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SOME ASPECTS OF PINUS CARIBAEA MOR. VAR. HONDURENSIS BARR. AND GOLF. NUTRITION IN PENINSULAR MALAYSIA

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SOME ASPECTS OF *PINUS CARIBAEA* MOR. VAR. *HONDURENSIS* BARR. AND GOLF. NUTRITION IN PENINSULAR MALAYSIA

by

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This thesis attached hereto, entitled "Some aspects of *Pinus caribaea* Mor. var. *hondurensis* Barr. and Golf. nutrition in Peninsular Malaysia" prepared and submitted by Abang Naruddin Zainorin in partial fulfilment of the requirements for the degree of Master of Science (Forestry), is hereby accepted.

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ABSTRACT

Three approaches were employed to study some nutritional aspects of *Pinus caribaea* var. *hondurensis* namely, soil analysis, soil bio-assay and foliar analysis.

Five soil composites each from Kemasul (Pahang) and Ulu Sedili (Johore) plantation areas were analysed for physical and chemical properties. For pot culture, a $2^2 \times 6$ factorial experiment using soil collected from Kemasul was conducted to study the effects of nitrogen, phosphorus and potassium on the growth of *P. caribaea* var. *hondurensis* seedlings. Nitrogen and potassium were applied at levels equivalent to 0 and 112 kg/ha; and phosphorus at 0, 168 kg/ha, 336.2 kg/ha, 504 kg/ha, 672.2 kg/ha and 840.3 kg/ha. At the end of the experiment, dry weight of roots, stems and needles were determined. Needles were analysed for N, P and K contents. Simultaneously, two randomised complete block fertiliser trials were laid out in the field. Nitrogen and potassium were applied at 0 and 224 kg/ha each while phosphorus was given at 0, 336.2 kg/ha, 672.2 kg/ha and 1008.3 kg/ha levels. Needles from these plants were collected at three times to concide with dry (February - May), transitional (June - September) and wet (October - January) seasons from five positions in the crown.

The study shows that phosphorus is highly deficient at both the sites. Application of P fertiliser at the rate of about 340 kg/ha at Ulu Sedili and about 504 kg/ha at Kemasul would be

desirable for optimum gorwth of *P. caribaea* var. *hondurensis* seedlings. Application of nitrogen at 112 kg/ha and phosphorus at the various levels resulted in increased concentrations of these elements in the foliage. Foliar P concentration of seedlings was positively and significantly related to height increment and total dry matter production. Only N:P and K:P ratios were positively and significantly related to height increment.

In the field, only N, P and Ca were significantly affected by the application of NPK fertilisers. However, foliar N, P and K concentrations were found to be insignificantly related to either height or diameter growth. The foliar concentrations of these elements were relatively low and did not cover the range necessary to relate nutrient concentration-growth relationship, presumably due to short period between fertiliser application and the last sampling. The field trial also showed that N and Mg were best sampled from the upper position in the crown while P, K and Ca were best estimated from the outermost sample position in the lower part of the crown. Sampling can be done towards the end of the dry season (February - May) or during the transitional period (June - September) when the concentration of most of the nutrients was less variable. For practical purposes, 15 to 20 trees would be required to be sampled from the upper part of the crown for a reliable estimate for most of the nutrients.

CHAPTER 1

INTRODUCTION

1.1 General

Malaysia is recognised as one of the world's leading exporters of tropical hardwoods. The humid rain forests form a rich and important natural resource of the country, covering about fifty-nine per cent of the total land mass of about 33.0 million hectares. The forests are known to comprise some 2,500 to 3,000 species of tree species belonging to almost 100 botanical families (Ng, 1976). However, at present only 15 families are of importance to the timber industry with Dipterocarpaceae accounting for about two-thirds of the total wood removal from the forests (For. Dept., 1977).

The increased land use for agriculture, the increasing demand for timber, technological advances in timber extraction machinery and equipment, and improvement in the infrastructure during the last few decades have resulted in large tracts of forest lands being cleared and at a fast rate. In Peninsular Malaysia, approximately 360,121 ha of forested lands were cleared annually in the recent years and about 75 per cent of the total lands cleared were for agricultural development (For. Dept., 1979). This has far exceeded what would have been permitted under the sustained yield management policy. With an estimated 5.1 million ha forest lands, 3.2 million ha are loggable and the rest are unproductive by virtue of their protective and other intangible benefits (For. Dept., 1979). If the present rate of harvesting is continued, it is projected that Peninsular Malaysia would be transformed into a net importer of tropical hardwoods by 1995.

