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A STUDY OF GROWTH, DEVELOPMENT AND N-FIXATION OF SEVERAL WHITE CLOVER (*Trifolium repens* L.) CULTIVARS UNDER DIFFERENT WATER DEFICIT AND PHOSPHORUS LEVELS

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ABSTRACT

White clover (*Trifolium repens* L.) is one of the most important pasture plants in New Zealand. It contributes nitrogen, high quality forage and seasonal spread of production. However, it has high requirements for phosphate and does not persist well under moisture stress conditions. In this study the effects of water deficit level and phosphorus (P) level on the growth, development and N-fixation of different white clover cultivars have been studied. Several New Zealand and overseas white clover cultivars of contrasting morphological characteristics were selected for this study. These cultivars were Kopu, Pitau, Dusi, Haifa, Huia, Tahora and Whatawhata.

The main objectives of this study were to determine the effects of water stress and phosphorus levels on growth, development, and N-fixation of these cultivars and to identify the plant characteristics most effective in distinguishing the cultivars used in the study. The research approach was to measure the responses of these cultivars to water deficit and P fertility treatments; and the responses were then related to selected plant characteristics, particularly morphological characteristics. Attempt was also made to distinguish the cultivars using multivariate analysis techniques.

The results of this study showed that the cultivars had responded differently to water deficit treatment and P treatments. The retardation they suffered in their growth and development, expressed by both dry weight (DW) and growth rate of stolon components (leaf, petiole and branch), was significantly different and, in many cases, could be related back to their morphology and development characteristics. Cultivars of small stature, such as Whatawhata and Tahora, were generally less affected by the stress treatments. Cultivars grown well under control conditions, such as Kopu and Haifa, suffered more severely under stress conditions. For all cultivars, parameters associated with leaf area were more sensitive to water deficit stress than those associated with growing points.

The study of plant water status of these cultivars under progressively decreasing water availability failed to identify any significant difference between the cultivars in their ability to avoid dehydration at medium to high water deficit stress levels. So it could be suggested that the difference between the cultivars represented their ability to tolerate water stress and was unlikely to be associated with their dehydration avoidance ability but

more likely to be associated with morphological characteristics such as deep root and reducing leaf area when water deficit stress occurred. The cultivars were different in their N-fixation ability, as measured by the acetylene reduction analysis (ARA), and this difference was related strongly to leaf size. But when expressed as ARA per unit DW, the difference between the cultivars was non-significant.

Overall, under control conditions, mainly the morphological characteristics, such as leaf size, leaf weight and petiole length, caused the difference between cultivars, other characteristics, such as the plant DW components, DW partitioning, and P and N partitioning in plant components, were less important. Among the morphological characteristics, leaf size and leaf weight per stolon were the most important characteristics differentiating between cultivars. These two characteristics were also the most important for determining plant yield. Under water deficit stress and P deficiency treatment, root DW and branch number were the two most important characteristics differentiating between the cultivars.

CHAPTER ONE
INTRODUCTION

While white clover is grown across a broad spectrum of climatic conditions (Gibson and Cope, 1985), it succeeds best in cool moist climates. It is not productive or even persistent under certain stress conditions; for instance, during summer drought or with severe soil phosphorus(P) and potassium(K) deficiency (Johns, 1978; Caradus, 1980; Thomas, 1984). Although such problems are relatively minor under normal farming conditions in New Zealand, summer drought can cause poor growth (Radcliffe, 1982) and so prevent the fulfilment of the advantage of a better seasonal spread of white clover (Brougham, 1966). Poor growth can also lead to poor persistence, especially of white clover cultivars selected under adequate environmental conditions for high yielding ability (Charlton, 1984). The white clover's productivity and persistency under poor conditions has been indicated as an important breeding objective by some workers (eg. Rhodes, 1984, 1985), however, the information of how white clover grows under water stress and its ability to adapt to such stress is not available.

Similarly there is a lack of information on the production and persistency of New Zealand white clover under conditions of phosphorus deficiency and with concurrent water stress. Overseas work indicates that some cultivars, such as Dusi, can tolerant water stress as well as low P fertility (Smith and Morrison, 1983). Such cultivars would provide an interesting comparison with New Zealand cultivars of similar growth characteristics. The limitation on fertilizer usage imposed by the current economic conditions makes it clear that for hill country pasture at least, a white clover cultivar tolerant of low fertility, particularly low P fertility, is desirable.

Therefore, the objectives of the present study are:

1. to determine the effects of water stress and P levels on growth, development, and N-fixation of selected white clover cultivars (or selection);
2. to identify and evaluate plant characteristics most effective in distinguishing the cultivars used in the study.