.13

Some information has been published from research trials. These trials are of both wide-spaced trees (at least 10 m apart) and close-spaced trees (both nelder and regular arrangement).

Close-spaced poplar

"Kawa' poplar grown in a nelder trial in Dargaville, Northland at age 18 years had mean DBH ranging from 27.5 cm to 57.5 cm varying with density (Table 5), and mean wood volume per hectare from 215.5 to 450.4 m^3 / ha (discounting data for 772 sph because of lost trees creating an edge effect).

For comparison, *P. xeuramericana* 'Tasman' measured in 2010 at age 15 years and *P. xeuramericana* x *yunnanensis* 'Toa' showed comparable growth rates at the various densities (Table 6). 'Tasman' nelder was on flat pastoral land, 'Toa' was on relatively steep farmland, 'Kawa' was on a floodplain. While these data (Table 5 & 6) are for small numbers of trees (193 trees in a nelder plantation) and from different geographical locations and situations the growth rates are higher than reported for the countries listed in the international section

Table 6. Tree diameter at breast height (1.4 m) for 'Tasman' poplar aged 15 years in a nelder plantation, Tikokino, Hawke's Bay, and 'Toa' poplar aged 16 years in a nelder plantation near Wairoa, Hawke's Bay.

stems per hectare	'Tasman' poplar mean DBH cm	'Toa' poplar Mean DBH cm
70	47.4	51.0
84	36.7	50.7
102	40.2	54.2
126	41.1	51.5
156	35.8	50.4
188	37.0	47.5
237	34.1	45.7
287	30.9	40.9
343	29.8	41.1
434	28.2	37.0
517	26.2	37.0
625	24.8	31.7
772	29.1	33.6

Growth data from two close-spaced mixed clone trials in Canterbury are given in tables 7 and 8. Spacing at the Kakahu trial was 4 m x 5 m (500 sph) and at the Rakaia River was 3 m x 3 m (1111 sph). The Kakahu trial was planted on a moderately steep pastoral hillside, and the Rakaia River trial was planted on berm land between the river and the stopbank.

Table 7. Growth after 27 years of poplars in a mixed-clone close-spaced planting at Kakahu, South Canterbury. Average values of DBH and height followed by the same letter do not differ significantly ($p > 0.05$).

Clone	Parentage	Mean DBH cm	Mean height m
'Argyle'	*P. deltoides × P. nigra* 'Italica'	39.8 fhi	27.5 defghij
'Dudley'	*P. deltoides × P. nigra* 'Italica'	30.3 bcde	25.3 cde
'Eastwood'	*P. deltoides × P. nigra* 'Italica'	37.7 efghi	28.6 efghij
'Henley'	*P. deltoides × P. nigra* 'Italica'	27.2 bc	28.2 efghij
'Kainga3'	*P. deltoides × P. nigra* 'Italica'	22.9 b	24.2 c
'Kilmog'2	*P. deltoides × P. nigra* 'Italica'	34.4 cdefgh	24.6 cd
'Luisa Av1anzo'	*P. deltoides × P. nigra*	12.6 a	13.6 b
'Margarita'	*P. deltoides × P. nigra* 'Italica'	30.1 cd	28.7 fghij
'Otahuao'	*P. deltoides × P. nigra* 'Italica'	38.0 defghi	25.9 cdef
'Pakaraka'	*P. deltoides × P. nigra* 'Italica'	35.4 cdefghi	26.8 cdefgh
'Schiavone'	*P. deltoides × P. nigra*	11.8 a	9.8 a
'Selwyn'	*P. deltoides × P. nigra* 'Italica'	33.1 cdefg	27.9 defghij
'Veronese'	*P. deltoides × P. nigra*	34.4 cdefgh	25.2 cd
'Weraiti'	*P. deltoides × P. nigra* 'Italica'	37.5 fghi	28.8 fghij
80-002-023	*P. deltoides × P. nigra* 'Italica'	38.0 efghi	29.7 ghij
80-002-033	*P. deltoides × P. nigra* 'Italica'	35.5 cdefghi	29.2 fghij
80-029-104	*P. deltoides × P. nigra* 'Italica'	33.7 cdefgh	26.9 cdefgh
'Eridano'	*P. deltoides × P. maximowiczii*	49.1 j	27.1 defghi
'Kawa'	*P. deltoides × P. yunnanensis*	42.4 i	29.7 hj
'Toa'	*P. deltoides × P. nigra × P. yunnanensis*	51.1 j	27.4 defghij
82-183-011	*P. deltoides × P. nigra × P. yunnanensis*	30.8 bcdef	26.6 cdefg

Table 8. Diameter at breast height (DBH) and height for the poplar clones at age 24 years on the Rakaia River. Average values of DBH followed by the same letter do not differ significantly ($p > 0.05$).