In view of this fact, it is now realised in Malaysia that the natural forests are not the inexhaustable resource they were once considered to be. Several strategies are therefore planned to ensure that this renewable resource is perpetuated at productive levels, one of them being to raise large scale plantations of suitable exotic and indigenous species. It is therefore not difficult to surmise that plantation forestry is going to play an important role in future in view of the many problems encountered in regenerating the natural forests in the tropics. Besides, on the ground of productivity alone, many tropical plantations grown on a 10 - 20 years rotation have an annual increment of 40 cubic meters/ha while the output of most tropical forests even with extensive use of secondary species is unlikely to rise above 250 cu m/ha when logged at the end of a cutting cycle lasting 60 - 90 years. The awareness of the importance of forest plantations in the tropics which aims at bridging production and demand of timber to meet the world market is thus evident. Some 50,000 ha of Pinus caribaea have been planted annually in the tropical countries in recent years (IUFRO, 1977). One of the widely accepted approaches is to raise 'compensatory' plantations. As the name implies, 'compensatory' plantations are not viewed as substitutes to the existing natural forests but rather are meant to improve the productivity of degraded areas or areas of low agricultural potential such as those under shifting cultivation.

Under the Fourth Malaysia Plan (1981 - 1985), fast growing tropical tree species, such as Gmelina arborea Roxb., Maesopsis eminnii Engl., Acacia mangium Willd., Albizzia falcataria Back., Eucalyptus deglupta Blume and Pinus caribaea Mor. var. hondurensis Barr. and Golf. will be planted under the compensatory plantation programme. So far, only P. caribaea var. hondurensis has been planted on a commercial scale in the country. This programme has been the result of extensive research begun in the 1950's when the species was first introduced in the country. The species was found to be favourable for ease of handling in the nursery, relatively low transplanting mortality, and capacity to compete with lalang grass (Imperata cylindrica Beaur.). Reports that the species could yield between 18 and 34 cu m/ha/ year were thought to be realistic (Voss, 1980). In well-managed plantations and over short rotation periods of 8 to 15 years the growth was expected to exceed 20 cu m/ha/year (Johnson, 1976). These figures far exceeded the mean annual increment (MAI) of tropical forests of 2.5 cu m/ha per year (Johnson, 1976). On better sites in Peninsular Malaysia, the species has been reported to yield 14 cu m/ha/year (Freezaillah, 1966), and between 20 to 30 cu m/ha per year in Sabah (Liew and Morrissey, 1979).

However, relatively small areas of better Class I and II sites under Land Capability Classification (Panton, 1965; Wong, 1974) are available for plantation forestry and most of the better sites have been allocated for agriculture. Soils in Peninsular Malaysia are basically granitic and non-volcanic in origin with parent materials ranging from 180 to 350 million years in age (Owen, 1951). Generally, most of the soils have been found to be deficient in one or more of the major nutrient elements, particularly phosphorus and nitrogen (Shorrocks, 1965a). Marginal soils of Class lll and Class Vl have physical and chemical limitations and are often characterised by heavy-texture, imperfect drainage, and nutritional imbalance (Platteborze, 1971a). In addition, tropical soils are highly leached. In the lowlands, the unweathered material is not available to the tree roots while chemical weathering cannot possibly supply the element lost by leaching (Waring, 1971). Current methods of land clearing and site preparation (Sakhibun and Mohd. Sharif Kudin, 1980) further result in a loss of fertility.

The earlier views that forest trees require small amounts of nutrients, and that such supplies could be developed and maintained by careful management of the crop no longer holds true in modern forestry. Pines, like any other crop, need adequate amounts of nutrients for optimum growth and productivity. A lack of, or a deficiency in any one of the essential elements is known to affect growth and yield severely. Pine plantations in Malaysia have shown poor growth and other malformations such as foxtailing, multiple leader shoots, shoot dieback, basket whorls and necrosis. Waring (1971) attributed most of the growth ill-healths to nutrient deficiencies while Slee, Spidy and Shim (1976) emphasised climatic factors particularly temperature and daylength as the causes of these abnormalities.

