HERBAGE ACCUMULATION PATTERNS OF PASTURES AT VARIOUS SITES IN NORTHLAND

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ABSTRACT

Pasture regrowth was monitored to assist the development of computer models of pasture growth prediction. Sequential regrowth curves were collected over eight week periods for 26 months from September 1984 at four sites in Northland, and nitrogen responses were measured separately at these and four other sites. Regrowth was measured from low levels of initial dry matter yield. The sites had ryegrass or kikuyu grass-based pastures. The shape of most curves was nearly linear. The calculated daily growth rates differed almost as much between sites within seasons as between seasons within sites, and the use of nitrogen fertiliser only slightly decreased the variation between sites.

Additional Key Words: pasture production, stubble, regrowth curves, nitrogen response, ryegrass, kikuyu grass, white clover, computer simulation.

INTRODUCTION

The use of computer models to predict pasture growth has become a reality. In Northland, the GRASS model (Baars and Rollo, 1987) is starting to be used by farmers and their consultants for a variety of farm management analyses. Pasture growth patterns in Northland conform with the general principles on which the GRASS model is based (Piggot *et al.*, 1986), but fine tuning to provide more valid output appears necessary, particularly with reference to species' effects, seasonal differences, shapes of the curves, and 'potential' growth rates. Relevant regional data is needed which is synchronised and charts pasture regrowth patterns at a variety of sites in a normal range of seasons. The provision of such data was the main purpose of the study reported here. This paper also reports the regrowth pattern of pastures from low residues to clarify the importance of the lag or exponential growth phase, since our preliminary work (Piggot *et al.*, 1986), cast doubt on the significance of the sigmoidal growth curve theory (Brougham, 1959). In addition, it was hoped that periods of exceptionally high growth could be 'captured' to indicate the limits of pasture growth in the region.

MATERIALS AND METHODS

This study was a re-designed continuation of the 1983/84 work of Piggot *et al.* (1986) and was conducted from September 1984 to November 1986 in two parts;

Growth Curves

The four sites were at Kaikohe (on Wairoro clay loam similar to Whakapara soils), Kamo (Waipapa clay), Dargaville (Te Kopuru sand), and Kumeu (Otonga peaty loam). The pastures were of temperate species except for Dargaville, which was a mixed kikuyu grass-temperate species association, and all pastures were in excess of eight years old. The Kaikohe site had been sown as a 'Grasslands Nui and Pitau' mixture, while at the other sites the component species were apparently volunteers. All sites were grazed rotationally by sheep, although at Dargaville and Kamo, cattle were occasionally grazed in spring and summer to control rank growth. Growth curves were monitored by caging paired areas fortnightly and sampling within each cage fortnightly for eight weeks, although cages were not re-sited in the fortnight about late July in both years. Thus, at any one time, four regrowth curves were being sampled and one new one established. At Kumeu all cages were briefly removed in early March each year. Sites for caging were pre-trimmed by rotary lawn mower to the point of scalping two weeks before siting and again at siting. Also, rank growth around the trial site was trimmed occasionally where necessary. Sample cutting was by hand shears in a 0.25 m^2 quadrat to the original trim height. In one cage of each pair, and on each new site, a sample of stubble yield was cut below the trim height each fortnight. The stubble samples were cut with a 0.1 m^2 quadrat by shearing handpiece to the level of the ryegrass crowns or unrooted stolons of white clover or kikuyu grass. This meant that sampling was below ground level when the soil was wet (because of soil swelling consequent on the high organic matter and clay content of the soils). Stubble samples were washed free of soil prior to the standardised drying (at 90 °C for 18 hours). Duplicate soil samples (0-15 cm) were taken fortnightly for moisture content determination.

