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SEASONAL AND SHEEP GRAZING MANAGEMENT EFFECTS ON BRANCHING STRUCTURE AND DRY WEIGHT OF WHITE CLOVER PLANTS IN MIXED SWARDS

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Abstract

Swards that had been either set stocked (SS) or rotationally grazed (RG) for five years were sampled monthly over two years by removing turves. The uncut white clover plants were then washed out. classified by branching structure (lst, 2nd, 3rd, 4th order) and then dissected into stolon and leaf before drying and weighing

Under both managements stolon dry weight per plant and branching structure of the population each indicated a strong seasonal shift from larger plant size during summer. autumn and winter (February, 109 mg stolon DW/plant, 7% of population 1 st branching order) to a preponderance of smaller plants in spring (October, 41 mg stolon DW/plant, 30% of population 1st branching order). Grazing management affected stolon DW per plant (means. RG 106 mg, SS 53 mg) but had little effect on branching structure. However, in spring, under RG management proportions of 1st branching order plants in the population were higher for a longer period than under SS management.

The simpler structure of plants in spring is thought to increase the vulnerability of the white clover population to adverse conditions at this time. While RG management allowed white clover to better utilize favourable growth conditions, it also increased the susceptibility of the population to large declines during stress periods; SS management reduced the potential for growth, but enhanced stability during stress periods. Hence where environmental conditions are unpredictable SS rather than RG mangement will favour retention of white clover in the sward. The seasonal and grazing management effects reported are likely to occur across a wide range of environments.

Keywords: *Trifolium repens,* individual plants, plant sire. seasonal variation, branching.

INTRODUCTION

Plant size may influence productivity, persistence and fecundity of an individual within a plant population (Harper 1977), and considerable information exists on number and size of plant components in swards (Frame & Newbould 1986), but little is known of the size of individual plants in the population of white clover under grazing.

In a one-year study Brock *et al.* (1988) reported the detailed structure of plants comprising the population of white clover in pastures under three different sheep grazing managements. Marked seasonal fluctuations in characteristics reflecting plant size were observed with a distinct minimum in spring and a maximum in late summer. This paper extends the study with a second years observations to confirm these effects and gain some measure of year to year variation.

MATERIALS AND METHODS

The site, pastures, and sampling and statistical procedures have been described in detail (Hay *et al.* 1983, Brock *et al.* 1988). An outline of essential features follows.

Pasture and grazing management

The pasture, at Grasslands Division, Palmerston North, was sown September 1978 to Grasslands Ruanui perennial ryegrass and Grasslands Huia white clover. Grazing managements imposed in September 1979 using self-contained farmlets stocked at 22.5 ewes + lambs/ha, were: 1) continuous set stocking (SS), 2) rotational grazing (RG).

Pasture utilization was similar for both grazing managements, averaging 11500 kg DM/ha/yr. Grazing management induced marked differences in pasture structure. Mean grass tiller density under SS ($14500/m^2$) was almost double that of RG ($8000/m^2$). White clover growing point densities were more variable, year 1 being SS 2200, RG $3600/m^2$, and year 2 SS 3100, RG 1050/m^2. Mean grass shoot biomass was 50% greater in the shorter denser SS pastures (3500 kg/ha) than in the open taller RG pastures (2400 kg/ha).

Clover plant sampling

Monthly samplings were conducted for two separate years (March 1984-February 1985 (year 1) and August 1986-July 1987 (year 2)) by removing intact from each grazing management 3 (year 1) or 4 (year 2) randomly selected 250 x 250 mm turves to a depth of 50 mm, by steel-edged quadrat and spade. In the RG system the paddock next to be grazed (with the longest regrowth) was sampled.

Soil was gently washed from each turf and all clover plants carefully separated intact from the vegetation mat. Plants cut by the quadrat edge were rejected. A maximum of 20 plants (randomly selected when more than 20 were present) were classified as 1st order, 2nd order, 3rd order, etc. depending the level of branching occurring, and then dissected into leaf and stolon components which were dried and weighed.

Data analysis

Data were weighted to counter sampling bias against large sized plants (Brock et *al.* 1988) and analysed by analysis of variance. The highest level of branching was 6th order, but as the 5th and 6th orders combined accounted for less than 2% of the population, and these orders had insufficient data for analysis, they were included in the 4th order for this study.

RESULTS

Environmental conditions contrasted markedly between year 1 and year 2. Although total rainfall was similar for both years at 95% of normal (N.Z. Met. Service 1983) the monthly distribution differed greatly between years (Fig. 3). Year I was dry in late autumn (April to mid May -50%) but moist over summer (December to January +30%), while year 2 was very dry from mid spring to mid summer (November to mid January -70%) and moist in autumn (March to mid May +50%).