In many countries, such as Australia and New Zealand, growth restrictions have been avoided by fertiliser applications. In fact, the practice has been well established in these countries and is an integral part of plantation forestry management. However, in developing countries, the use of fertilisers in plantation forestry is relatively new and has yet to be accepted as an operational routine. In agriculture plantation crops such as rubber, oil palm, cocoa, however, the use of fertilisers has been well recognised. For instance, Hevea needs nitrogen and phosphorus for optimum productivity. Besides, the fertiliser programme is well developed in relation to plant age, type of clone, soil conditions and management practices (Puspharajah and Tan, 1972).

In pine plantations, the early capture of the site and rapid canopy closure are desirable if weed competition is to be avoided and nutrient cycling initiated in the stand. Failure to achieve this will result in poor growth. Several studies in Malaysia have indicated that fertilisation of young pine has resulted in increased growth (Platteborze, 1971b; Carmean and Kok, 1974; Lim and Sundralingam, 1974; Sundralingam and Ang, 1975).

1.2 Aim and scope of the study

Presently, throughout the world, the importance of fertilisers in forestry is gaining recognition. Fertiliser use is now a standard silviculture practice both in the nursery and in the field. Several techniques to determine the nutritional status of soils and plants have been tried. Among the popular techniques used are soil bio-assay, soil and plant analyses. Lately, the latter has been preferred for assessing the status of soils and predicting fertiliser requirements of the crops.

In temperate and subtropical countries, the method of foliar diagnosis has been widely used to determine nutrient deficiencies before corrective measures are implemented. However, one constraint of this method is that the concentration of nutrients in the foliage is usually influenced by both the internal physiological factors and external climato-edaphic factors. This can be overcome, however, by standardising the sampling technique. In many countries, investigations of the sampling techniques to meet specific purposes have been conducted in detail and systems of monitoring nutrient status of the growing crops have been made available to forest managers (Mead and Will, 1976). The sampling techniques used in temperate and subtropical regions may not be applicable to the tropical region where the climate is non-seasonal and plant growth is continuous throughout the year (Srivastava and Hiew, 1980; Srivastava and Abu Bakar, 1980). Moreover, relatively few studies have been conducted on these aspects in the tropics in general and Malaysia in particular.

With the establishment of the compensatory plantation programmes in Malaysia, there is a need to carry out nutritional studies so that critical levels of nutrient requirements can be assessed and soil amendments carried out. With this in mind, the main aim of this study is to determine the fertiliser requirements, particularly phosphorus, using soil analysis, soil bio-assay and foliar analysis. Since foliar diagnostic technique has not been used widely in Malaysian forestry, it is therefore important to standardise the sampling procedures for predicting fertiliser levels. With this, it is hoped that this preliminary investigation using the three methods will provide some analytical data useful for developing a fertiliser regime for this promising species.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Fertilisers in forestry

The importance of fertilisation in forestry has been well recognised and has been reviewed extensively by Stoeckeler and Arneman (1961), Tamm (1964), Mustanoja and Leaf (1965), Boule (1973) and Ballard (1978). Experiments using fertilisers started as early as in 1901 in Germany and subsequently Henz in 1904 recommended the use of nitrogen fertiliser on forest trees (Stoeckeler and Arneman, 1961). To-day, the use of fertiliser has developed from that of correcting nutrient imbalance to one of increasing growth and production. The extent and magnitude of the use of fertilisers in forestry has greatly increased as illustrated by Boule (1973), Atkinson and Morison (1975), Pritchett and Smith (1975) and Woolons and Will (1975). This was due to the fact that plantation forestry has become more and more important in view of the shrinking volume and area of natural forests in the world. It is projected (Johnston, 1976) that by the year 2000, there would be a shortfall of wood products due to a rapid increase of world population. The problem could only be surmountable by the establishment of plantation forestry which is in fact has become the current trend of forestry practices in many countries.

However, for fast out-turn and high productivity, plantation forestry requires a high nutrition level which could not be always attained from the untreated soil. The response of forest crops