Clone	Parentage	Mean DBH cm	Mean height m
'Argyle'	*P. deltoides × P. nigra* 'Italica'	31.1 bc	29.4 c
'Pakaraka'	*P. deltoides × P. nigra* 'Italica'	30.9 bc	28.3 c
'Veronese'	*P. deltoides × P. nigra*	30.1 bc	24.8 a
'Crowsnest'	*P. deltoides × P. nigra × nigra*	22.8 a	25.7 ab
'Kawa'	*P. deltoides × P. yunnanensis*	29.7 bc	25.8 ab
'Toa'	*P. deltoides × P. nigra × P. yunnanensis*	33.5 c	27.9 bc

Wide-spaced poplar

For wide spaced poplars grown for soil conservation purposes on steep hill sides growth is much more variable, each tree's performance varying with such variables as clone, slope position, wind exposure, soil depth (Figure 3). The data published below are unpublished but are from the series of trials reported at age 8 (McIvor et al. 2011)

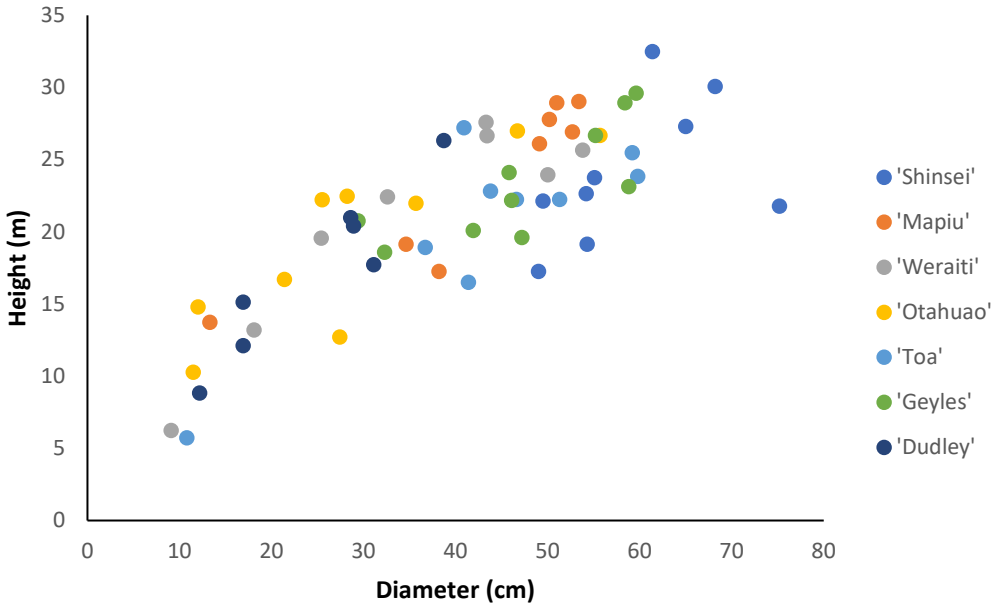
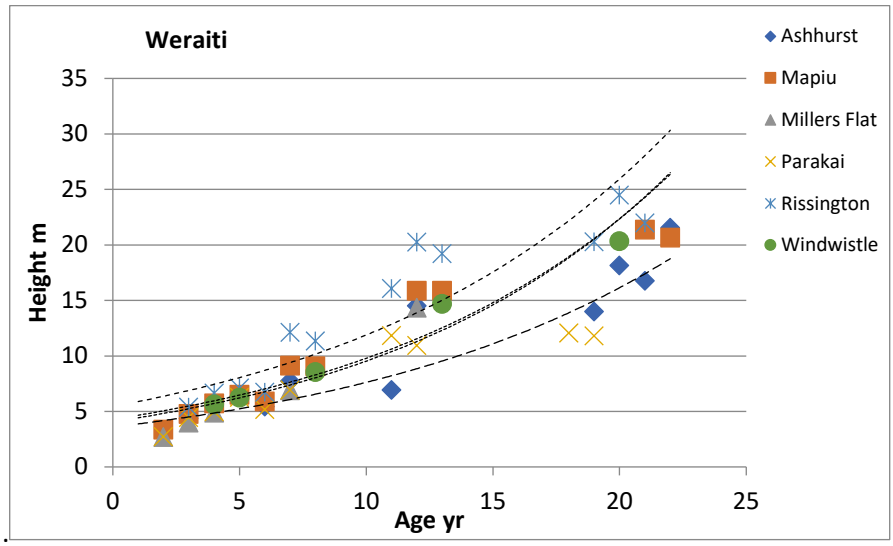


