EFFECT OF STAGE OF GROWTH AND SEASON ON YIELD OF LUCERNE (MEDICAGO SATIVA L.) AND ON IN VITRO DIGESTIBILITY OF THE WHOLE PLANT AND ITS COMPONENT PARTS

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ABSTRACT

Lucerne was sampled at the early vegetative, mid-vegetative, green-flower bud and 10% flower growth stages during four regrowth periods from November, 1975, to June, 1976. Each regrowth period began after flail cutting at the 10% flower growth stage.

During the first three regrowth periods dry matter yields were highest at the green-flower bud or 10% flower growth stages; lucerne remained vegetative during the fourth period. Growth rates were highest (65-99 kg DM ha^{-1} day^{-1}) during the spring and summer.

Percentage leaf (whole plant, DM basis) generally declined with maturity but digestibility of the leaf remained similar (approximately 73%) at all growth stages. However, digestibility of the stems declined from 70-80% to 55% with maturity. The multiple correlation coefficient (R) between whole-plant digestibility and stem digestibility and percentage stem was 0.88.

Data on the digestibility coefficients of leaf and stem and the DOM yields from 8 cm sections taken vertically down the plant are given and the results are discussed in relation to utilization of the lucerne crop.

INTRODUCTION

Lucerne is grazed by cows on 85% of dairy farms (R. B. Gordon, pers. comm.) in the Central Plateau pumiceland of the North Island. Despite its importance as a feed few studies have been made of its nutritive value in New Zealand.

Joyce and Brunswick (1975) using lucerne grown at Wairakei and Fletcher (1976) using irrigated lucerne in Canterbury showed that digestibility declined with increasing maturity and this was associated with a reduction in leaf/stem ratio or percentage leaf, thus confirming the earlier results of Christian *et al.* (1970) and Terry and Tilley (1964).

Stock preferentially graze the apices and leaves of relatively mature lucerne. When grazing pressure is increased and stock are forced to eat a greater proportion of stems, stock performance declines (Joyce and Brunswick, 1977). If high utilization of the lucerne crop is desirable then animals will have to graze down to the basal region of the sward. However, there is no information available in New Zealand on how yield and digestibility of lucerne changes vertically down the sward and how this is affected by growth stage and season. To obtain such data an experiment was carried out to determine these variables.

METHODS

A three-year-old stand of New Zealand certified 'Wairau' lucerne growing on a Horotiu silt loam above sandy loam at the Nutrition Centre, Ruakura, was used.

A 0.24 ha area of lucerne was flail-cut to a 4 cm stubble on 6 November, 1975. The area was then divided equally into two plots (29 m x 42.5 m) which were sampled at early-vegetative (EV), mid-vegetative (MV), green-flower bud (GB) and 10% flower (10F) growth stages. At each growth stage, 5 representative quadrats in each plot (1 m x 1 m) were cut with hand shears at crown level. Plants with more than 50% of their shoots within the quadrat frame were included in the sample but litter and any volunteer species were excluded. Quadrats previously cut were avoided at subsequent samplings. After the 10% flower quadrat samplings were made, the whole area was again flail harvested and the regrowth again sampled at the various growth stages. Four regrowth periods were sampled.

During the trial 35 kg K and 17.5 kg P ha^{-1} was applied after each flail-cut with 3.6 kg Cu, 1.8 kg Na, 1.6 kg B and 0.04 kg Mo ha^{-1} being applied only after the first.

Herbage cut from each quadrat was weighed and subsamples were dried at 100°C. On each occasion the length of 250 shoots of lucerne from one quadrat per plot was measured from base to apex to the nearest cm, the mean of which was assumed to be the mean height of the sward. Shoots (200-250) with a height within 1 cm of the nearest multiple of 8 to the mean sward height were selected from the 5 quadrats, cut into 8 cm sections from the apex to base and each 8 cm section was then dissected into leaves (plus petioles), flowers (if present) and stems. Remaining lucerne shoots were bulked within plots and a subsample dissected into leaf and stem, referred to subsequently as 'bulk leaf' and 'bulk stem'. A second subsample of intact shoots is referred to subsequently as 'whole-plant'. All samples were dried for 24 h in a forced draught oven.