Nitrogen Response/Site Differences

The nitrogen (N) response was monitored on the four growth curve sites plus one north aspect site at Kamo (on Purua clay loam), and three additional sites at Dargaville; these sites included the 'kikuyu grass' and 'ryegrass' sites measured during the 1983/84 year (of Piggot *et al.* 1986), and a northern aspect site with kikuyu grass-based pasture. On five dates per year a trimmed site (pre-trimmed a fortnight previously) was caged with six cages, three receiving N and three not. The dates were those used in 1983/84; from about 12 September, 6 November, 15 January, 26 March, 19 June. Nitrogen was applied as urea at 100 kg N/ha equivalent except for 50 kg N/ha in the third period (summer). Samples for DM yield were cut after four and eight weeks except for period 5 (6 and 12 weeks), and the second cut was taken at 10 weeks for period 2. A sample for botanical species analysis (by DM dissection) was sub-sampled from the −N cages at the first cut in each period. Stubble samples were taken from one cage each of the −N and +N treatments at each sampling.

Each operator conducted all cuts at each site, although the Kamo operator took over the Kaikohe site from May 1986. Soil tests at each site indicated adequate pH, phosphorus, and potassium status and all sites received at least 0.5 t/ha of 30% potassic superphosphate per year. Pest control consisted of maldison-based black field cricket bait applied in February at 20 kg/ha. Climatic data were available from adjacent sites of the New Zealand Meteorological Service except at Kamo where rainfall, soil 10 cm temperature, and air maximum/minimum temperatures were recorded daily.

RESULTS

Herbage accumulation curves, stubble yields, average daily herbage accumulation (averaged over all caged areas), soil temperatures, soil moistures, and rainfall patterns are shown for the Kaikohe results of 1985/86 in Figure 1. Similar curves for all sites in both years are available on request. As a test of the importance of the lag phase, a regression of growth rate over each fortnight on starting DM yield was calculated (207 fortnights). Positive regression coefficients (averaging $+ 0.028 \pm 0.013$) were recorded as statistically significant ($P<0.05$) in 32 fortnights. These positive coefficients mostly occurred in spring. Statistically significant negative coefficients were recorded in 13 fortnights (averaging -0.022 ± 0.007) and appeared to coincide with herbage decomposition periods. When the curves were tested for linearity, only 37 of 203 curves had a statistically significant quadratic component indicating curvature, and of those, 22 had an apparent sigmoid or exponential shape.

The stubble yields showed a strong seasonal pattern, highest in summer and lowest in winter. There was a trend for stubble yield to be lower at the higher DM yield, although this effect was not statistically significant. Stubble yield was slightly but non-significantly higher in −N compared with +N cages. Growth rates (or herbage accumulation rates) in excess of 100 kg DM/ha/day occurred during some fortnights at all sites, but in most cases were restricted to one fortnight only. The annual yields, calculated from the averaged growth rates for the two years (as t DM/ha excluding stubble variation) were; Kaikohe, 24.7 and 21.5; Kamo, 16.1 and 15.5; Dargaville, 16.2 and 23.5; Kumeu, 18.5 and 18.0 (being an underestimate because of the lost days in March of each year).

The differences in pasture growth between sites were very large (Fig. 2). Without N the standard deviation of

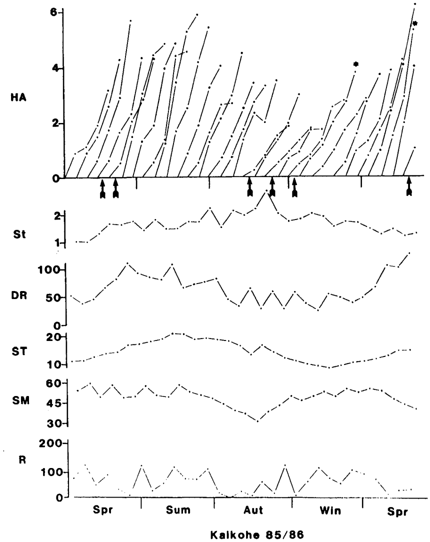

Figure 1: The annual pattern of data from the Kaikohe site in 1985/86.

