SULLA (*Hedysarum coronarium* L.); AN AGRONOMIC EVALUATION

A THESIS PRESENTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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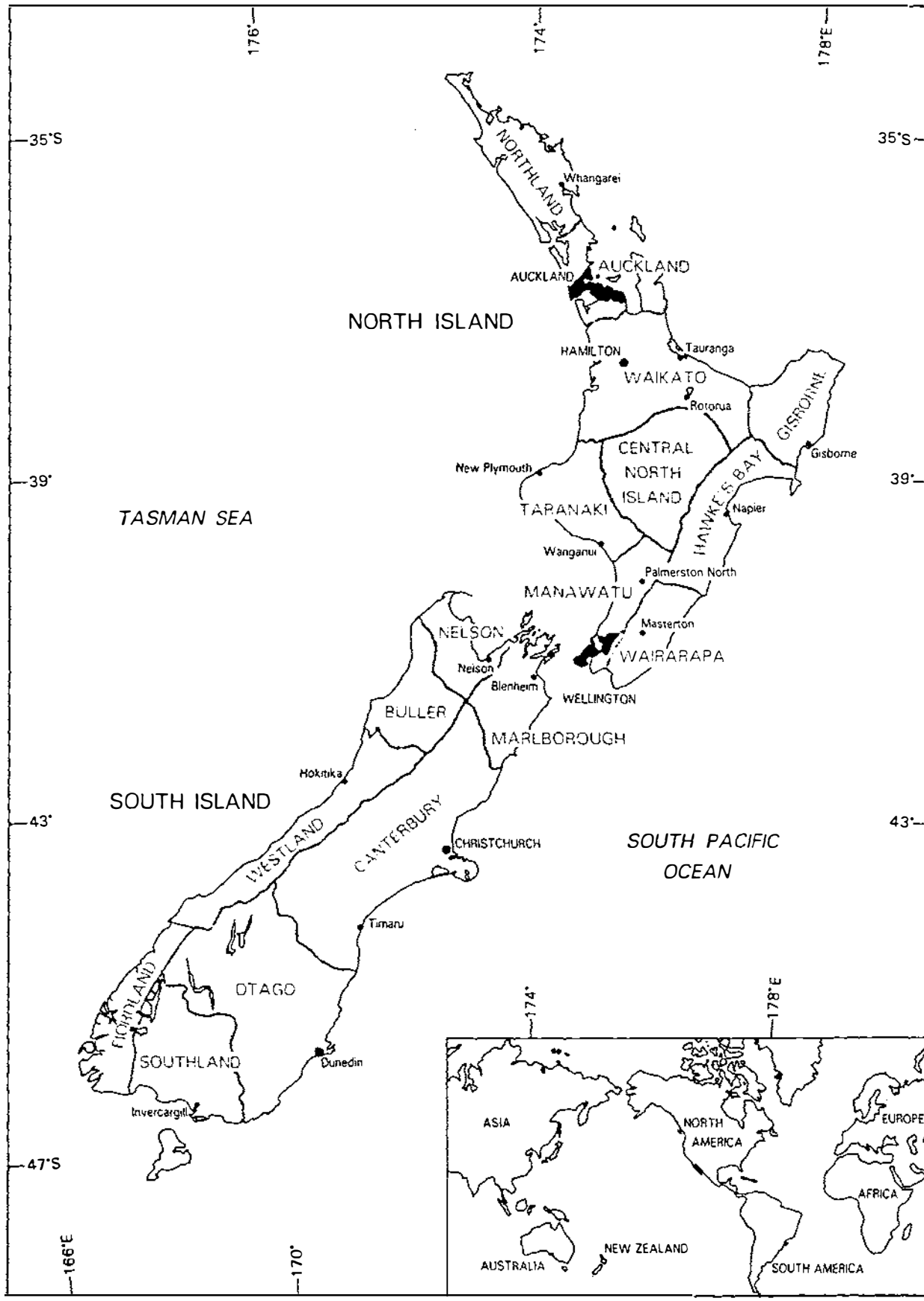
'THERE IS NOTHING GRATEFUL BUT THE EARTH; YOU CANNOT DO TOO MUCH FOR IT: IT WILL CONTINUE TO REPAY TENFOLD THE PAINS AND LABOUR BESTOWED UPON IT'

