PRODUCTION, STABILITY AND BIODIVERSITY OF NORTH ISLAND NEW ZEALAND HILL PASTURES

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ABSTRACT

The relationship between pasture biomass and pasture stability with species diversity was derived for two low fertility, hill land sites. At one site, pasture production increased with an increased number of species contributing to biomass. The coefficient of variation in biomass, however, decreased with higher numbers of species. At a second site, pasture biomass was also found to increase with increasing species diversity, but the relationship between yield stability and species diversity was not as strong as at the first site. This suggested there were other factors that influenced the stability of pastures, which could include the substitution effect between species or the greater contribution of particular species to yield and stability.

KEYWORDS

Hill land pastures, low fertility, production, stability, species diversity

INTRODUCTION

There has been continued debate about the hypothesis that diversity begets stability, within plant communities (Tilman, 1996). Elton (1958) suggested that decreased diversity would lead to decreased ecological stability and functioning while others (May, 1973) showed that population dynamics were more stable as the number of species decreased. In long term studies on rangeland pastures, Tilman (1996) found that biodiversity stabilised plant community and ecosystem processes, but not plant population processes. Species rich plots were found to have less variation in annual yield (ie more stable) when subjected to a major perturbation (eg. drought) or year to year variation in climate, but year to year variability in species abundances was not stabilized by plant species richness. In order to test Tilman's findings, data was collected from two low fertility North Island hill pastures. It was hypothesised from the results of Tilman (1996), that sites with more species present would have a higher green yield than those with low species diversity and that there would be less variability in the yield (ie greater stability) of species rich sites.

MATERIALS AND METHODS

In September and October 1968, a survey was carried out on two low fertility North Island, New Zealand hill country sites (175° 50' E, 40° 19' S), 500m apart and having an Olsen P of 3.4 and 1.9 mg P/g soil, respectively. The first site had an average north-west facing slope of 29°. It had been predominantly grazed by cattle and comprised a Mangamaku steepland soil derived from silty sandstone. The second site had an average west facing slope of 24° and had been predominantly grazed by sheep. It comprised a Ngamoka silt loam soil derived from loess and sandy siltstone. Herbage from 20 - 5 cm diameter turf plugs per plot was removed to ground level, from 200 plots randomly located within a 20X20 m area per site. Herbage was manually dissected into dead matter and all major species present, and subsequently dried. SAS was used to perform the regression analysis and the coefficient of variation for each number of species was calculated. The coefficient of variation for plots with 10, 11 and 12 species were bulked, as there were very few plots with these numbers of species.

RESULTS AND DISCUSSION

The species found most commonly at sites included *Agrostis capillaris, Anthoxanthum odoratum, Cynosurus cristatus, Musci* spp., *Trifolium repens, Lolium perenne, Dactylis glomerata, Poa* spp., *Festuca rubra, Rytidosperma* spp., *Nertera setulosa, Centella* spp., flatweeds (*Plantaginaceae* and *Asteraceae*), with rarer occurances of other species (*Cirsium arvense* and *C.vulgare*) and other legumes (*T. subterraneum* and *T.dubium*). This botanical composition was similar to previous surveys (Suckling, 1954; Lambert, 1986; Grant and Brock, 1974).

Figure 1 shows the relationships between green biomass and the number of species contributing to green biomass for sites 1 and 2. The regression lines for the relationship were significant at both sites ($P<0.01$ and $P<0.05$, respectively), and showed increased biomass with increasing numbers of contributing species, in agreement with the results of Tilman (1996). The strength of the relationship varied between sites, probably due to more favourable environmental conditions on the first site (including higher fertility and less intense grazing). The lower mean yield on the second site may have been due to sheep rather than cattle grazing.

The coefficient of variation of green biomass for both sites showed a similar pattern of decreasing coefficient of variation with increasing species diversity, though the relationship appears to be more variable for the second site (Fig. 2). This result is of significance in agriculture as it suggests that with fewer species present there is the chance that a very low biomass yield could occur, whereas if there are more species present, there is a smaller chance of a very low yield occuring.

These results strongly suggest that in low fertility hill farmlands, biomass is increased with increasing species diversity. There was, however, variation in the strength of this relationship depending on factors yet to be determined. The site 1 data showed that the stability of pasture yield increased with increasing species diversity, the site 2 data did not show this relationship as clearly. This suggested that there are other, presently unknown factors which influence the stabilty of hill pastures, but which could include the substitution effect between certain species or the greater importance of certain species as yield contributors (eg *Agrostis capillaris*) (Lamont, 1995). The results presented here cannot be extended to higher fertility hill farmlands (ie Olsen P > 10) or other topographic classes without similar pasture surveys being conducted. The literature suggests (Suckling, 1959; Lambert, 1986) that under high fertility, fewer species might contribute to yield. The importance of carrying out such a survey and analysis as this on higher fertility hill farm lands should not be overlooked as the trend on New Zealand hill land farms is to increase fertility by fertiliser application and legume oversowing (Suckling, 1959). If relationships between species diversity, yield and pasture stability on higher fertility hill lands can also be identified, then more efficient use can be made of the hill land resource in its current fertility status.