Distribution of plants among branching orders

Large differences in the proportioning of numbers of plants among the four branching orders were associated with month of sampling ($P<0.001$; Fig. 1). The major seasonal feature was the big increase in late spring (October-December) in the proportion of the population in the 1 st branching order (single stolon plants) and the corresponding decrease of, in particular, the 3rd and also the 4th orders. Over this period approximately 75% of the population comprised 1 st and 2nd order plants. By January the distributions of the various branching orders was that of the early spring period (August-September). The mean distribution among branching orders was similar (within 5%) for both years,

The management x branching order interaction was not significant. The management x month x branching order interaction ($P<0.05$) (showed in part in Fig. 2) indicated that under RG, compared with SS, the proportion of 1st order plants was higher in spring and remained higher for longer into summer while the proportion of 3rd order plants showed the reverse.

Stolon dry weight (DW) per plant

The mean stolon DW/plant of RG plants was double that of SS at 106 ± 2.2 mg and 53 ± 2.0 mg respectively. Mean stolon DW/plant varied with month of sampling ($P<0.001$), with smallest values in October-November and largest values in summer and autumn provided that rainfall was adequate (Fig. 3). The early summer drought in year 2 prevented a recovery in stolon DW/plant of RG plants from the low spring values until February. Once sufficient rainfall had fallen surviving RG plants grew rapidly to large size, exploiting the reduced density of the pastures induced by the drought. In contrast SS plants remained relatively unaffected. Conversely the high summer rainfall in year 1 enabled the weight of SS plants to increase in February as grazing pressure was reduced, a result of the rapid increase in herbage mass which was not controlled at the stocking rate used. Mean stolon DW/plant

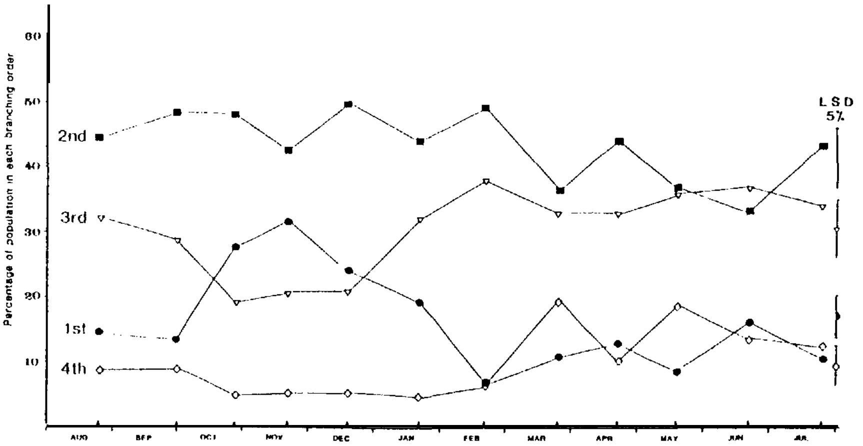

Figure 1: Seasonal variation (meaned over years and grazing managements) in the percentage of an intensively grazed white clover population in each of four branchmg order categories.

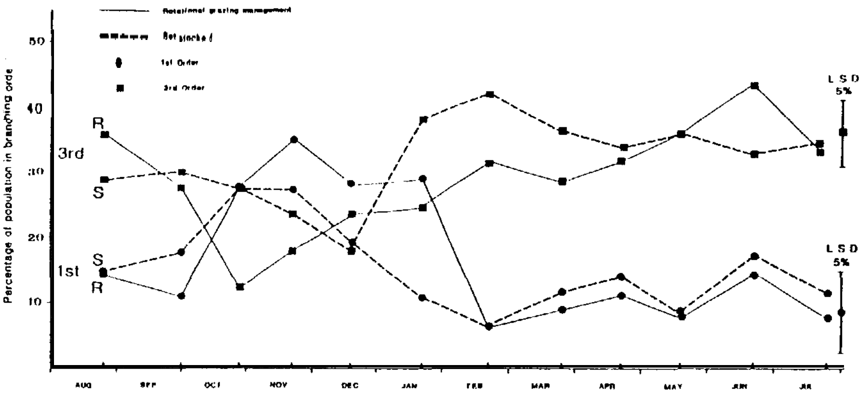

Figure 2: Seasonal variation (meaned over years) for RG and SS managements in the percentage of each population in the 1st and 3rd branching order categories.

increased with degree of branching complexity (14 ± 3.1, 40 ± 2.0, 87 ± 2.4 and 167 ± 4.2 mg for 1st, 2nd, 3rd and 4th branching orders respectively).

DISCUSSION

In established pastures white clover grows foward at the stolon apices and dies from the stolon base towards the apex (Erith 1924). Rotting of older basal portions of stolons, causes the severance of branch stolons which then form new plants (Chapman 1983). In this environment stolon biomass studies have shown that large quantities of older buried stolon die and decay probably as a result of internal plant stress caused by the demands of increased growth in spring (Hay et al. 1983). This would result in the break up of large plants into several smaller plants, The large shift observed in the population towards smaller (Fig. 3), less complex (Fig. 1) plants in spring is a result consistent with the operation of those processes. Rapid growth made over the summer period, should rainfall be adequate, increases plant weight and branching complexity again.

