EFFECTS OF ROTATIONAL GRAZING AND SET STOCKING ON PASTURE PRODUCTION UNDER SHEEP GRAZING

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ABSTRACT

An experiment at Ruakura Agricultural Research Centre evaluated the effect of rotational grazing, set stocking all year round and combinations of set stocking in different seasons and rotational grazing over the remainder of the year on annual and seasonal pasture production over a 3 year period.

The adoption of different grazing management strategies resulted in major changes in total annual pasture productivity and its seasonal distribution. In the first year, the annual pasture productivity of the rotational grazing and set stocking in spring and autumn treatments was about 18-20% higher than other set-stocked treatments. After 3 years, controlled set stocking in spring with rotational grazing for the remainder of the year proved to be far more productive than set stocking or rotational grazing alone. Spring set stocking followed by rotational grazing gave a 15 and 31% higher annual production and 20 and 9% higher summer and autumn production than set stocking or rotational grazing respectively in the third year of the experiment. This finding supports the widespread practice of set stocking over the lambing period.

Grazing management strategies had significant effects on the number of rooting white clover nodes. Continual all year round rotational grazing without development of rank growth resulted in a significant and steady drop in the number of rooting nodes of white clover. This may explain the sudden decrease in total annual dry matter production in the third year under rotational grazing.

Additional Key Words: ryegrass, white clover, tillers, rooting nodes

INTRODUCTION

Despite the normal practice of set stocking pastures on many farms, its effect on sward growth and productivity is poorly understood. In particular, the difference between continuously stocked swards and rotationally grazed swards has never been studied over long periods. On dense, intensively grazed swards, Koblet (1979) found that because of a high radiation efficiency, swards can obtain daily growth rates close to a maximum with a leaf area index (LAI) of 2 to 3. On set stocked swards, this may be obtained at relatively low sward height. Thus it has been suggested that the highest rates of production might be achieved under a continuous set stocking regime that maintains the LAI near an optimum value which corresponds to the point of complete radiation interception by the canopy (Alcock, 1964). Under rotational grazing, light interception is not complete until LAIs of 4 to 5 are reached and consequently not all incident radiation is used in photosynthesis. In addition, rotational grazing may lead to substantial reductions in tiller numbers.

Farm advisers are currently advocating rotational grazing on sheep and beef farms and are claiming that it allows improved per head performance at existing stocking rates or that stocking rates can be increased without an associated decline in per head production (Smith *et al.*, 1979, CGS newsletters). On a farm the main benefit of rotational grazing is better control over the feed supply compared with loosely controlled set stocking. Experimental comparisons of set stocking and rotational grazing have failed to demonstrate the superiority of either method (Wheeler, 1962), because of confounding with fixed stocking rates and/or rotation lengths.

The objectives of the present study were to compare firstly net pasture growth rates under the two contrasting systems of management: continuous set stocking at a level necessary for maximum growth rates and rotational grazing and secondly to investigate if the strategic use of set stocking may have advantages in changing the seasonal distribution of dry matter productivity.

This paper presents the initial results of direct interest to advisers for the first 3 years of the continuing experiment.

EXPERIMENTAL

Site

The trial was conducted at Ruakura Agricultural Research Centre from October 1980 to August 1983 on two soil types: Kaipaki shallow peaty loam and a Hamilton clay loam. The climate is warm temperate with a mean annual rainfall of 1650 mm. Rainfall data are presented in Fig. 1. The site was of high fertility, having been topdressed annually, with 375 kg/ha potassic superphosphate over many years preceding the trial. The pasture consisted of perennial ryegrass (mainly 'Grasslands Nui') and white clover ('Grasslands Huia'), in which Poa species were present during winter-spring.

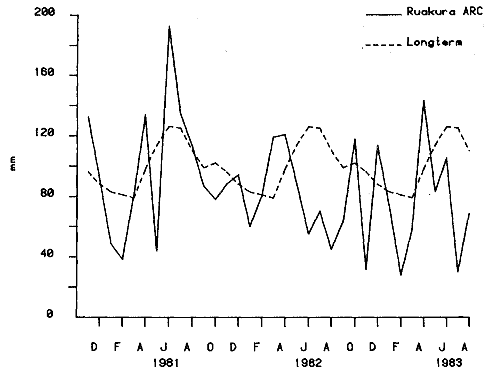

Figure 1: Monthly rainfall over the trial period compared with long term monthly averages (Ruakura ARC: 1905-80).

Design

The layout used was a randomized block design of 36 paddocks (0.13 ha) with four replicates on each soil type.