Figure 3. Height and trunk diameter of seven poplar clones aged 22 years growing in a wide-spaced trial (10 m x 20 m) at various positions on a steep hillside at Mapiu, Waikato.

Diameters range from 10 cm to 75 cm. The data show that on hill slopes poplar plantations can be very productive under the right conditions, and very unproductive under the 'wrong' conditions. The data also indicate that New Zealand bred poplar clones provide several options for timber production, and mixed clone plantings are feasible.



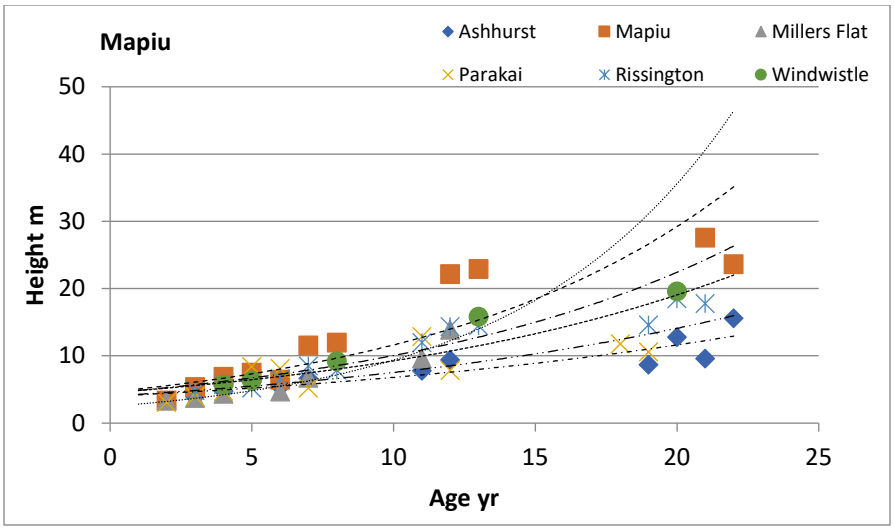


Figure 4. Height growth curves for two representative clones growing in a wide-spaced trial at six locations across New Zealand. 'Weraiti' is a *P. xeuramericana* hybrid clone and 'Mapiu' is a *P. maximowiczii x nigra* hybrid clone.

Figure 4 provides evidence that 'Weraiti' performs better in the drier Hawke's Bay (Rissington) and Mapiu performs better in the colder Southern region (Millers Flat). Table 9 provides an indication of growth rates in New Zealand. These can be compared with growth rates for countries reported in the international section of this report. While these data are for wide-spaced trees (10 m x 20 m), they are also for trees growing on pastoral slopes typical of pastoral hill country in New Zealand with 10◦ to 22◦ slopes.

Table 9. Comparison of growth data for three selected clones growing in a wide-spaced trial across six geographical locations at different ages.

Clone	Clonal Grouping	Height (m)			Diameter (cm)			Volume m^3 per tree
		8 years	13 years	20 years	8 years	13 years	20 years	20 years
'Weraiti'	DN	9.56	16.38	22.54	18.48	26.56	46.97	2.38
'Otahuao'	DN	8.81	14.33	18.66	15.60	22.29	38.01	1.14
"Mapiu'	MN	10.01	18.49	19.07	11.40	26.96	35.85	1.06

Diseases and Pests

New Zealand does not have endemic species of poplars or willows. Consequently, we do not have those natural relationships between poplar and its natural flora and fauna that occur in Europe, North America and Northern Asia. These lead to periodic disease and pest outbreaks and at other times low levels that need to be managed.

