The trees are watching you....

Archimedes had his bathtub, Isaac Newton his apple, and Marie Curie her photographic film. I had my DBH tape. The main difference between top-quality scientists and the substantially more numerous second-rate ones (such as myself) is the follow-through. Let me tell you about my Eureka moment, in the hope that some young starry-eyed PhD will take up from where I left off.

In 1985 we established 17 final-crop stocking trials throughout the country. Each was about 5 hectares in area and contained two replicates of the following treatments: 600, 400, 200, 100 and 50 stems/ha. Many eyebrows were raised over the latter, but Harry Bunn's rule was to test ridiculous extremes. This rule yielded dividends in spades. The 300-Index growth model arose from an analysis of these trials, and (thanks to the genius of Graham West, Leith Knowles and Mark Kimberley) now promises to supersede all other stand models.

My expectations of diameter increment? That the ultra-low stockings would be in a state of "free growth" – growing to the maximum of their ability unencumbered by the presence of neighbours. You should realise that at the time of trial establishment the trees were typically 10 metres tall, and a stocking of 100 stems/ha equates to an average between-tree spacing of ten metres. At 50 stems/ha, spacing is 14 m.

At such wide distances, the shadow of one tree does not even touch the base of its neighbour. A drop of water in the gaps will not reach any pine's roots – after thinning they take some time to fill the space. For the lower stockings (50, 100, 200) there was a constant selection ratio. I "paper thinned" the stands down to a ratio of 3:1 and then selected the best tree to retain. Baffled forest managers and contractors would fell superb trees just to leave a runt nearby. "Yet another example of academic idiocy", they muttered.

Exactly one year after the thinnings, I compared the diameter increments. I had expected that there would be no difference at low stockings ("free growth") but with increasing competition, the differences would be great. The exact opposite was true. The difference in diameter growth between the 50 stems/ha and the 100 stems/ha was far greater that between 100 and 200, which was greater than between 200 and 400. What was going on?

After several years' measurements, the effect was clear: trees at very low stockings have an astonishing increase in diameter growth and a corresponding loss in height growth. I wrote a paper describing the height loss as an "exposure" effect, but that was a cop-out (necessary to get past scientific reviewers). A key discovery was that the effect was observable only in large plots. Low stockings in small plots inside larger stands grew just like any other tree. My plots were substantially different from any other that had ever been attempted – the 50 stems/ha treatments, including the buffer, occupied over one hectare each.

Most importantly, the stocking effect continued for decades after the initial thinning. But at low stockings a natural forest of mahoe, coprosma, and other woody weeds sprang up. In this jungle of trees, how did the pines *know* they were supposed to be at lower stockings?

The trees could obviously detect the presence or absence of their neighbouring pines, distinguish them from other species, and grow differently as a result. Some measurements indicated that they appear to do this at age three or less. We are arrogant, arrogant, arrogant in assuming that a pine tree is an incredibly simple object that merely reacts passively to the environment in the same way as a beer-can hit by a rock.

For a start, pines have a genome ten times the size of a human being. If you were God, would you need ten times the size of blueprint to design a pine? OK, OK, I realise that most of this is junk DNA, but my point remains. Pine trees are sufficiently complex to react strategically to environmental clues. Plenty of other pines around, albeit scattered among the mahoe?

Strategy: go for height growth, to avoid being overtopped. Few pines around? Put your resources into a sturdy root and butt-log to avoid windthrow, and then concentrate on large branches with lots of cones for reproduction.

So how do pines detect the presence of other pines? We don't have to freshly discover everything in forestry; agricultural researchers have been doing their bit. Plants have a substance called phytochrome that acts as a sensor to detect changes in the colour of light that is reflected from the surrounding environment. Coloured mulch or shade netting is being used to alter the ratio of far-red to red light and increase the yield of crops like strawberries and tomatoes. Note that it also changes the branching characteristics and height of horticultural trees.

What are the implications? Controlling the shape of your crop by planting surplus trees is crude and expensive, while genetic engineering is like using lobotomy to cure a mental patient. Instead, we could grow the ideal tree with a subtle application of hormones or just by manipulating the colour of the understorey. A truly major breakthrough, but if I had attempted to develop it there would have been a lifetime of insufficient FRST funding and the scorn of my colleagues.... Over to you, young doctorates.

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