THE EFFECTS OF CLOSING AND CUTTING DATES ON THE YIELD AND NUTRITIVE VALUE OF PASTURE FOR CONSERVATION

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ABSTRACT

Changes in the yield and nutritive value of ryegrass/clover pasture were measured following closing at three dates in spring 1980. Times of closing for treatments 1, 2 and 3, respectively, were 30 September, 21 October and 12 November following the application of 150 kg N/ha on 25 September to ensure that nitrogen supply did not constitute a major constraint on growth. Six weeks after closing, the dry matter and digestible dry matter yields (kg/ha) and dry matter digestibility, respectively, for the three treatments were (1) 6808, 4693, 69.0%; (2) 4650, 3075, 66.1%; (3) 2766, 1912, 69.4%. Compared with the earliest closed pasture, the dry matter and digestible dry matter yields declined considerably when the closing date was delayed until after the start of stem elongation (treatment 2) and the digestibility of the herbage was also decreased. In treatment 3, 65-70% of the reproductive tiller meristems were removed at closing and although the ensuing vegetative growth retained relatively high digestibility, the yield was considerably less than in the first two treatments.

INTRODUCTION

Conservation is the principal means by which farmers meet seasonal deficits in feed supply which occur during summer-autumn droughts and in winter. In 1976-77, 496,000 ha of hay and 83,000 ha of silage were made, making pasture for conservation the most widely grown crop in New Zealand. It is therefore important to understand the physiological changes which occur during uninterrupted pasture growth in spring and early summer.

Regrowth of pasture following grazing or cutting follows a sigmoidal pattern with a lag of 5-8 days before the attainment of high growth rates (e.g. Brougham, 1959). This means that uninterrupted growth for 6-7 weeks usually results in a considerably higher total yield than obtained by repeated defoliation over the same period. In spring, grass growth rates are maximal as a result of favourable environmental conditions and the fact that a physiologically determined increase in growth rate and related processes accompanies reproductive development (Anslow and Green, 1967; Parsons and Robson, 1981). While reproductive development leads to rapid accumulation of dry matter, the production of the stems and flower heads brings a decline in the nutritive value of the crop (Alberda and de Wit, 1961; Green *et al.*, 1971).

In this paper we report the results from the first year of a trial to determine the changes in yield, digestibility and nitrogen content of a mixed ryegrass/clover pasture during uninterrupted growth following closing at different dates in spring. The changes observed are related to the altering proportions of stem and leaf material in the crop which are affected by the stage of reproductive development of the ryegrass at the time of closing.

MATERIALS AND METHODS

The experiment was carried out on an established ryegrass/clover pasture oversown in 1978 with 5kg/ha Grasslands Ruanui perennial ryegrass and growing in a mole and tile drained Tokomaru silt loam fragiaqualf at the DSIR Tiritea Research Area, Palmerston North. The area used was grazed by sheep until 15.9.80 and to ensure that nitrogen supply was not a constraint on growth, 150 kg N/ha as urea was applied to all treatments on 25.8.80. Four replicate plots (20 x 8 m) for each of three closing dates (treatments 1, 2 and 3) were arranged in a randomised block design. The pasture was cut to 7.5 cm on 30.9.80 (all treatments), 21.10.80 (treatments 2 and 3) and 12.11.80 (treatment 3) and the cut material removed. The closing date of each treatment was taken as the last day on which it was mown. At each sampling time during the subsequent uninterrupted growth, six randomly selected quadrats (1 x 0.5 m) were taken from each plot using a shearing handpiece to remove material above 3 cm. The fresh weight harvested from each quadrat was measured and the material from each plot then combined. One sample (100 g) was taken from the bulked material for herbage analysis and a second (250 g) dried in a vacuum oven at 40°C, weighed and ground to pass a 1 mm screen prior to chemical analyses.

Digestibility was assessed by the method of Roughan and Holland (1977). Briefly, this method uses the extent of solubilisation of the material following treatment with neutral detergent and *Trichoderma reesei* cellulase to predict *in vivo* dry matter digestibility using a correlation (r = 0.98) based on samples of known *in vivo* dry matter digestibility. Nitrogen content was measured using a

TABLE 1: Monthly weather data for Palmerston North during the trial period compared with the long term mean values.

Month	Rainfall (mm)		Grass minimum temperature (°C)		Accumulated air temperature degree days (base 5 °C)	
	1980/81	Mean	1980/81	Mean	1980/81	Mean
October	130	89	7.1	4.8	267	229
November	146	79	7.7	6.4	248	276
December	55	104	9.2	8.1	340	341
January	16	84	11.8	9.0	435	378

modified micro-Kjeldahl method (Haslemore and Roughan, 1976).

