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APPLICATION OF THE DIAGNOSTIC AND REMMENDATION INTEGRATED SYSTEM (DRIS) TO YOUNG PLANTATION EUCALYPTS IN NEW ZEALAND - A PRELIMINARY EVALUATION BASED ON PROVISIONAL STANDARDS

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EXECUTIVE SUMMARY

Provisional Diagnosis and Recommendation Integrated System (DRIS) standards were developed for three species of eucalypt (*E. regnans*, *E. Saligna* and *E. delegatensis*).

The standards for each species were calculated from a very narrow, but survey-based database relating to 2- and 3-year-old eucalypts (sampled nationwide in summer 1988). The standards were found to be sufficiently different between species to preclude combining data for the three species. A single test was applied to each of the *E. regnans* and *E. saligna* standards using independent data from a nutrient subtractive trial (AK 1023-2) located in Tairua SF. As no suitable test data currently exist for *E. delegatensis*, standards for this species could not be tested.

Considering the narrowness of the databases, the results of very limited testing of the provisional standards for *E. regnans* and *E. saligna* are reasonably encouraging; they allow room for cautious optimism, that DRIS can be usefully applied to these species for diagnostic purposes. However to improve the reliability and accuracy of DRIS for young NZ eucalypts, the database needs to be expanded. Also, for species of interest, factorial fertiliser trials need to be established at nutrient-poor sites to provide suitable response and foliar data for more thorough testing of provisional DRIS standards.

INTRODUCTION

THE DRIS SYSTEM

The diagnostic and recommendation integrated system (DRIS) recognises antagonisms and synergisms among plant nutrients and emphasises the importance of balance among nutrients rather than individual nutrient sufficiencies. In essence, DRIS is a mathematical means of ordering a large number of nutrient expressions (such as ratios or products of various nutrient pairs) into simple nutrient indices that can be more easily interpreted.

The system was developed by Beaufils (1957, 1971, 1973) over a 20 year period. Beginning with rubber, he went on to develop and refine the system for maize in South Africa, and later applied it to other crops such as potatoes, ryegrass, lemons and soya beans. In later work, Beaufils collaborated with Sumner to apply the DRIS approach to sugar cane (Beaufils and Sumner 1976, 1977). Since that time, Sumner (1977a, b, c, 1978) and various other researchers (Elwali and Gascho 1984; Davee *et al* 1986; Alkoshab 1986; Mackay *et al* 1987, Righetti *et al* 1988a, 1988b) have extended the application of DRIS to other arable, horticultural, or orchard crops.

Fundamental to the development of DRIS was the observation (Beaufils, 1973) that the higher the yield the smaller the variation of analytical values around their means; in other words the coefficient of variation is lower at high yield levels.

Successful application of the concept to a species requires (1) foliage analysis data from a large number of sites (2) matching crop productivity values for each foliage sample, and (3) independent foliar and growth (productivity) data for that species, e.g. from factorial fertiliser trials. (1) and (2) are needed for determination of important nutrient expressions for DRIS index equations and/or the calculation of DRIS standards, and (3) for testing the validity and accuracy of the DRIS standards. One procedure commonly used in DRIS is to divide the sample population into 'desirable' and 'undesirable' populations (on the basis of productivity) so that norms for the 'desirable' or high yielding population can be calculated.

The advances in computing facilities which have occurred in the last decade now make contemporaneous and statistical treatment of large amounts of diverse data a relatively simple matter, so that, with suitable programming, the numerous and varied computations which DRIS involves can now be carried out efficiently and quickly.

In a critical review of DRIS, Jones (1981) summarised the basic assumptions which underly the system as follows:

(1) Ratios of nutrient element concentrations are often better indicators of nutrient deficiencies than single nutrient element concentrations.

(2) Concentration ratios for some nutrient elements are more important than others.

(3) Maximum crop yields are attainable only when the values of 'important' ratios approach an optimum value; for a particular ratio, the mean value for a selected high-yielding (or otherwise desirable) population approximates the optimum value.

(4) Since 'important' ratios must approach their optimum values for high yields to be attained, the variance of an 'important' ratio is smaller in a high yielding population than a low-yielding one. Thus the ratio of the variance in a low-yielding population to that in a high-yielding one can be used to select important ratios.

(5) A DRIS index can be calculated for each nutrient element determined. This index is based on the mean deviation of each important ratio (in which the nutrient element is either the numerator or denominator) from its optimum value. The optimum DRIS index for any nutrient element is zero, with a negative index indicating relative deficiency, and a positive one indicating relative sufficiency.

In recent years there has been increasing interest by forest nutritionalists in DRIS application to forest crops (See reviews by Mead (1984), Powers (1984), Weetman and Wells (1986), and Schutz and de Villiers (1987)).

Leech and Kim (1979) used DRIS to assess the nutrient requirements of poplars, and subsequently (Leech and Kim, 1981 and Kim and Leach, 1986) as a guide to fertiliser strategy for poplar plantations.

Truman and Lambert (1980) used the same technique to study the balance between foliar N, P and S in *Pinus radiata* growing in NSW.

Svenson and Kimberley (1988) using site index data, examined the diagnostic potential of DRIS norms for *Pinus radiata* growing under New Zealand conditions. Their study was limited to a range of macronutrients (N, P, K, Ca, and Mg).

In Western Australia, Ward *et al.* (1985) calculated separate DRIS indices for N, P, K, Ca and Mg for six types of *E. saligna* tissue (newly expanding foliage, young fully expanded foliage, older leaves, twigs, branches, and fruit) in upper and lower canopy positions. They found that only DRIS indices for fully expanded leaves of the upper crown successfully predicted and ranked the nutrient deficiencies previously established from responses to nutrients in a factorial fertiliser trial.

In Hawaii, Yost *et al.* (1987) used DRIS to study the effects of N and P fertilisation on the early growth and nutrient status of *E. saligna*. They reported that, in general, DRIS indices for N and P were more strongly related to present size or growth increments for the initial 12, 18 or 24 months from planting, than were absolute concentrations of these elements.

The present study is a first attempt at establishing and testing DRIS standards for New Zealand populations of young (2 and 3-year-old) plantation eucalypts (*E. delegatensis, E. regnans* and *E. saligna).* The standards for each of these study species were based on data from a recent NZ-wide survey of nutrient concentrations in eucalypts conducted in summer 1988.

METHODS

In this study, in adopting the proposition (Jones 1981) that both the mean and/or variance of 'desirable' and 'undesirable' populations be used as criteria for selecting nutrient ratios for DRIS formulae, we have included all possible 'important' ratios.

Two of three modifications to standard DRIS computation originally proposed by Beverly (1987) were also adopted in the present study namely:

1. Use of logarithmic transformation of nutrient ratio data to reduce skewness in the distribution of concentration ratio values, and to simplify computations (see below)

2. Use of a single index calculation method; this replaces the practice of using two alternative equations (to calculate the function describing variation of the observed nutrient ratio