The effect of poplar stand density on hill country pastures

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Andrew James Wall
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Abstract

One-third of the North Island of New Zealand has been identified as requiring increased soil conservation if pastoral farming is to be sustainable. For over 50 years the planting of widely spaced poplar trees (*Populus* spp.) has been one of the main methods used to control soil erosion on hill pastures. Research has shown that these plantings have successfully decreased soil erosion but their impact on the productivity of pastoral farming has received little research attention. The research that has been undertaken has found poplars can suppress understorey pasture production by up to 40%, suggesting that farmers require more research information on the impact of planting conservation trees on the productivity of their farm if the use of conservation trees is to be more widely adopted on erosion prone land.

The objective of this thesis was to provide comprehensive data on the relationship between the range of poplar densities used for soil conservation on the light and soil under poplars, and consequently the effect on understorey pastures. Three field sites on commercial sheep and beef hill farms, in regions with contrasting summer soil moisture availability, Manawatu (one site) and Central Hawke's Bay (two sites), were monitored for two years. Tree stocking rates ranged from 0 to 375 trees/ha. Measurements were based on units of four trees with most measurements either directly below the tree crowns or in the gaps between the trees, but more intensive transect measurements were also made.

Photosynthetically active radiation (PAR) and the ratio of red to far red light (R:FR) were measured under the trees and in open pasture controls. Stand density indices used included all the commonly used measures of tree canopies, including digital photography, and stem diameter at breast height (DBH). PAR transmission was inversely related to all of the stand density indices with canopy closure based on digital photographs being the most robust of the indices used. PAR under the trees, relative to open pasture, was greater in the gaps than below tree crowns. Under a completely closed canopy, PAR transmission was reduced to 15-20% and 50-55% of the open pasture in summer and winter, respectively. The R:FR under the trees, relative to open pasture, decreased markedly at high stand densities (allowing less than 40% PAR transmission) in summer, but was similar in winter. The change in PAR under the trees was shown to be a major factor limiting pasture growth, particularly directly below the tree crowns. For both summer and winter, canopy closure

measured with a standard digital camera was strongly related to stand level PAR transmission (r^2=0.88-0.97; P<0.0001) and was also a practical method of measuring canopy closure in the field.

The soil measurements confirmed earlier research that soil pH increases under mature poplar trees. There was a 0.2 – 0.7 unit increase in soil pH in the upper 75 mm of soil over both contrasting regions. The soil fertility under the trees in terms of requirements for pasture growth was similar to that of the open pasture with calcium and potassium up to 2.2 and 9.0 quick test units higher in the soil under the trees than in the open pasture, respectively. The direct cause of the increased concentration of some cations under the trees was the annual tree leaf litter. Overall, the soil fertility under the trees had the potential to produce similar pasture production to that of the open pasture with the added advantage of less acid conditions.

Averaged over all sites the respective annual net herbage accumulation (ANHA) under poplar canopy closures of 25, 50 and 75 % was estimated from the equations developed to be 77, 60 and 48% of the open pasture. The greatest decrease was directly below the tree crowns where at canopy closures greater than 20% the ANHA was a relatively constant 50% of open pasture. In the vertically projected gap between trees the ANHA decreased by 6.6% relative to open pasture for each 10 % increase in canopy closure. At approximately 80% canopy closure there was no difference between the ANHA directly below the trees and in the gap. Pasture net herbage accumulation (NHA) under the trees relative to open pasture was at its lowest in summer and autumn (36% of open pasture under a closed canopy), and at its greatest in early spring before tree canopy leafed out (72% of open pasture under a closed canopy). The botanical composition and feed value of the pasture under the trees was broadly similar to that of the open pasture.

The greatest impact of the poplars on the pasture was decreased NHA due to shading. The decrease in NHA directly below mature unpruned poplars is substantial and would decrease farm profitability if the poplar stand density were high over a large area of the farm. The use of poplars for soil conservation is essential but these results show the importance of managing trees through pruning and thinning so that canopy closure is minimised. ANHA under the trees can be maintained at 75% of the open pasture if canopy closure is prevented from exceeding 30-40%.

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