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Influence of slope position on 'Veronese' poplar root growth

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Introduction

Poplars are planted extensively in hill country to retain productive topsoil on slopes. The distribution of the poplar root system has a key influence on soil physical properties such as soil strength and soil water content, which in turn influence both soil stability and pasture growth.

The root systems of three *Populus deltoides* x *nigra* 'Veronese' trees in their twelfth growing season were excavated at upper slope (32.0° slope) henceforth referred to as TU, mid-slope (28.6°, TM) and lower slope (21.8°, TL) positions on an erodible hillslope.

Results

A. Dimensions of the excavated trees

Table 1. Dimensions of three excavated 'Veronese' poplar trees aged 11.5 yr growing at upper (TU), mid (TM) and lower (TL) positions on a slope. dbh = diameter at breast height; DM = dry matter.

Tree	Height (m)	dbh (cm)	Above ground mass (kg DM)	Root length (m)	Root mass (kg DM)	Root crown: mass (kg DM)	Trunk cross-section (cm^2)	Leaf area (m^2)
TU	11.15	18.9	61.48	293.2	8.15	6.60	281	10.3
TM	12.95	27.2	210.87	1131.3	38.77	16.50	581	102.3
TL	13.40	29.0	260.79	1611.3	81.35	18.18	661	175.0

B. Root mass and length

Table 2. Length and mass of coarse roots (≥ 2 mm diameter) in 6 diameter classes. Figures in brackets are percentages calculated from data within each column.

Root diameter mm	Root length (m)			Root mass (kg DM)		
	TU	TM	TL	TU	TM	TL
2<5	169 (58)	644 (57)	977 (61)	0.6 (7)	1.4 (4)	2.4 (3)
5<10	57 (19)	266 (24)	379 (24)	0.9 (12)	2.5 (6)	4.5 (6)
10<20	44 (15)	145 (13)	176 (11)	1.7 (20)	6.2 (18)	8.6 (11)
20>40	16 (6)	59 (5)	54 (3)	2.2 (27)	9.4 (24)	9.4 (12)
40<80	7 (2)	13.5 (1)	18 (1)	2.1 (26)	9.3 (24)	12.5 (15)
>80	0.1 (<1)	3.7 (<1)	7.9 (<1)	0.6 (8)	10.0 (26)	44.1 (54)
Total	293.2	1131.3	1611.3	8.2	38.8	81.4

The TL tree had a coarse root mass 10x that of TU and 2x that of TM. and a root length 5x and 1.4x the root length of TU and TM, respectively. The percentage distribution of root biomass was strongly influenced by the investment in the large roots close to the stump, which increased markedly from TU to TL.

C. Root distribution and interaction with underlying bedrock

Roots extended up to 11m from the trunk (Figure 1), but were not distributed uniformly around the trunk

Roots in the downslope direction were mostly shallow, located at 0-30 cm depth, while uphill roots tended to grow horizontally into the slope, getting deeper into the soil. In TU, where the soil was shallower and therefore had a lower water storage capacity, upslope roots tended to follow hollows containing deeper soil. These hollows represent natural watercourses through the soil.

Soil depths to the bedrock were 0.35-0.4 m, 0.3-0.8 m and 0.6-1.4 m at the upper slope, mid-slope and lower slope positions, respectively. Some roots of TU and TM penetrated cracks in the bedrock and extended both upslope and downslope within the bedrock between the sedimentary layers however no roots of TL had grown into the bedrock. Radial root extension upwards increased with the steepness of the slope

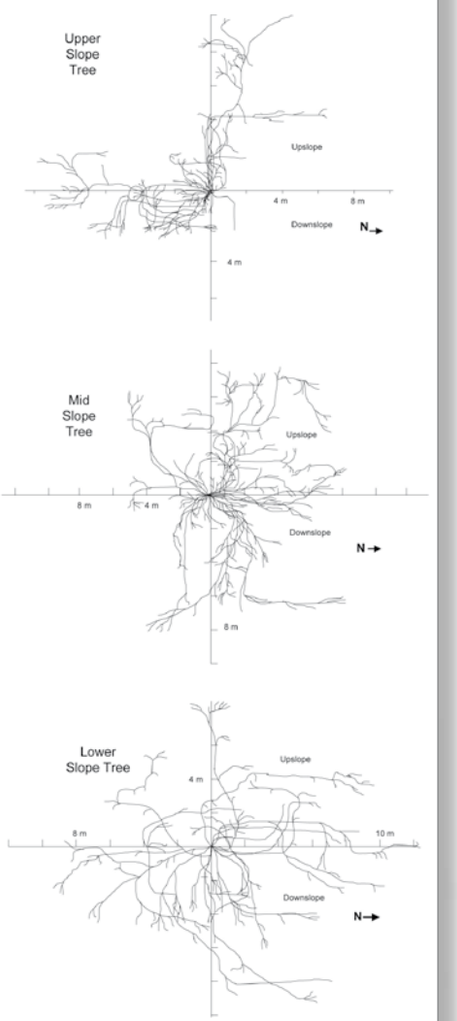

Figure 1. Radial distribution of coarse roots (≥2 mm diameter) of the three 'Veronese' poplar trees aged 11.5 yr.

D. Relationships between DBH and root mass / root length

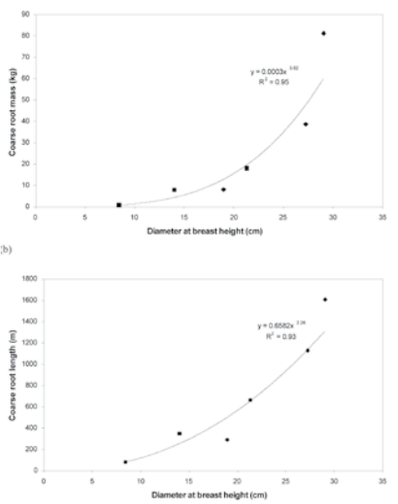

Figure 2. Relationships between (a) coarse root mass and (b) coarse root length and diameter at breast height for six Veronese poplar trees growing on a slope, incorporating present data (♦) and data reported previously (■) for trees aged 5, 7 and 9.5 yr

Figure 3. Flattened roots of TU extending between layers of the bedrock

Discussion

Past slope erosion has resulted in depletion of soil from the upper slope and accumulation of soil on the lower slope, and exaggerated the ridges and hollows of the upper slope. Tree growth is limited by available soil and water resources. Variation in soil depth results in variability in available water, nutrients and drainage, which likely influenced the paths that extending roots followed. In TU roots extending upslope were largely located in the hollows where soil depth was greater.

Greater numbers of roots and a greater root length were present uphill of the crown. This pattern (noted in other studies), becomes more pronounced with increasing slope.

Depth of penetration of vertical and sinker roots was limited by the available depth of the soil above the bedrock (0.35 m at the upper slope to 1.4 m at the lower slope). Penetration of tree roots into the underlying bedrock, as with TU, likely increased both tree anchorage and soil stabilisation.

For poplars growing on slopes there is a strong relationship between DBH and root development (Figure 2). There isn't however necessarily a good correlation between age and root development.

The soil depth and consequent water storage capacity are the most likely factors influencing the root distribution of Veronese poplars growing at different positions up an erodible slope.