The extent of first ear emergence and the density of reproductive ryegrass tillers in the sward were assessed from herbage analysis data and also from twice weekly counts of two fixed quadrats (0.2 x 0.3 m) located within each treatment. Loss of apical meristems caused by mowing at each closing date was estimated by counting the meristems recovered in samples of cut material from a measured area.

Weather data was collected by Grasslands Division at the DSIR campus 4 km from the experimental site. Degree days accumulated during each month were calculated from the average of the monthly mean maximum and minimum temperatures using a 5 °C base. A comparison of rainfall, degree day accumulation and grass minimum temperatures between the months of this trial and the long term means is included in Table 1. Higher than usual rainfall was recorded in October and November but December and January were both exceptionally dry. It is likely that growth in treatment 3 would have been depressed towards the end of the trial by the dry conditions. Monthly average grass minimum temperatures were consistently higher than the long term means but the monthly air temperature degree day accumulation data show values higher than the norm only in October and January.

RESULTS AND DISCUSSION

Herbage composition is summarised in Table 2. Perennial ryegrass was the dominant species in the sward, usually making up more than 80% of the herbage. Other grasses (mainly *Poa* spp.) accounted for about 10% of the total after 3 weeks growth but declined in importance as the sward developed. Clover was a minor component of the herbage in Treatments 1 and 2, but in treatment 3 it increased to 9.5% of the total by 60 days. The amount of dead material in the sward increased steadily during each growth period.

Changes in the dry matter (DM) yield, digestibility and digestible dry matter (DDM) yield with time after closing are shown for each treatment in Fig. 1 together with changes in the proportions of ryegrass leaf, ryegrass stem and dead material in the herbage. Curves were fitted to the DM and DDM data using polynomial regression and digestibility data were analysed by linear regression.

TABLE 2: Summary of herbage analysis data of ryegrass/clover pastures at different stages of uninterrupted growth following closing on three dates. Data are as a percentage of total dry weight.

Closing date		Approximate time after closing 21 days	40 days	60 days
30.9.80	*Lolium perenne*	83.6	89.9	90.8
	Other grasses	12.0	5.0	0.9
	Trifolium spp.	3.3	0.6	1.7
	Dead material	1.1	4.5	6.5
21.10.80	*Lolium perenne*	87.3	86.1	87.1
	Other grasses	6.4	5.8	1.2
	Trifolium spp.	2.1	3.0	1.9
	Dead material	4.2	5.1	9.8
21.10.80	*Lolium perenne*	80.4	73.4	74.0
	Other grasses	9.3	9.0	2.7
	Trifolium spp.	3.3	9.3	9.5
	Dead material	7.0	8.3	13.8

Differences in DM and DDM yields among treatments were significant ($p < 0.05$) throughout the measured period. Values derived from the fitted equations are quoted with the corresponding standard error.

The DM yield in each treatment increased rapidly from 20 to 50 days after closing but the rate of increase had declined considerably by day 65. The growth rate fell markedly as closing date was delayed. At 30 days after closing the rates were 182 ± 12, 137 ± 13 and 83 ± 12 kg/ha/day for treatments 1,2 and 3, respectively. Harvests from treatment 3 consistently produced less than half the dry weight of comparable harvests from treatment 1.

The digestibility of herbage from all the treatments declined quite rapidly from the first harvest but there are important differences among the curves as a result of the different physiological states of the pasture. In treatment 1,the digestibility was 79.8 ± 1.1% at day 21 and fell at an average rate of 0.55 ± 0.04%/day. In treatment 2, the digestibility at day 21 was only 75.3 ± 0.8% and this was correlated with the higher percentage stem and lower percentage leaf in the herbage compared with the first closing date. The decline in digestibility for treatment 2 (0.52 ± 0.03%/day) was similar to that in treatment 1, so the digestibility remained lower in the second closing treatment throughout the growth period. The digestibility