LORD RAVENSWORTH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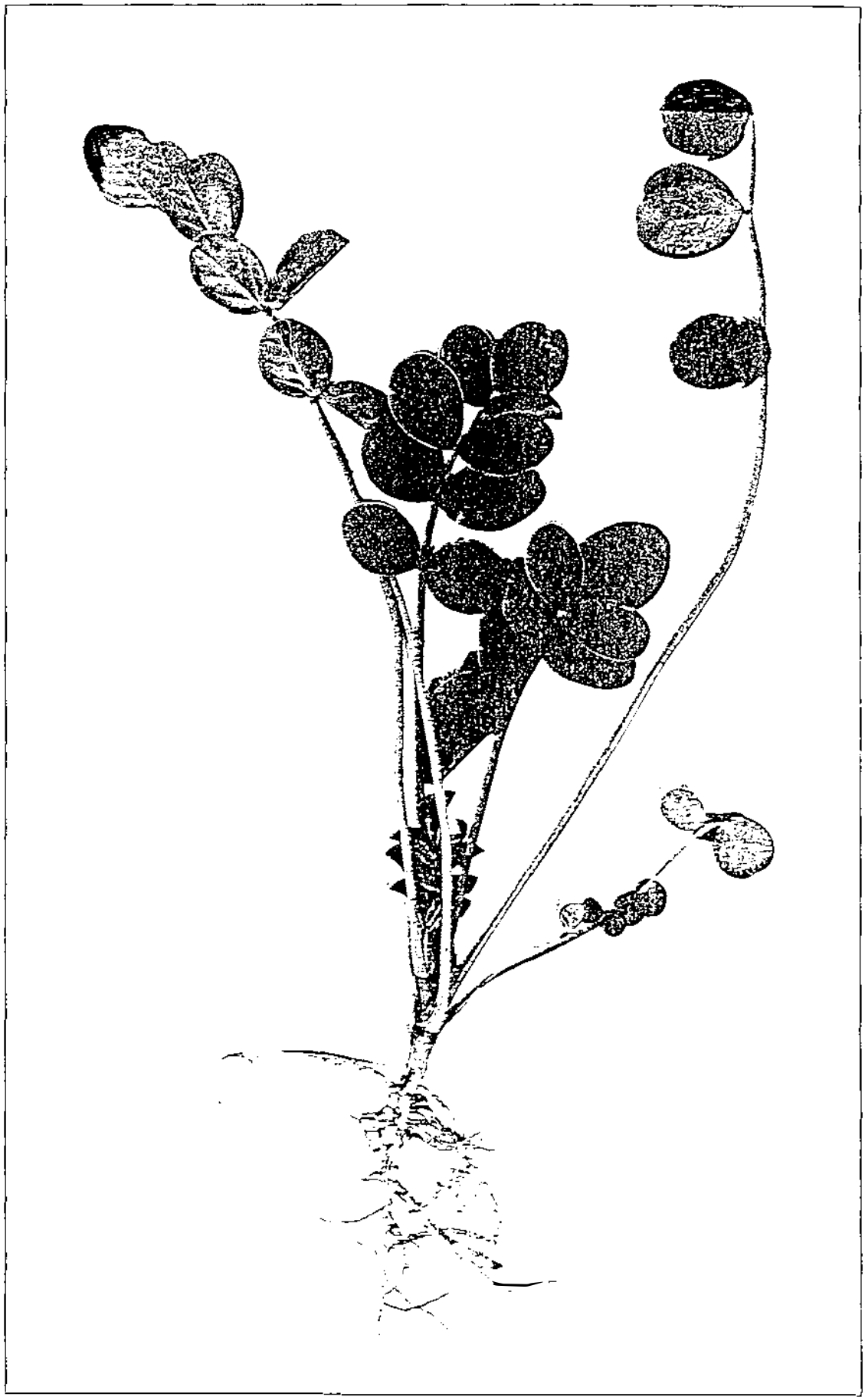

ABSTRACT

This thesis reports three studies conducted on the agronomic evaluation of the recently introduced forage legume species sulla (*Hedysarum coronarium* L.) cv. Necton, for its potential use in animal production systems in New Zealand. The utilisation of forages, grasses and legumes, in New Zealand is predominantly by grazing *in situ*. Sulla was introduced to New Zealand for soil conservation, but its use as a forage under a cutting regime is well known in the Mediterranean countries. Information was inadequate for its use under a grazing regime.