Poplar leaf rust Melampsora arrived in New Zealand in 1973 and spread rapidly. Leaf samples bearing a heavy rust load were collected from a range of infected poplar clones (mostly *P. xeuramericana* hybrids or *P. nigra*) and in most of the regions nationally. During 2009 and 2010 ollections were made late in the season during February-March 2009 and March-April 2010. Identification of the rust species was made from 37 separate samples taken in 2009-10, geographically apart and from both North and South Islands. All rust samples were identified as belonging to *Melampsora larici-populina*. More importantly, there was no evidence of hybridisation or new rust species based on the urediniospore appearance. Previous evidence of *Melampsora medusaepopulina*, a unique interspecific hybrid (Spiers & Hopcroft 1985), appears to be no more extensive and probably reflects the limited range of *Melampsora medusae* (Sivakumaran and McIvor 2010).

Poplar leaf rust is the primary pathogen of concern for the breeding program, and there are several commercial poplar clones available with high rust resistance.

Poplar sawfly was first detected in New Zealand in January 2019. The larvae of this insect are defoliators. At this stage it is not considered an economic risk to poplars.

Currently pests are of little consequence in poplar cultivation in New Zealand, and disease risk ins limited to poplar leaf rust which can be managed by choosing resistant cultivars or planting mixes of resistant and susceptible cultivars. However, incursions of new exotic pests and diseases should be factored into consideration in future, as in all our primary industries.

Poplar species and clones – regional suitability

Currently there is no indicative site suitability map that matches poplar species/clone with region. Rust susceptible cultivars are better suited to summer-dry regions. Information on the range of commercially available poplar cultivars can be found on www.poplarand willow.org.nz and covers conditions under which the cultivar performs best (see also McIvor I et al. 2011). Satchell D (2023) provided important information about the suitability of ‘Kawa’ poplar for the Northland climate. In contrast, *P. trichocarpa* grows very well in colder regions of the South Island, an environment unsuited to ‘Kawa’ poplar.

A more complete site suitability inventory is needed.

Source material

Jones T, McIvor I. May 2016. Performance of poplar and willows on the Rakaia River in mid-Canterbury. A Plant & Food Research report prepared for: NZ Poplar and Willow Research Trust. Milestone No. 67749. Contract No. 28910. Job code: P/442048/01. SPTS No. 13201.

Jones T, McIvor M. May 2016. Performance of poplars on the downlands in South Canterbury. A Plant & Food Research report prepared for: NZ Poplar and Willow Research Trust. Milestone No. 67748. Contract No. 28910. Job code: P/442048/01. SPTS No. 13202.

McIvor I & Jones T I. June 2014. Poplar and willow breeding programme. A report prepared for: New Zealand Poplar & Willow Research Trust, Contributing Regional Councils and Beef + Lamb NZ. Plant & Food Research data: Milestone No. 51327.
Contract No. 28910. Job code: P/442048/01. SPTS No. 10149.

McIvor I et al.2011. Survival and growth to age 8 of four *Populus maximowiczii × P. nigra* clones in field trials on pastoral hill slopes in six climatic zones of New Zealand. *New Zealand Journal of Forestry Science* 41 (2011) 151-163

McIvor IR and GB Douglas 2011. Poplars and willows in hill. Country – stabilising soils and storing carbon. Advanced nutrient management: Gains from the past – Goals for the future (Eds LD Currie and CL Christensen OCCASIONAL Report No 25 .11p

Research Brief 14 Wood production of 'Kawa' poplar in an agroforestry trial.
https://www.poplarandwillow.org.nz/documents/wood-production-of-kawa-poplar-rb14.pdf

Research Brief 13 Effect of slope position on poplar growth.
https://www.poplarandwillow.org.nz/documents/effect-of-slope-position-on-poplar-growth-rb13.pdf

Satchell D and J Moore 2022. Sawn timber and structural products from 'Kawa' poplar (*Populus deltoides* Marshall *x P. yunnanensis* Dode) grown in Northland, New Zealand. *New Zealand Journal of Forestry Science* (2023) 53:1 https://doi.org/10.33494/nzjfs532023x238x

Sivakumaran S. and I. McIvor 2011. National poplar rust disease survey 2009-10.
Satchell D. (2023) Kawa poplar timber – properties and market opportunities (a draft report).
https://www.nzffa.org.nz/farm-forestry-model/resource-centre/reports/reports-by-species/poplar/kawa-poplar-timber---properties-and-market-opportunities/

Spiers AG, Hopcroft DH 1985. Ultrastructural studies of pathogenesis and uredinial development of Melampsora larici-populina and M. medusae on poplar and M. coleosporioides and M. epitea on willow. New Zealand Journal of Botany 23:117-133.