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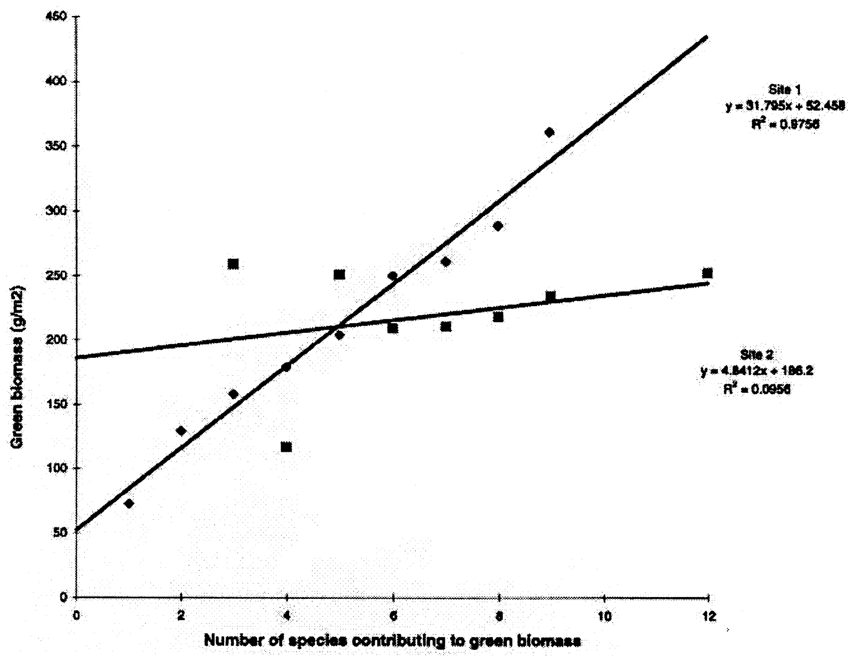

Figure 1
The relationship between green biomass and the number of species contributing to green biomass for two sites in North Island, New Zealand hill farm land (symbols are the means of 5-25 plots).

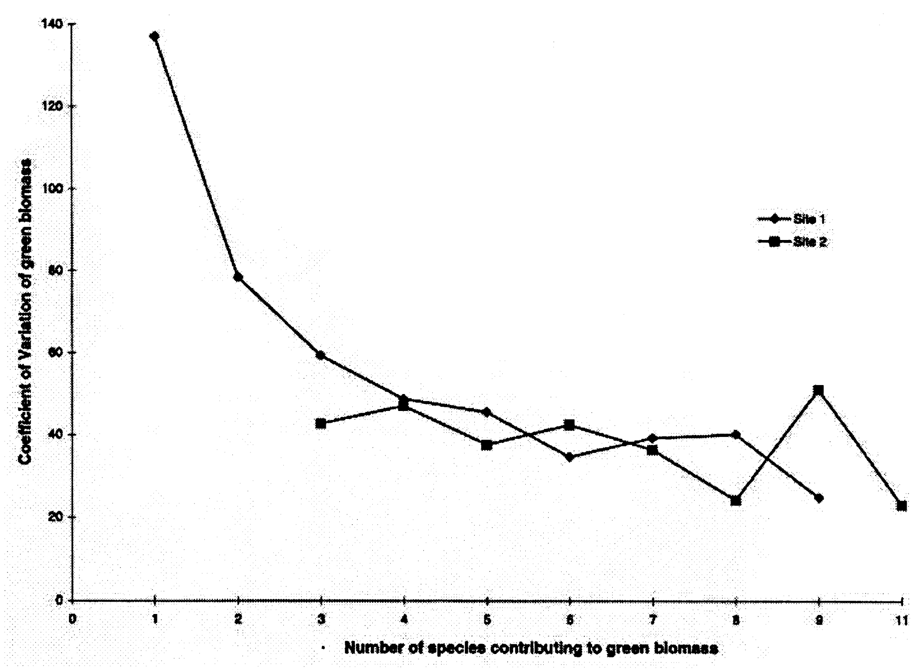

Figure 2
The coefficient of variation of green biomass in relation to the number of species contributing to green biomass for two sites in North Island, New Zealand hill farm land (symbols as for Fig. 1).