Grazing managements were:

1. Rotational grazing from 2800 kg/ha standing dry matter before grazing to 1200 kg DM/ha after grazing.
2. Set stocking in spring and rotational grazing in other seasons.
3. Set stocking in spring and autumn with rotational grazing in other seasons.
4. Set stocking in spring, summer and autumn and rotational grazing in winter.
5. Set stocking at a canopy level of 1000-2000 kg DM/ha all year round.

The spring, summer, autumn, and winter changeover dates from set stocking to rotational grazing were 1 December, 1 March, 1 June and 1 September.

Management

a. Rotational grazing

Pre- and post-grazing standing DM levels for treatments 3, 4 and 5 were similar to treatment 1, when they were rotationally grazed.

Rotationally grazed paddocks were grazed with ewes for 24-28 hour periods.

Sheep were placed on and removed as closely as possible according to the management criteria, the number of stock being adjusted proportional to the level of standing DM and intensity of grazing required.

b. Set stocking

In set stocked paddocks, the number of stock was regularly adjusted to maintain the standing levels of dry matter between 1000 and 1200 kg DM/ha throughout the year.

Measurements

Visual assessments of total herbage mass before and after grazing under rotational grazing were made in all paddocks.

Under set stocking pasture growth was measured with four cages in each paddock. Cages were replaced every 2-4 weeks depending on season and pasture production was equated to the difference between the inside cage visual assessment and the previous visual assessment of standing DM outside the cages.

Analyses

a. Calibration of visual estimates

Linear regressions between cuts and visual scores were determined at each assessment. They were based on quadrats chosen to represent the range in standing dry matter present over the trial area.

b. Pasture accumulation rates

Rates were calculated separately for each paddock by forming a record of cumulative accumulation and then using linear interpolation to get an estimate of average accumulation rate for each month from November 1980 to August 1983. Rates during grazing in rotational phases are the average for the periods before and after grazing. Rates plotted in figures have been averaged for each treatment over sites and replicates.

c. Tillers

The tiller populations of individual treatments were measured 15 times during the trial. Ten to twenty tiller cores (5 cm diameter) were taken from each paddock. Dead and live tillers were noted for ryegrass and Poa and the number of rooting white clover nodes was recorded.

RESULTS

Calibration of Visual Estimates

R^2 values varied from 0.8 to 0.9 and residual standard deviation values averaged about 250 kg DM/ha. Errors calculated for herbage mass are based on differences between paddock values which include contributions from both real differences between paddock means and measurement errors including those in visual estimates.

TABLE 1: Effect of grazing management on annual production (kg DM/ha).

	Year 1 Nov 80 – Aug 81	Year 2 Sep 81 – Aug 82	Year 3 Sep 82 – Aug 83
Rotational grazing	10 680	12 360	10 710
SS* spring	10 110	12 920	14 030
SS spring + autumn	10 520	11 660	13 370
SS spring + summer + autumn	8 680	11 100	12 950
SS all year	8 600	10 260	12 210
S.E.D.	630	627	589

*SS = set stocking

Total Annual Herbage Accumulation

Total sward yields for each year are presented in Table 1.

In the first year, rotational grazing and set stocking in spring and set stocking in spring and autumn outproduced the other set stocked treatments. In the second year, there was also no difference between set stocking in spring and rotational grazing, while the latter two treatments outproduced set stocking by at least 2000 kg DM/ha (21%). However, in the third year, set stocking in spring outproduced rotational grazing by 3320 kg DM/ha (31%), while set stocking all year round yielded 1500 kg DM/ha higher production than all year round rotational grazing.

Seasonal Distribution of Dry Matter Production

The seasonal distribution of yields for each treatment since the start of the trial is presented in Fig. 2.

