FORESTRY

Precocious Male Cone Production associated with Low Nutrient Status in Clones of *Pinus radiata*

WAREING[1] has reported that in *Pinus sylvestris* male and female cones are frequently borne on separate shoot systems. Female cones develop first, appearing on strong leading shoots on the main stem, and later also on vigorous first-order branches. Male cones are not produced until some years after the first female cones, and then appear on weaker twigs in the basal region of the lower branches. This distinction in the position of male and female cones suggests that the type of cone developing on a branch system is dependent on the internal condition of that system. Moorby and Wareing[2] have since suggested that the condition necessary for the onset of male coning is a certain degree of ageing, and they showed that ageing occurs in a branch system when this becomes sufficiently complex to lead to intensified competition for nutrients between the constituent shoots of the system. That is, male cones may tend to occur on twigs where the nutrient supply is limited.

Wareing's observations on the location of male and female cones in *P. sylvestris* apply also to *Pinus radiata;* and, while his observations were made on seedlings, the behaviour of vegetatively propagated material from mature trees is comparable, except for the fact that cones appear at a younger age in the vegetatively propagated material. Female cones are usually produced in the second or third year after propagation, and male cones some three or four years after this. A consideration of Moorby and Wareing's findings suggests that it may be possible to produce male cones sooner than is normal after vegetative propagation by restricting the supply of nutrients available to the plants concerned. Such production, however, is likely to be at the expense of female cones.

In the spring of 1960, cuttings were taken from the crowns of several trees of *Pinus radiata* which were then aged 12 years from sowing. At this age the trees were producing both male and female cones, but the cutting material collected had not itself borne cones. The cuttings, collected for a study of wood density, were set under an intermittent mist spray: when rooted in the winter of 1961 they were transferred to galvanized iron tubes each with a soil content of approximately 750 ml. Soon after this the original experiment was abandoned, and the rooted cuttings were left in the tubes.

In the spring of 1963, the plants, which had then been in tubes for two full growing seasons, produced a heavy crop of male cones, but no female cones (Fig. 1). Foliage analyses were carried out on seven of these plants. The analyses, on needles which emerged from the same overwintering bud as the male cones, showed that at this stage the plants were severely deficient in nitrogen and potassium, but well supplied with phosphorus (Table 1).

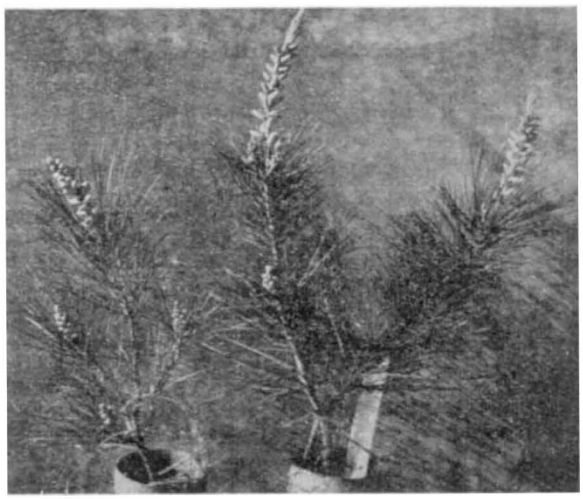

Fig. 1. Male cone production in 2-year-rooted cuttings of *Pinus radiata*

Table 1. NUTRIENT-LEVELS

	Nitrogen %	Phosphorus %	Potassium %
Tubed plants	1·09 (0·07)	0·21 (0·03)	0·21 (0·02)
Critical levels below which growth is restricted	1·60 (ref. 3)	0·10 (ref. 3)	0·40 (ref. 6)

(Values in parentheses are standard errors.)

Initiation of the male-cone primordia must have occurred during the plants' second growing season in the tubes. Since by that time the supply of nitrogen and potassium available to the plants was limited, and since male cones are not normally found on open-grown propagules of such small size, it is suggested that the production of male cones was in direct response to the low nutrient status of the plants. Whether the combined deficiencies of nitrogen and potassium, or deficiency of either of them singly, is responsible for the male cone production is uncertain. Will[4] found nitrogen-levels in the foliage of *P. radiata* to be lowest in the older needles towards the base of the tree, and it is on branches in these regions that male cones are usually found.

Further support for the suggestion that formation of male cones may be stimulated by nitrogen deficiency has been obtained from field fertilizer trials in the Nelson district of New Zealand. There the growth rate of second-rotation crops of *P. radiata* is reduced by nitrogen deficiency and the understorey of younger trees present has lower foliage levels of nitrogen than the main-crop trees[5]. These understorey trees frequently bear male cones on the leader and side branches without any female cone production at all. In plots treated with nitrogen fertilizers, however, production of male cones in the understorey trees has been almost completely eliminated.

Areas for the production of genetically high-quality seed are normally isolated from outside pollen sources, and, with the time lag in production of male cones, the first three or four years' crops of female cones remain unpollinated. The stimulation of precocious male-cone production in some of the trees would allow these cones to be pollinated, and would give a much earlier seed yield.

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ENTOMOLOGY

Larval Diapause induced by a Maternally-operating Photoperiod

IN several insects it is known that environmental factors such as nutrition and temperature, or intrinsic factors such as age, can induce diapause in the progeny by affecting the maternal generation[1–5]. This communication produces evidence that the production of diapause larvae by the parasitic wasp *Nasonia vitripennis* is controlled by a maternally-operating photoperiod.

The experiments were performed with two strains of *Nasonia* : one (the Woods Hole 'wild-type', *WH+*) was isolated by Prof. P. W. Whiting at Woods Hole, Massa-

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