RESEARCH INTO PROBLEMS OF PINUS PINASTER PLANTATION ESTABLISHMENT

by

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Basis of the Research

This work is centred on Wanneroo, and is largely carried out under the direction of Inspector Havel by T.A. Edminston and two assistants. To a large degree it is the follow-up of site studies carried out earlier, in that it seeks to find answers to problems associated with differential productivity on various sites. For this reason the findings of the site studies will be briefly recapitulated.

On the Coastal Plain, the main determinants of pine growth are the availability of soil moisture and the capacity of the soil to provide nutrients. The second part refers to retention of applied nutrients rather than to initial reserves of nutrients which are low throughout the coastal plain.

There are four broad categories of sites with respect to moisture availability -

1. Broad flats with ground water close to the surface, but never above the surface.

2. Swamps and swamp margins with ground water rising above the surface in winter and spring.

3. Grey sand dunes with unfavourable soil conditions except in winter.

4. Yellow sand dunes, underlain by limestone, lacking ground water storage.

Of these four categories, the first provides optimum conditions for pine growth, particularly where coupled with organic matter accumulation, and presents no problem. The less severe case of the second category should be amenable to improvement through drainage and mounding, and large scale operational trial using an imported mounding plough is planned for this winter. The third category is usually associated with unfavourable nutritional conditions and on our present knowledge cannot be brought into effective production. The fourth category presents the greatest challenge.

Management of Dry, Weakly Leached Sites

The relatively high content of inorganic colloids in the soil means that the initial content of nutrients is slightly better than for the third category, and that nutrients applied, in particular phosphorus, are not leached out so rapidly. The growth of pines which occurs mainly in spring is therefore quite good on these sites, so good in fact that it rapidly exceeds the capacity of the soil to supply water during the long summer drought. Native vegetation tends to stabilise itself at a density which matches the moisture reserves. Neutron probe studies of soil moisture down to the depth of 23 feet indicate that whereas under native vegetation the soil is completely rewetted each winter, under a dense unthinned stand of pines this no longer happens. Instead a dry zone develops at depth, and rises higher and higher until in a year of below-average rainfall the pines use up water early in the dry season and respond by dropping much of their foliage or even dying. The problem is most acute in the north, where unfortunately the bulk of our plantations will go in future. It is accentuated by occurrence of limestone. The first step is the avoidance of very shallow soils by site classification before planting. The second step is the determination of stand density, which can be carried on a particular site. In order to achieve this, a large thinning experiment has been established in our oldest pine plantation north of Yanchep. It covers the full range of sites in that area. The treatments consist of reducing the density, expressed in terms of basal area, stepwise from the high level of 107 sq.ft/acre to a very low level of 31 sq.ft/acre, and maintaining it there. Apart from measuring the response of the trees in terms of diameter and volume increment, a detailed hydrological study has been intergrated with the thinning experiment. The amount of rain falling in the district is being related to the amount that falls through the canopy and that runs down the stems, as well as to the rate and extent of rewetting of the soil. The optimum treatment will obviously be the one which combines the best growth rate with annual rewetting of the soil without any subsoil drainage, that is, the one that gives full utilization of the site without drought danger. It is intended to further widen the scope of study by incorporating fertilization into the design.

Management of Strongly Leached Sites

A similar experiment on the grey sands and flats in the Gnangara area is intended to study the effect of the water regime on the growth rather than the survival of the pines. The drought

danger is low because ground water is present at depth, and consequently a dense stand can be supported. However, whereas in unthinned stands diameter growth ceasea early, in heavily thinned stands it continues well into the dry season.

Fertilization of Yellow Sands

The change in emphasis from the grey sands at Gnangara to yellow sands at Yanchep has necessitated revision of our fertilizer application. Experiments currently in progress aim at determining what quantity per acre, and what form of phosphatic and zinc fertilizers give the best results on these sites.