In vitro organic matter digestibility (Drew, 1966) was determined on ground sampled. All samples were analysed in duplicate with whole-plant lucerne standards of known *in vitro* digestibility always included; duplicates within 2 percentage units were considered satisfactory.

TABLE 1: Seasonal growth rates (kg DM ha^{-1} day^{-1}) and DM yields (kg DM ha^{-1}) of lucerne.

	Growth Stage	Days Regrowth	Growth Rate	DM Yields
I	EV	14	65	910
(7/11/75 – 19/12/75)	MV	28	97	2 716
	GB	35	99	3 465
	10F	42	80	3 360
II	EV	18	79	1 422
(20/12/75 – 28/1/76)	MV	30	81	2 430
	GB	34	77	2 618
	10F	39	85	3 315
III	EV	14	55	770
(29/1/76 – 25/3/76)	MV	27	71	1 917
	GB	41	63	2 583
	10F	55	46	2 530
IV	EV	18	62	1 116
(26/3/76 – 17/6/76)	MV	41	50	2 050
	V+	61	30	1 830
	V	83	16	1 328

+ Lucerne remained vegetative throughout Period IV.

RESULTS

Dry matter yields were highest within each regrowth period at green-bud or 10% flower growth stages which in the first two periods were about a week apart (Table 1). Growth rates were highest from early November until the end of January and the time required to reach 10% flower increased as the growth rate slowed with the onset of autumn. Yields declined with increasing maturity in the fourth period as plants began to deteriorate. This was accompanied by loss of leaf caused partly by foliar diseases.

Percentage leaf declined rapidly with maturity during all regrowth periods (Table 2).

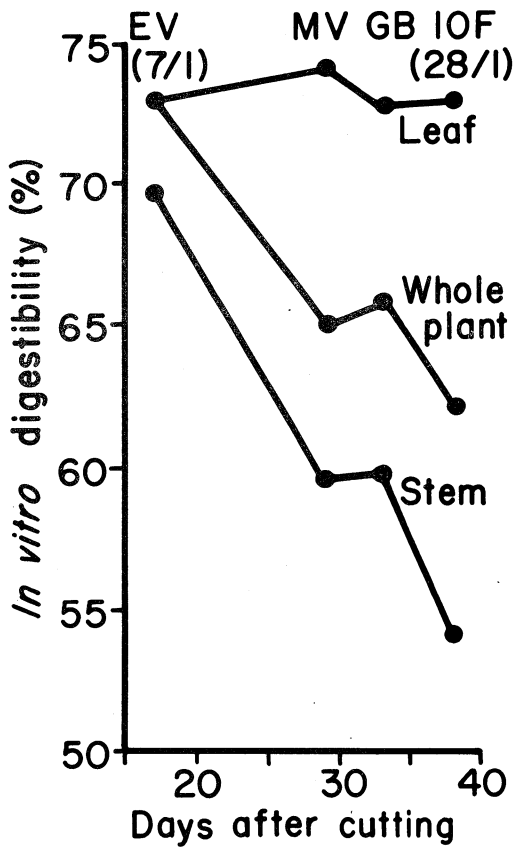
TABLE 2: Percentage of leaf (dry matter basis) in lucerne herbage at different growth stages during four regrowth periods.

	Growth Stage			
Period+	EV	MV	GB++	10F++
I	77	51	43	41
II	66	47	50	45
III	71	58	50	55
IV	76	62	54	44

+ See Table 1.
++ Absent in Period IV.

Bulk leaf digestibility coefficients were similar at all stages of maturity in all regrowth periods. The mean values were 76.0 ± 3.96, 73.2 ± 0.94, 72.8 ± 2.83 and 72.6 ± 2.79 for periods 1-4, respectively. However, with the exception of the fourth period, where growth was much slower and the plants

Figure 1. Leaf, stem, and whole-plant organic matter digestibility in period II.



remained vegetative, bulk stem digestibility coefficients declined from an initial value of 70-80%, to levels near 55% by 10% flower. In the fourth period stem digestibility coefficients declined from 70% to 63% over 83 days growth. Similar changes with time (Figure 1) occurred in digestibility of the whole plant with values intermediate between leaf and stem.

