Chicory (*Cichorium intybus*) and plantain (*Plantago lanceolata*); physiological and morphological responses to water stress, defoliation, and grazing preference with implications for the management of the Herb and Legume Mix

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Abstract

Cranston L (2014) Chicory (*Cichorium intybus*) and plantain (*Plantago lanceolata*); physiological and morphological responses to water stress, defoliation, and grazing preference with implications for the management of the Herb and Legume Mix. PhD Thesis, Massey University, New Zealand. 315 pp.

Herb and legume sward mixes containing chicory (*Cichorium intybus*), plantain (*Plantago lanceolata*), red clover (*Trifolium pratense*) and white clover (*T. repens*) are being increasingly used by farmers to improve animal performance compared to perennial ryegrass and white clover swards. However, little is known about the agronomic properties of this Herb and Legume Mix. The objectives of this research were to examine key factors likely to affect the success of the Herb and Legume Mix as a perennial sward mix. This thesis included a series of glasshouse experiments, a grazing experiment (examining plant parameters and animal grazing preference) and a mowing experiment. The glasshouse experiments indicated that chicory and plantain have different strategies for coping with moisture stress. The results suggest plantain may be more productive under moderate drought due to its greater shoot mass fraction, whereas chicory may be more productive and persistent under severe drought due to its greater root mass and taproot diameter. The Herb and Legume Mix accumulated greater annual dry matter when removed under Hard grazing (post-grazing residual of 4cm) compared to Lax grazing (post-grazing residual of 8cm). Hard grazing favoured plantain growth and persistence, while Lax grazing favoured red clover growth and resulted in chicory with a larger taproot diameter. It was concluded that grazing management decisions should be determined by ensuring optimal management of chicory. Ewe lambs displayed grazing preference for species within the Herb and Legume Mix; however this varied between seasons and was affected by the species availability, vertical access and palatability. The Herb and Legume Mix had a greater herbage nutritive value than the ryegrass and white clover sward and had a more stable composition over time than pure swards of chicory and plantain under a wide range of defoliation regimes. The results suggest the Herb and Legume Mix might be a more flexible perennial forage option than pure swards of chicory and plantain. Overall the results of this thesis indicated that the Herb and Legume Mix can be successfully utilised in most New Zealand grazing systems as a perennial forage sward.

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Foreword

This thesis is written so that the chapters can be readily converted into papers for publication. Therefore, each chapter contains a full and thorough discussion and the overall discussion chapter provides a succinct overview of the entire thesis content. Throughout the thesis the convention used for stating significance in tables is $P = 0.05$, as done in the journal Animal Production Science. The references from each chapter are combined and presented at the end of the thesis. It must be pointed out that this work is only focused on the performance of the plant species in the Herb and Legume Mix and not animal performance or weed control. Ultimately, this thesis aims to provide answers for grassland farmers utilising the Herb and Legume Mix.

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