Yellow Pines Signal Potassium Deficiency in Reforested Old Pasture Land in Tasmania

By Philip J. Smethurst

In Tasmania, the development of yellow needles has been observed in some plantations of radiata pine (*Pinus radiata*) established on sites previously used for pasture. An insufficient supply of soil nitrogen (N) or potassium (K), and competition from pasture regrowth were suspected to be causing the deficiency symptoms. Research has shown that a combination of weed control and K application can improve tree colour and increase tree growth.

Many private forests are being established in Tasmania on land that has previously been used for grazing. Young plantations on some of these sites are developing yellow needles in at least the lower parts of the crown. Deficiencies of N or K were suspected since these nutrients have not traditionally been applied to pastures. Over time, large amounts of both nutrients would have been exported as animal products. Furthermore, plantations established on ex-pasture sites commonly develop a dense sward of grasses and other pasture species. Previous research has shown that pasture species compete strongly with trees for nutrients and soil moisture. Nutrient analysis of foliage showed that nutrient concentrations were similar in yellow and green trees, with the exception of K. Yellow trees had foliar K concentrations of 0.18 percent, compared to 0.23 percent in green trees, and both were lower than the published critical concentration of 0.30 percent for radiata pine.

An experiment was undertaken on a two year-old plantation established on land that had previously been pasture. The pines were planted in winter 1997 with good cultivation and weed control using residual granular herbicides to control grass growth. Shortly after planting, the trees were fertilized with N and phosphorus (P). Tree survival at two years was 100 percent. Trees averaged 1.43 m in height, but the sward of pasture had also re-grown. By spring 1999, most trees were yellow to some degree. In December 1999, five replicated treatments were applied to determine the effect of weed control as well as N and K applications on tree growth. The treatments were:

- Control
- Weed removal

- Weed removal with 150 kg N/ha (as urea)
- Weed removal with 120 kg K_2O/ha (as KCl)
- Weed removal with N and K applied as above.

After nine months, all treatments had affected tree colour, foliar K concentration, and tree growth. Weed removal and K fertilization greatly improved the green colour of all trees. Weed control increased the foliar concentration of several nutrients including, N, P, calcium (Ca), and magnesium (Mg), but the extent of increase was greatest for K. Four months after the experiment was started, the concentration of foliar K in control plots was 0.16 percent. Weed removal alone increased foliar K concentration to 0.33 percent, which was above the published critical concentration (**Figure 1**).

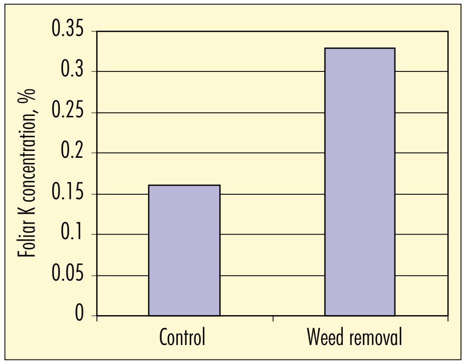

Figure 1. Effect of weed control on foliar K concentration in radiata pine trees (Tasmania).

Tree growth was assessed by indexing the increase in stem volume since the beginning of the experiment. Weed control alone improved tree growth compared to the control. However, where weed control was coupled with K fertilization, tree growth more than doubled (**Figure 2**). Application of N had no measurable effect on tree growth.

Nutrient deficiency also appeared to be exacerbated by drought. During the third year of growth, low rainfall conditions prevailed before the drought broke in winter 2000. Tree yellowing became more severe during the dry period, but decreased after rain (**Figure 3**). In moist soils, K moves to root surfaces largely by diffusion but also by mass flow in the soil solution. Low soil moisture inhibits both processes and, thus, the amount of K available at the root surface for uptake. Increasing the concentration of K in the soil solution by fertilizer, and thus the concentration gradient between the bulk soil solution and that at the root surface, can overcome some of the limitations imposed by dry soil.

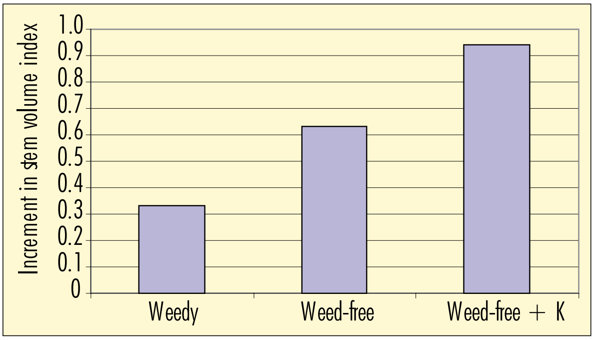

Figure 2. Effect of weed control and K fertilization on radiata pine tree growth (Tasmania).

As a result of this research, guidelines for fertilizing pine plantations on ex-pasture sites in Tasmania include an application of 30 kg K_2O/ha as a spot treatment 15 to 20 cm from the tree 4 to 8 weeks after planting. Additionally, a total application of 115 to 138 kg K_2O/ha over the next four years as 1 to 2 m wide strip applications either side of each row of trees is suggested. Good weed control consists of using knockdown and preferably residual herbicides applied in at least 1 to

Figure 3. The same K deficient tree at ages 2, 2.5 and 3 years (left to right). This tree received no weed control or fertilizer. Yellowing due to K deficiency increased with drought (2.5 years) but decreased when the drought broke (3 years).

2 m wide strips along tree rows. Expert advice should be sought to identify sites at risk of K deficiency and to develop site-specific recommendations.

While K deficiency in forest plantations has not been observed in Tasmania previously, it was documented in Gippsland, Victoria, during the 1960s and 1970s where it was also most noticeable on ex-pasture sites. Recently, K deficiency has been suspected in *Eucalyptus globulus* plantations on ex-pasture land in Western Australia. Future work to determine critical leaf K concentrations and growth responses in this species is warranted. **BCI**

Research undertaken by the Cooperative Research Center (CRC) for Sustainable Production Forestry and Commonwealth Scientific and Industrial Research Organisation (CSIRO) Forestry and Forest Products in collaboration with Private Forests Tasmania.