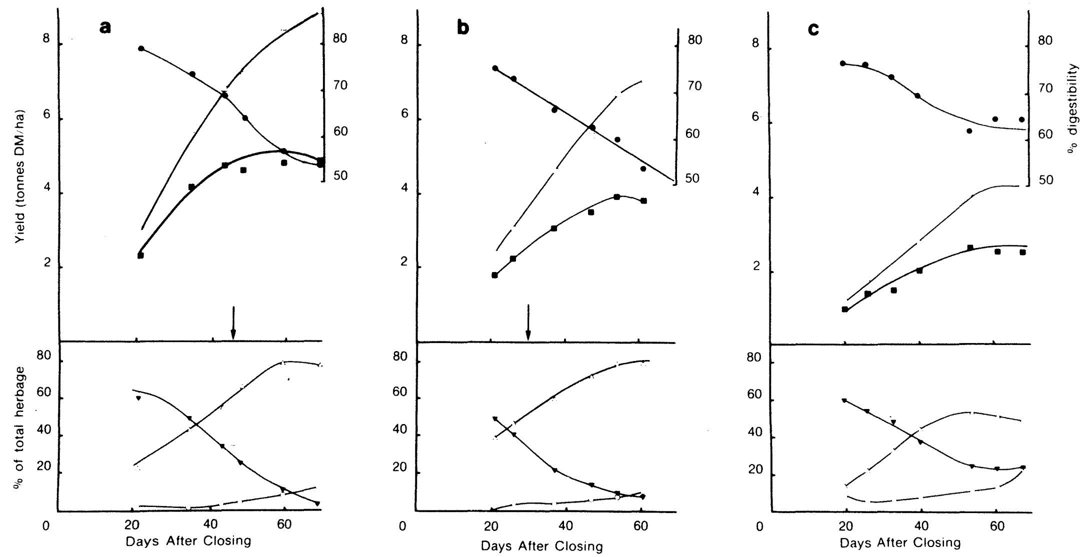

Figure 1: **Changes occurring in ryegrass/clover pastures during uninterrupted growth following closing at three dates in spring. Closing dates were (a) 30.9.80, (b) 21.10.80, (c) 12.11.80. □ Dry matter yield, ● digestibility, ■ digestible dry matter yield, △ *Lolium* stem, ▼ *Lolium* leaf, o dead matter. Arrows show the times of 50% ear emergence in treatments 1 and 2.**

in treatment 3 was generally similar to treatment 1 up to day 45, but levelled off at 63.2 ± 0.9% during the later stages of the experiment because of the higher proportions of ryegrass leaf and clover in the sward compared with treatments 1 and 2. This meant that the average rate of decline in digestibility (0.38 ± 0.03%/day) was considerably lower than in treatments 1 and 2. The effect that the proportions of stem and leaf in the herbage had on digestibility is demonstrated more clearly in Fig. 2 where the digestibility for all harvests is plotted against the percentage of ryegrass dry weight present as stems. The strong relationship shown indicates that stem development is the major direct cause of the decline in digestibility observed in all treatments. The fact that the digestibilities of the last three harvests of treatment 3 fall below the curve in Fig. 2 may be due to the accumulation of dead material after prolonged growth (Table 1).

The DDM yields calculated from DM and digestibility data plateau more quickly than the corresponding DM curves. This was most marked in treatment 1 which reached a maximum value after only 40 days. Nevertheless, the peak DDM yield for treatment 1 (4.8 ± 0.26 t/ha) was considerably higher than from treatment 2 (3.9 ± 0.13 t/ha) or treatment 3 (2.6 ± 0.13 t/ha).

The differences with time and between treatments shown in Fig. 1 may be interpreted in terms of the pasture response to closing at the three dates used in this study. Data on the progress of flowering and the balance between flowering and non-flowering ryegrass tillers in the pasture are summarised in Table 3. The pasture contained 3,400

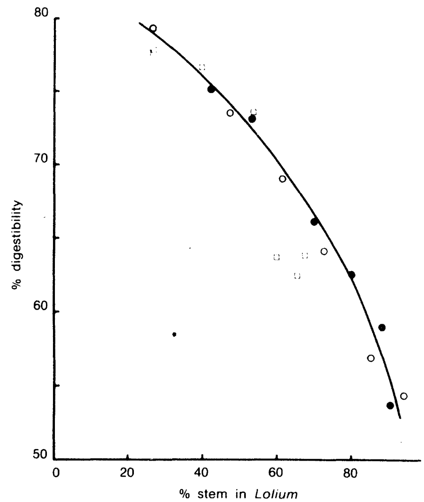

Figure 2: **Correlation between digestibility and the proportion of ryegrass stem in pasture during uninterrupted growth in spring 1980. Data are for closing dates of 30.9.80, ● 21.10.80, □ 12.11.80.**

TABLE 3: Changes in reproductive and vegetative tiller numbers/m² and the timing of 50% emergence for ryegrass in pasture closed on three dates.