Key:
HA — Herbage accumulation (t DM/ha)
St — Stubble yield (t DM/ha)
DR — Average daily growth (kg DM/ha)
ST — Soil temperature at 10 cm (oC)
SM — Gravimetric soil moisture (%)
R — Fortnightly rainfall (mm)
Asterisks denote curves with a statistically significant quadratic component (at $P<5\%$).
Arrows denote these fortnights with a statistically significant positive regression coefficient for the regressing of growth rate on standing DM.

daily yields between sites averaged 44% of the mean per season yield, while the use of N only slightly decreased this variation (to 41%). The standard deviation of the all-site means compared across the 11 seasons was close to the site-within-seasons value; it was 49%. In other words, the growth rates differed almost as much between sites within seasons as between seasons within sites. One source of this variation was botanical composition; Fig. 3 gives the pattern of species composition for the four main sites, the full data are available on request.

DISCUSSION

The finding that regrowth recovery from severe trimming does not always exhibit a marked lag or exponential phase in Northland pastures is important. Despite the artificial defoliation technique, it firstly indicates that computer models should allow for fine tuning to adapt to such regional information. Secondly, it implies that pasture regrowth in Northland could be regularly

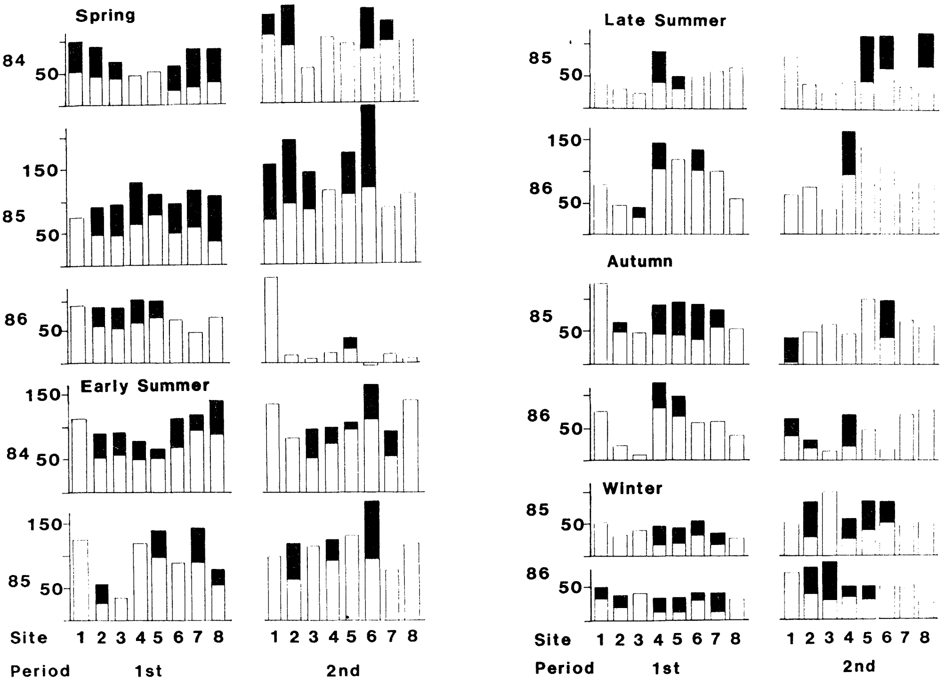

Figure 2: **Site differences in average daily growth rate (kg DM/ha) for two sequential cutting periods.**
Key: **Blacked areas denote the size of any statistically significant (P<5%) nitrogen response.**
The 8 sites in order are Kaikohe, Kamo, Kamo-hill, Dargaville, Dargaville-hill, Dargaville-kikuyu, Dargaville-ryegrass, Kumeu.

unresponsive to grazing severity (in the absence of hoof or pugging damage). Such a conclusion is supported by recent reviews and grazing experiments conducted elsewhere in New Zealand (Bryant and Sheath, 1987; L'Huillier, 1987).