Fertilization of Highly Leached Grey Sands

An important fertilizer trial has been established to find a way of handling the so called "sub flats" at Gnangara, which combine reasonable moisture conditions at depth with very rapid leaching of applied fertilizers. At present the initial application of superphosphate to the base of the trees is largely lost through leaching in three to four years. In past second application could not be carried out until after low pruning at age seven, when tractor-drawn fertilizer spreaders could be employed. By then, stagnation set in and resulted in a considerable loss of increment. Two alternatives are now under study. The first concerns merely the feasibility of earlier fertilization, for which the obvious solution is the use of aerial application. A large scale trial, monitored in detail by the research branch, showed that the method is eminently suitable for coastal plantation. Improvements have been suggested in the method application to avoid spilling the fertilizer, at relatively high rates, onto adjacent firebreaks. The second alternative is to apply more fertilizer, or less soluble form of fertilizer, in the initial treatment at the time of planting. This too is being investigated in a relatively large, complex experiment which should indicate the best combination of type and quantity of fertilizer and timing of application.

Row Thinning

The high cost of marking for first thinning and the difficulty in extracting individual trees has led to a local trial of row thinning, already practised by some paper companies. The experiment, initiated by Inspector van Noort, spans a very wide range of sites. In low-thinning, the main silvicultural problem is the retention of sufficient number of final crop trees of goof form. The ultimate solution to this will come through tree breeding. There is also a marked difference in the proportion of suitable trees between sites, so that the method will present less problems on poorer, drier sites where the economic aspects of thinning are most critical.

Nursery Studies, Maintenance of Soil Conditions

Research into nursery problems has taken the form of operation study to detect the areas of weakness. The three main weaknesses were found : the maintenance of adequate organic matter content in our very poor sandy soils. The loss of seedlings through damping-off and root-rot and the competition by weeds. The level of organic matter in the soil was found to be the main determinant of moisture and fertilizer retention, and through it of seedling growth. Past methods of maintaining this level through green cropping was found to clash in timing with other nursery operations, in that the lupins had to be sown earlier, too late or harvested too early. In any case, the large increase in the rate of production made the taking up of two thirds of the nursery under green crops impracticable. The discovery of large local deposits of peat provided a very cheap alternative. In anticipation of the problems which arise from heavy application of peat, such as excessive acidification and lowering of nitrogen availability, a comprehensive experiment incorporating four rates of peat, four rates of urea and four rates of agricultural lime was established. Some of the sixty-four possible combinations led to marked improvement of growth, others depressed growth and brought on various deficiency symptoms.

Soil Sterilization

In studying the problem of seedling mortality it was found that once this commenced, control was difficult, and that it was far better to anticipate the problem by sterilizing soil in the susceptible portions of the nursery. The main reagent used initially was formaldehyde, and the optimum combination of method, timing and quantity of application was defined. Current trials involving other reagents indicate that Di-trapex is more effective and easier to apply by mechanical means. A bonus benefit of soil sterilization is the initial control of weeds. On the other hand, too heavy a rate of application can lead to interference with mycorrhiza.

Weed Control

After a number of weedicide trials involving several types of weedicides applied under a wide range of conditions, a combination of pre-emergent application of Dacthal, followed where necessary by post-emergent application of a power and lighting kerosene mixture has been recommended. Weeds have now largely ceased to be a problem in the nursery.

Future Developments

What of the future? With many long term trials under way, much of future effort will need to go into their maintenance. The anticipated changes are not so much in the nature of investigations as in the use that is made of them. Much of the information that has come in, or is coming in from experiments dealing with individual problems needs to be reworked into a larger more complete story by a process that is now coming into prominence in forestry research, namely simulation. The basis of this is simply this : if we know how the species we are growing responds to certain combinations of site, fertilizer and thinning treatments, it should be possible, by means of mathematical models and computer analysis, to fill any gaps in our knowledge. Not only that, we should be able to predict what kind of tree crop these treatments will produce over a specified period of time. If the crop can be priced, and cost assigned to each operation involved in producing it, we have the means of comparing the economic benefits of the various treatment combination. Ultimately we hope to be able to select the one that is financially most advantageous.