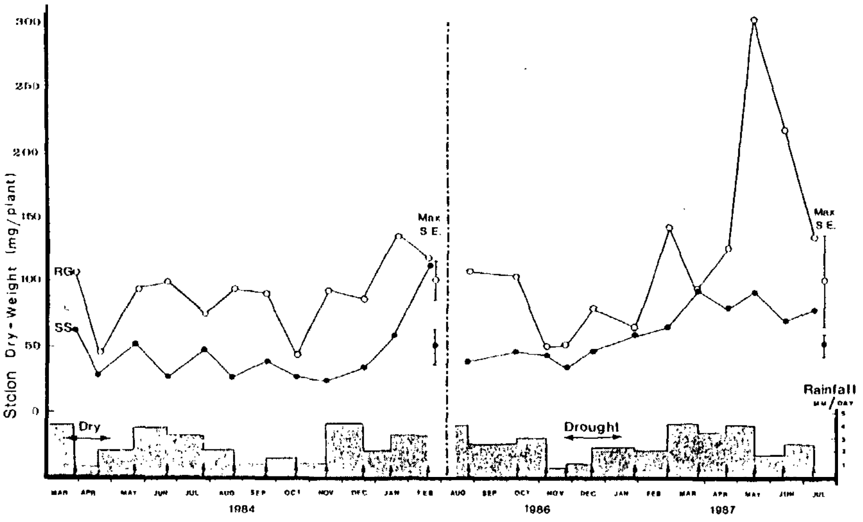

Figure 3: Seasonal variation in mean stolon dry weight per plant under RG and SS grazing managements and mean dally rainfall of each sampling Interval.

As small plant size in many plant communities decreases survival and productivity (Harper 1977), it is possible that conditions during spring, when plant weight and branching structure are at a minimum, or later as plants are tending to increase in size, are crucial for the subsequent presence of white clover in swards. For instance in Canterbury, dry winter-spring conditions at Lincoln in 1984 drastically altered the vertical distribution of stolons and reduced stolon mass by 70% (Hay et al. 1987) and two years of successive spring droughts at Kirwee reduced stolon mass to 30% of original values (Vartha & Hoglund 1983). Thus a factor underlying some of the often noted dramatic and unexplained declines in white clover content in swards (Frame & Newbould 1986) could be that the simpler structure of plants in spring exaggerates the negative effects on population size of adverse conditions occurring during this period.

However, there were differences in the response of white clover plants in the different management systems to the contrast in weather patterns between years. Overall FIG plants were twice the weight of SS plants, but periods of stress caused RG plants to reduce in weight to levels comparable with those of SS plants, i.e. in spring during the normal cycle of decay and break up and during periods of moisture stress (April year 1, December-January year 2). Once favourable growth conditions returned, RG plants rapidly increased (recovered) in weight. In contrast under SS management mean stolon DW/plant generally had a more stable pattern (Fig. 3).

A more stable white clover presence under SS management was also found in measurements of stolon biomass in adjacent paddocks taken before (December 1986) and after (February 1987) the early summer drought. Here, RG stolon biomass reduced from 185 to 90 kg/ha whereas SS biomass was not affected (260 and 275 kg/ha respectively). Increased stability of white clover in SS swards was again indicated in that although the minimum plant weight and branching complexity under both managements occurred in spring (Figs. 1 and 3), the extent of this effect for both characters was much greater in RG than in SS swards (Figs. 2 and 3). These facts all indicate that under SS compared with RG, plants have a more limited capacity to exploit favourable conditions, but on the other hand enhanced stability during stress periods, Although grazing management had a large effect on size (DW) of plants, it had little effect on plant structure. Numbers of growing points, leaves and axillary buds per plant were similar (Brock et *al.* 1988) as were the branching patterns of the two populations, which is a result consistent with the findings of Chapman (1983). Thus the mechanisms responsible for the differences in stability of RG and SS populations when stressed are unlikely to be associated with branching structure and are not necessarily associated with the difference in plant weight. Possibly of more importance are other factors associated with management, such as effects of the open (RG) and dense (SS) swards on plant microenvironment and/or differences in the physiological responses to stress of plants conditioned by different defoliation patterns (Brock et *al.* 1981).

CONCLUSIONS

RG management enables greater expression of the potential for growth of white clover, but increases susceptibility to environmental stress, such as drought. In contrast SS management reduces the potential for growth but enhances stability during stress periods. Where spring early summer rainfall is unreliable SS rather than RG management will favour retention of white clover in the sward. Many studies (Frame & Newbould 1986) report similar increased size of the components of white clover in RG compared with SS swards, thus the finding that the system of grazing management had little effect on the branching structure of plants could apply to clover in swards grown across a wide range of environments.

Because the pattern of seasonal plant changes described is matched by previously reported seasonal variations in stolon mass, its vertical distribution and morphology at this and other sites (Hay *eta/.* 1983, Hay *et al.* 1987), similar seasonal patterns of change in plant weight and branching complexity probably also occur in the white clover populations of grazed swards throughout the country.

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