The "near linearity" of the growth curves measured in this work should not, however, be seen as in conflict with the sigmoidal or logistic regrowth theories developed out of the work on ryegrass pastures by Brougham (e.g. Brougham, 1959), or on kikuyu grass by Colman and O'Neill (1978). The pastures of those studies were much less varied in composition providing much clearer growth curves and better defined potential growth rates. Also my work had relatively fewer data points on each curve or during each fortnight meaning that statistical analysis had a higher chance of recording non-significant results. Hence, the computer models based on logistic growth curves are valid when used in Northland provided fine tuning can limit the influence of the exponential phase. The design of the GRASS model allows for growth curve parameters to be changed (Baars and Rollo, 1987). Few "ceiling yields" were reached over the eight weeks recorded in this study supporting the conclusion from the previous Northland work (Piggot *et al.*, 1986), that ceiling yield is not a factor of major significance in current pastoral farming practice.

Very high fortnightly growth rates were again recorded in this work, but unlike the preliminary study of Piggot *et al.* (1986), the trial technique was more appropriate for studying these phenomena and it was clear that these were sporadic and isolated events. The prediction of such high rates appears unlikely with our current knowledge since presumably fortuitous soil, climatic and plant physiological events coincide. Farm management can only respond to, not await, such events.

The very large quantitative differences in growth between sites within seasons (Fig. 2) was unexpected. Since the N trials were primarily conducted to provide continuity with the previous work, any reasons for the site differences cannot be supported by good biological data. They will be used to support the next stage of this research programme which involves the testing of the GRASS model against real data and the tuning of the software to provide farmers with valid pasture growth diagnoses. Such work is currently in progress.

ACKNOWLEDGEMENTS

Dr J.A. Baars and Dr J.E. Waller assisted with design, while C.A. Farrell, D.G. Fraser, H.M. Morgan and W.B.

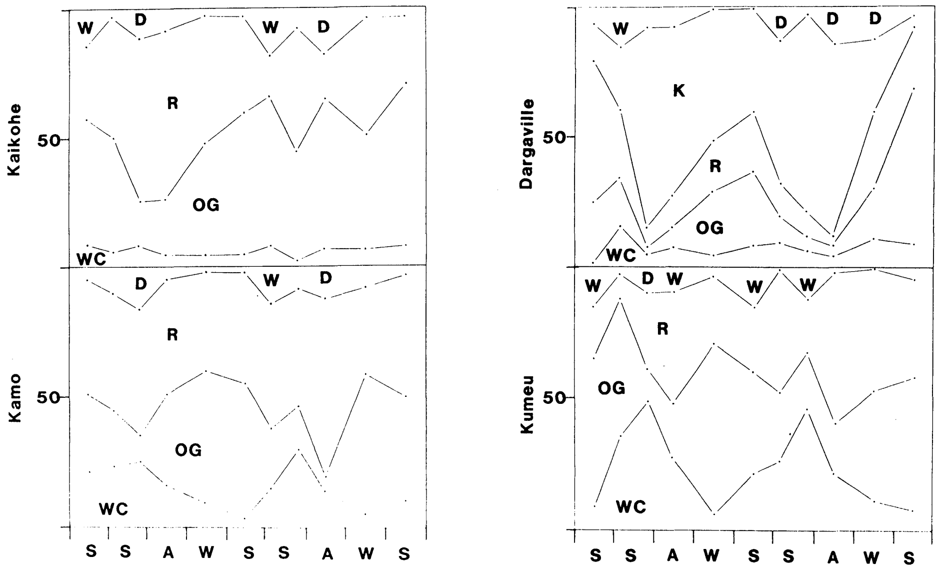

Figure 3: The composition (as % of DM) of pastures during the trial period from spring 1984 at four sites.
Key: **WC — White clover**
OG — Other grasses
R — Ryegrass
K — Kikuyu grass
W or D — Weed or Dead matter if the primary component of the balance.

McMeikan conducted the field work, and Mrs D.J. Woolley and Mrs J.F.C. Whiting conducted the laboratory analyses.

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