	Closing date		
	30.9.80	21.10.80	12.11.80
Meristems lost at closing	0	560 ± 40	2,300 ± 100
Total reproductive tillers at end of treatment	3,400 ± 170	3,260 ± 290	1,000 ± 70
Non reproductive tillers at end of treatment	<200	<200	1,600 ± 300
Days from closing to 50% ear emergence	46 ± 1	30 ± 1	25 ±2
Date of 50% ear emergence	15.11.80	21.11.80	7.12.80

reproductive ryegrass tillers/m² at the beginning of the experiment as assessed by the number of flower heads subsequently measured on treatment 1. Stem elongation had not started by 30.9.80 when treatment 1 was closed. Almost all the tillers present at the end of the growth period in treatment 1 were reproductive and ear emergence followed a sigmoid curve with 50% ear emergence occurring on 15.11.80, 46 days after closing. Delaying closing until 21.10.80 allowed removal of meristems from 15-18% of the tillers but secondary tillering apparently made up this loss since both treatments 1 and 2 achieved the same final density of flowering stems. Fifty percent ear emergence was delayed by only six days (to 21.11.80) by the 21 day delay in closing but the removal of predominantly leaf material from the developing reproductive tillers led to lower leaf and higher stem in the herbage and resulted in the reduced rate of DM accumulation and lower digestibilities in treatment 2 compared to treatment 1. A further 21 day delay in closing date meant that, in treatment 3, 65-70% of the apical meristems were removed at closing and the lower number of secondary tillers subsequently produced were all vegetative. The interruption of reproductive development in treatment 3 is associated with much lower rates of dry matter accumulation than in either treatment 1 or 2. However, the change to vegetative growth caused an increase in the proportion of ryegrass leaf in the herbage, which, together with the higher level of clover, lead to the digestibility in treatment 3 levelling off at 63%.

For herbage of a given species composition, digestibility is strongly correlated to voluntary intake and live weight gain by livestock (Blaxter *et al.*, 1961; Raymond, 1969) and is therefore a useful indicator of feed value of the crop. For this reason it is convenient to compare the status of the three crops at the same digestibility value (Table 4). The 70% digestibility value used in Table 4 corresponds closely to the 65% D-value (organic matter digestibility) used as a basis for comparing different species and cultivars by Green *et al.* (1971) and is slightly less than the 67% D-value recommended by NIAB (e.g. NIAB, 1979) as representing a crop giving a suitable compromise between yield and feed value under U.K. conditions. Whereas treatments 1 and 3 took 42 and 40 days respectively to reach 70% digestibility, the area closed on 21 October took only 32 days. This is a result of the generally lower digestibility of material from treatment 2 which we have already interpreted as being caused by the loss of leaf material from the reproductive tillers at closing without the compensating encouragement of vegetative tillering and clover growth which occurred after the removal of apical meristems in treatment 3. The dry matter and digestible dry matter yields show a sharp drop between the first and second closing dates, with a further decline to the third treatment. The crude protein contents on all the treatments were higher than values reported for pure ryegrass swards of 65% D-value (Green *et al.*, 1971) and would normally meet the nitrogen requirements for productive livestock.

TABLE 4: Status of ryegrass/clover pasture upon reaching 70% digestibility following closing at different dates.

	Closing date		
	30.9.80	21.10.80	12.11.80
Days after closing	42	32	40
Calendar date	11.11.80	23.11.80	22.12.80
DM (tonnes/ha)	6.6	3.8	2.8
DDM (tonnes/ha)	4.6	2.7	2.0
Fraction of *Lolium* as stem	58%	62%	55%
Crude protein (% N x 6.25)	15.8	13.8	11.9

CONCLUSIONS

The yield increase obtained from uninterrupted pasture growth as opposed to continuous or rotational grazing is greater in spring when the grass component changes from vegetative to reproductive growth. However, it is important to recognise the decline in digestibility and feeding value which occur as the flowering stem develops. The rate of decline in digestibility measured in the present study (0.52 - 0.55%/day) are similar to those reported elsewhere (0.48 - 0.50%/day, Minson *et al.*, 1964; Green *et al.*, 1971). The decline in digestibility may be related to the changing morphology of the sward (Fig. 2) or to the timing of ear emergence in the dominant ryegrass component. In treatment 1,70% digestibility was reached 4 days before 50% ear emergence, while in treatment 2 the same value was reached 2 days after 50% ear emergence. Since the relationship between digestibility and ear emergence varies with cultivar (Green *et al.*, 1971), these results only illustrate the general pattern of development which occurs during uninterrupted reproductive growth. The interaction between increasing dry matter and decreasing digestibility means that digestible dry matter becomes the important parameter for assessing the yield of the crop. In treatment 1, for example, dry matter continued to increase after 50% ear emergence, but digestible dry matter remained virtually constant and the quality (digestibility) of the herbage continued to fall.

The preliminary data presented here suggest that pasture closed in late September (treatment 1) will give the highest yield of digestible dry matter and that the digestibility of this herbage will reach 70% after 6 weeks growth at about the time of 50% ear emergence. Closing after stem elongation has started but before many of the apical meristems can be removed by cutting (treatment 2) will cause a drop in both the quantity and digestibility of the resulting herbage. Removal of the apical meristems in mid-November and the return to vegetative growth (treatment 3) will lead to improved digestibility in pasture closed at this time, but the yield will be considerably less than from pasture closed in early spring.

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