Leaf digestibility remained above 65% from apex to the base of the plant whereas stem digestibility declined steadily from a level similar to the leaf at the apex to about 50% digestibility at the base (Table 3). The trends were evident from mid-vegetative growth until 10% flower within each regrowth period. When data was combined for the four regrowth periods the correlation coefficient between whole-plant digestibility (y) and stem digestibility (x_1) and the proportion of total dry matter as stem (x_2) was 0.88**.

At the GB and 10F growth stages in the second regrowth period, approximately 60% of DM and 66% of DOM (digestible organic matter) in the lucerne was above a height of 24 cm (Table 3). Similar data (58%, 60% for DM; 63%, 66% for DOM) were obtained at these growth stages in the first and third regrowth periods, respectively, but in the fourth period GB and 10F growth stages were not reached. In all regrowth periods, DOM yield declined rapidly in sections below the top 8 cm and reached a relatively constant level of about 22 g m^{-2} in the basal 24 cm of the lucerne sward.

DISCUSSION

The decline in lucerne digestibility with increasing maturity (Figure 1) along with a reduction in percentage leaf (Table 2) agrees with the findings of other workers (Terry and Tilley, 1964; Christian *et al.*, 1970; Joyce and Brunswick, 1975; Fletcher, 1976). The stem component of the lucerne plant has the greatest effect on whole-plant digestibility as shown by the high correlation (0.88) between whole-plant digestibility and stem digestibility and the proportion of total dry matter as stem.

It is generally recommended that lucerne should be utilised at about the early flowering stage in order to maximise dry matter yields and to maintain stand longevity (Keoghan, 1967; Smith, 1970; Langer, 1973). Consumption of all feed on offer (including the stubble of stems) is also thought necessary to stimulate recovery growth and reduce weed infestation (Iverson, 1967; Langer, 1973). This means that harvesting of progressively less digestible herbage is advocated even though stem digestibility declines to a low level with maturity (Figure 1) and with section down the plant (Table 3). The lower portions of the plant also contain a smaller proportion of DOM (Table 3).

Some farmers feeding dairy cows on lucerne in the Central Plateau pumiceland claim that milk production declines if cows are forced to consume the 'stemmy stubble'. In trials of 3-4 weeks duration, Bryant (1978) found a significant reduction

TABLE 3: *In vitro* digestibility (%) of leaf and stem and dry weight (g m^{-2}) and DOM (g m^{-2}) in 8 cm sections of lucerne shoots in regrowth Period II.

Growth Stage	Section+	IVD		Dry Weight	DOM
		Leaf	Stem		
EV	1	76.3	80.3	100.0	68.8
(7/1/76)	2	72.0	68.6	45.7	28.4
MV	1	75.7	79.2	95.2	68.5
(19/1/76)	2	72.7	64.8	55.2	33.9
	3	68.8	60.8	41.7	24.0
	4	69.7	55.1	38.7	20.8
	5	67.6	47.0	40.2	18.3
GB	1	75.3	76.7	85.2	57.4
(23/1/76)	2	72.8	66.1	58.8	37.3
	3	71.1	59.5	51.9	30.7
	4	70.3	58.5	40.7	23.0
	5	70.9	54.7	38.3	20.1
	6	66.5	50.3	41.4	19.9
10F	1	74.5	74.0	98.0	64.6
(28/1/76)	2	71.3	62.1	72.5	44.1
	3	69.5	56.6	63.1	35.8
	4	70.1	55.2	52.8	28.4
	5	71.6	53.5	48.0	24.8
	6	-	47.9	50.3	21.0

+ Section 1 = apex (8 cm) of the lucerne shoot.

in milk yield from cows grazing mature lucerne in early lactation compared to those grazing pasture, but not in mid or late lactation. Furthermore, he suggested that the rate of decline in milk yield with decreasing dry matter allowance (increasing utilization) was no greater for lucerne than for pasture and may be less. Other workers (Croy and Weeda, 1974; Joyce and Brunswick, 1977) have reported that the performances of growing beef cattle were depressed when utilisation of the lucerne crop was high. Since a high proportion of the dry matter and DOM yields are located in the upper portions of a relatively mature lucerne sward (Table 3) little feed value would be sacrificed if the basal regions of the sward were not utilised. However, further research is required to determine the effects of a wide range of levels of utilisation on immediate and longer term dry matter yield and quality of lucerne and also its effects on animal production.

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