A preliminary study was conducted under sheep grazing to assess annual herbage production, seasonal patterns of DM production and persistence. Nodulation failure resulted in the application of 100 kg N ha^{-1} after each grazing. Severe grazing (H=70-75% herbage consumed) and less severe (L=60-65% herbage consumed) grazing intensities were imposed at the early reproductive (ER) and late reproductive (LR) growth stages. The resultant management treatments over one year were ERHHHH, ERHLLL, ERLHHH, ERLLLL, LRHHH and LRLLL. Grazing intensities did not affect herbage production as residual herbage senesced after grazing. The annual herbage production ranged from 12000-20000 kg DM ha^{-1} in the ERGS and LRGS treatments. Plant density declined 83 and 46% in the ERGS and LRGS respectively. Regrowth originated from the crown region in both growth stages. Autumn grazing management, ineffectively nodulated plants, inadequate weed control and poor stand persistence were identified as constraints to herbage production and needed further research. An effective *Rhizobium* strain ICMP 10149 was reisolated, and a concurrent trial elsewhere, not by the author of the thesis, identified Stomp 330 E a preemergent herbicide as suitable for sulla.

A greenhouse defoliation trial was conducted to elucidate the influence of plant growth stage at defoliation and grazing intensity on herbage accumulation in the absence of compounding factors such as selective grazing and trampling. Plants were defoliated to 1, 7, 15 and 30 cm at the late vegetative (LV), midstem elongation (MSE) and early flowering (EF) growth stages. Across growth stages, the residual leaf area was 0, 84, 180 and 415 cm^2 respectively. Destructive harvests were carried out on days 0, 14, 25, 40 and 60 after defoliation. Plant maturity at defoliation and defoliation intensity were determinants of herbage increase in 60 days of regrowth. Complete (1 cm) defoliation at the LV growth stage resulted in

a smaller root system, decreased starch accumulation and reduced plant size. Defoliating to 15 cm at the EF growth stage produced the maximum regrowth of herbage, maintained high taproot starch and root mass.

A grazing trial was designed to evaluate annual herbage production, seasonal patterns of DM production and plant persistence in an effectively nodulated stand with minimum weed competition. Severe (H=70-80% herbage consumed) and less severe (L=60-70% herbage consumed) grazing intensities were applied at the late vegetative (LV), midstem elongation (MSE) and early flowering (EF) growth stages. LVHHHH, LVLLLL, MSEHHHH, MSELLLL, EFHHH and EFLLL were the resultant management treatments over one year. Grazing intensity did not influence herbage produced as the postgrazing herbage senesced. Across intensities, the annual herbage produced ranged from 22000-25000 kg DM ha^{-1} for the various growth stages. Herbage accumulation rates were 55 kg DM ha^{-1} d^{-1} in early summer and peaked at 78 kg DM ha^{-1} d^{-1} in late summer and early autumn. Plant density declined 79, 74 and 29% over a year in the LV, MSE and EF treatments respectively and remaining plants subsequently disappeared. Late autumn grazing in wet soil conditions resulted in significant plant losses which affected spring herbage production.

Sulla was best grazed or cut at the EF growth stage for maximum herbage production and persistence. Complete removal of herbage maximised utilisation as remaining stubble senesced and did not contribute to herbage accumulation. Under grazing sulla was short-lived and thus should be managed as an annual forage species. Allowing seed to shatter may be a potential management tool for the maintenance of stands. An autumn sowing for spring utilisation to exploit winter growth activity may be advantageous. However, late autumn grazing especially with high stocking densities under wet soil conditions should be avoided, and, in general, damage to the crown should be minimised. Although a residual leaf area (200 cm^2) on the stubble would improve the rate of regrowth this would appear difficult to attain under grazing. It may be best to cut sulla to exploit its winter growth activity. Sulla has potential as a special purpose forage when summer and autumn/winter pasture deficits restrict animal production.

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