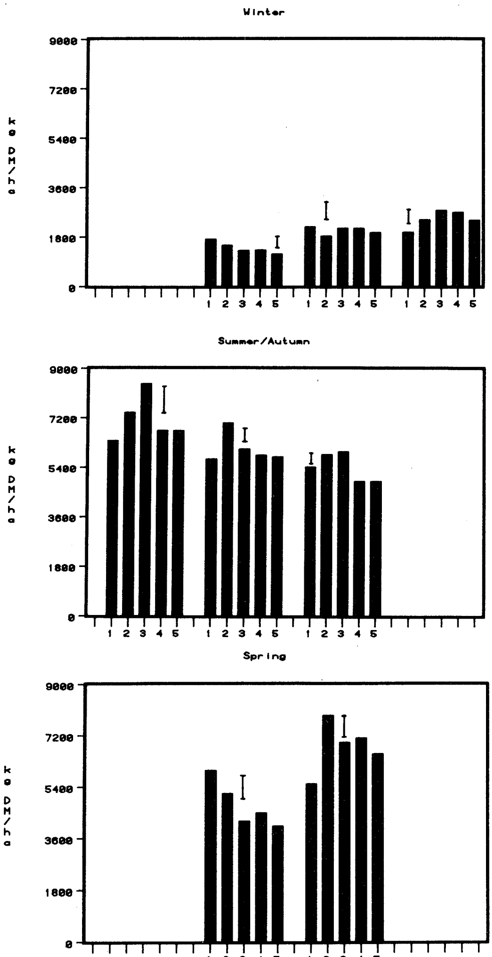

Figure 2: Seasonal production of grazing management treatments.
1 — Rotational grazing
2 — SS* spring
3 — SS spring + autumn
4 — SS spring + summer + autumn
5 — SS all year
***SS = set stocking. I — LSD (5%).**

a. Spring

In the second year, treatment 1 (RG) gave 810 kg/ha more than treatment 2 (SS Sp), while outproducing the other treatments by at least 1500 kg DM/ha. In the third year, however, treatment 2 (SS Sp) yielded 3400 kg DM/ha more than rotational grazing while outyielding the other set stocked treatments by at least 750 kg DM/ha.

b. Summer-autumn

Treatment 2 (SS Sp) or treatment 3 (SS Sp + Au) gave 1400 kg DM/ha and 2000 kg DM/ha more than treatment 1 (RG) the first year. The same difference was recorded for treatment 2 (SS Sp) in the second year while the advantage to treatment 3 (SS Sp + Au) was only 300 kg DM/ha. In the third year, summer-autumn production was again higher for the set stocked treatments (2 and 3), but the differences only amounted to about 500 kg DM/ha.

c. Winter

In the first year, treatment 1 (RG) had the highest yield of all treatments however, in the third year, treatments 3 (SS Sp + Au) and 4 (SS Sp + Su + Au) yielded at least 19% higher than treatment 1 (RG).

Number of Rooting Nodes of White Clover

The number of nodes decreased in all treatments in the first summer (Fig. 3). Thereafter numbers in treatment 1 (RG) were lower than other treatments on most occasions. Treatment 5 (SS all year) had the highest number of nodes on most occasions.

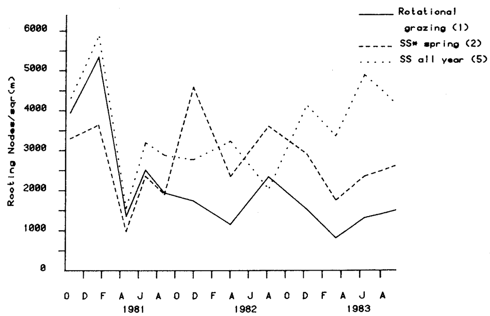

Figure 3: Seasonal trends in the number of rooting nodes of white clover.

DISCUSSION

This experiment showed that in conditions where feed is used efficiently and standing dry matter levels are carefully controlled, strategic set stocking results in considerable changes in tiller numbers and dry matter production. This finding is in direct contradiction with the conclusion by Ernst *et al.* (1980) that annual herbage accumulation is relatively insensitive to variations in grazing management and stocking rate within the range likely to be of practical significance. The introduction of different managements also lead to an immediate change in seasonal distribution of pasture production. Over time, significant changes in tiller numbers also occurred and this explains the significantly higher growth rates in spring 1982 in the set stocked treatments. Clearly, grazed swards are dynamic and can change rapidly under different grazing managements.

All year round rotational grazing resulted in a significant and steady drop in the number of rooting nodes of white clover. It is suggested that this may explain the sudden decrease in total annual dry matter production in the third year of the experiment. We postulate that decreased clover growth reduced nitrogen fixation and hence pasture growth. An additional factor is less stable pasture performance with an open sward type and lower tiller densities in the event of soil moisture stress or other factors causing tiller death.

Set stocking during spring will maintain higher tiller densities and therefore increase summer-autumn production considerably in years with sufficient summer-autumn rainfall. However, when rainfall is well below average as in 1983 when February-March rainfall was 75 mm lower than average, the difference was only 500 kg DM/ha.

The above practices can be applied to different areas within the farm each year e.g. to allow better clover performance and productivity. Thus management options on a farm may have to be reconsidered and modified as this experiment has shown that grazing management strategies can lead to considerable changes in dry matter production. The final application of these principles awaits incorporation and further developments in the construction of packages for paddock shifts on microcomputers that can be readily applied and understood by farmers with full consideration of differences in farm layout and subdivision.

CONCLUSIONS

This paper suggests management options which will improve pasture production at critical times of the year. Controlled set stocking in spring or spring and autumn can improve both spring and summer/autumn production. Continual all year round rotational grazing finally leads to a decrease in annual dry matter productivity probably because of diminishing clover content.

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