FACTORS AFFECTING THE SOIL BINDING CAPACITY OF THE ROOT SYSTEMS OF SOME *POPULUS* AND *SALIX* CLONES

A thesis presented in partial fulfilment of the requirements
for the degree of Master of Science in Botany
at Massey University

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1973

SUMMARY

The variation in the soil binding capacity of the root systems of six Populus and Salix clones was investigated, and the characteristics of the root systems causing this variation determined.

There were significant differences between clones in soil binding capacity, as measured by the load required to remove the root systems vertically from the soil. This was due more to differences in the morphology of the root systems, particularly the amount of fibrous roots, than to the variation in the tensile strength of individual roots. The variation in the amount of fibrous roots and the tensile strength of individual roots accounted for 71.3% of the variation in the soil binding capacity of the root systems.

There was considerable variation in the morphology of the root systems of trees grown on the same site. The poplar clones generally had more large horizontal roots near the ground surface, with few deep penetrating roots or fibrous roots, while the willows had mostly deeper root systems, and more fibrous roots. An exception was P. yunnanensis, which had both vertical and horizontal roots well developed, and a large number of fibrous roots.

There was more variation within clones than between clones in the tensile strength of individual roots. Intra-clonal variation in anatomy had a significant effect on tensile strength, variation in specific gravity accounting for 79% of the variation in the tensile strength of the stele of P. I488, and variation in microfibril angle accounting for 31% of the variation in fibre wall strength and 19% of the variation in specific tensile strength. In general, tensile strength was negatively correlated, with the diameter of the roots.

There was relatively little difference between clones in the tensile strength of the woody part of the roots, only those of P.I78 being significantly greater in the tensile strength of the stele and specific tensile strength. Differences noticeable in the field were due mainly to variation in the amount of stele present in the roots, which ranged from 25.1% of the cross-sectional area in P. deltoides to 50.3% in S. matsudana. There was some variation between clones in specific gravity and the size

and number of vessels present. Gelatinous fibres were present only in the roots of the willow clones. There was some variation between clones in cellulose and lignin contents. The variation in tensile strength of the stele was correlated with percent fibre wall area and specific gravity, and variation in fibre wall strength and specific tensile strength with cellulose content. There were some significant differences between clones in Young's modulus and strain at failure.

There was considerable seasonal variation in the specific gravity, chemical composition, and tensile strength of the roots. The tensile strength of the stele was highest in the winter months and was correlated with variation in specific gravity. Seasonal variation in fibre wall strength and specific tensile strenth was correlat at a significant level with lignin content and the lignin/cellulose ratio.

ACKNOWLEDGEMENTS

I sincerely thank my supervisor, Dr. E.D. Penny, Botany Department, Massey University for his guidance, assistance, and critical reading of this thesis.

Professor R.G. Thomas, Botany Department, Massey University is sincerely thanked for discussions on the presentation of the thesis, and helpful comments on the text.

The study was carried out whilst employed by the National Plant Materials Centre, Water and Soil Division, Ministry of Works, and I am indebted to Mr C.W.S. van Kraayenoord, Scientist in Charge, for his assistance and advice, and for the provision of nursery facilities.

The Director, Physics and Engineering Laboratory, D.S.I.R., Lower Hutt, is thanked for making the Instron tensile testing instrument available, and I am grateful to Mr D. Baguley for assistance in its operation.

Thanks are due to Mr B.A. Meylan, Physics and Engineering Laboratory, D.S.I.R., Lower Hutt, for helpful advice on methods of tensile testing, and to Dr. R. Bailey, Applied Biochemistry Division, D.S.I.R., Palmerston North, for advice on lignin determinations.

Finally, many thanks to my sister, Kaye, for her excellent typing of this thesis, and to my wife, Heather, for assistance with the text, and considerable patience and encouragement.

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INTRODUCTION

Man-induced changes in the vegetation of New Zealand over the last century have resulted in large areas of actively eroding land, both in the steeplands which still retain a form of forest cover, and in large areas of moderate to steep hill country cleared for pastoral use.

By 1941, the seriousness of the problem had been recognised, and Catchment Authorities were constituted, under the auspices of the Soil Conservation and Rivers Control Council, to undertake river and erosion control programs.

Many techniques were used in erosion control work, but most emphasis has been placed on the planting of trees, largely Populus and Salix species.

The planting of trees has proven to have a beneficial effect on counteracting erosion by slumping and gullying, both in retired areas and in those still grazed. It may be assumed that this effect is due primarily to the reinforcing and binding effect of their root systems. The reduction of soil moisture by evapotranspiration is considered to be of secondary importance, as water loss from these deciduous trees is very low in winter, which is the period of maximum soil moisture content and thus maximum instability.

In the past, the selection of poplars and willows for erosion control purposes has been based on the growth and characteristics of the shoot of the tree, while almost nothing was known of the root systems. Variations in morphology and strength of root systems obviously are important factors in the selection of the most suitable species or varieties for soil stabilisation purposes.

Objectives of the study

The primary objective of the study was to investigate the morphology, anatomy, and soil binding capacity of the root systems of a representative number of Populus and Salix clones, in order to determine whether any of the clones were likely to be superior for soil stabilisation purposes, and to determine which characteristics of the root systems were most important for this purpose, as a basis for the selection of improved varieties.

This involved, firstly, the investigation of the morphology and soil binding capacity of the complete root systems of six clones, and the relation between morphology and soil binding capacity. As the soil binding capacity was likely to depend to a considerable extent on the strength of the individual roots comprising the root system, it was also intended to investigate intra-clonal, inter-clonal, and seasonal variation in anatomy, composition, and tensile strength of individual roots, and the relation between these features.