THE EFFECT OF CUTTING MANAGEMENT ON THE YIELD, CHEMICAL COMPOSITION AND *IN VITRO* DIGESTIBILITY OF *TRIFOLIUM SEMIPILOSUM* GROWN WITH *PASPALUM DILATATUM* IN A SUB-TROPICAL ENVIRONMENT

R. J. JONES*

ABSTRACT

Trifolium semipilosum *(Kenya white clover) cv. Safari, growing with* Paspalum dilatatum *was cut to* 3.8 *or* 7.5 *cm every* 4 *or* 8 *weeks over a four year period. Total dry matter yields were* 16% *greater for the* 8 *week cutting but there was no effect of cutting interval on clover yields. The lower cutting height increased total yields by* 27% *and clover yields by* 87%. *Clover contributed* 36% *of total yield at the lower cutting height and* 24% *at the* 7.5 *cm cutting height.*

Yields of T. semipilosum *were greatly dependent upon moisture supply and less dependent upon temperature. It persisted well but high yields were only achieved when rainfall exceeded evaporation for prolonged periods. Consequently, in S.E. Queensland, with a predominantly summer rainfall, highest yields may be expected in summer.*

Mineral composition (except for sodium) was excellent and little affected by cutting interval or cutting height. In summer and autumn the nitrogen concentration was lower than in winter or spring.

Mean in-vitro *dry matter digestibilities were* 75.1% *and* 71.3% *for the* 4 *and* 8 *week cut respectively with no marked seasonal differences.*

A virus attack in the fourth year reduced yields and plant density.

INTRODUCTION

Trifolium semipilosum var glabrescens (Kenya white clover) is a species originating in the equatorial high altitude areas of East Africa (Bogdan 1956). In Kenya it has been shown to respond to phosphorus and sulphur (Poultney 1963, Suttie 1970), to combine with a range of grasses under grazing (Strange 1955), and to be more drought tolerant than *Trifolium repens* cultivars (Anon 1960, Suttie 1970).

From controlled environment studies on the growth of *T. semipilosum*, Mwakha (1969) postulated that the species would be of limited value outside the high altitude tropics. However, in Australia ('t Mannetje 1964, Evans 1967) this species has been grown successfully outside the tropics.

Although *T. semipilosum* has been recommended as a valuable pasture legume for the medium altitudes of Kenya for a number of years (Bogdan 1965) there have been few reports on its response to management in mixed pastures, chemical composition, or feeding value.

The trial reported here sought to determine its cutting response, chemical composition and *in vitro* digestibility under the sub-tropical conditions of south-east Queensland.

MATERIALS AND METHODS

An established 5 year old stand of *P. dilatatum* and Kenya white clover CPI 27218,† inoculated at planting with *Rhizobium* strain CB 782 was used for the experiment. This was at Samford S.E. Queensland, on a parairie soil pH 5.8 (Thompson and Murtha 1960). At the start of the experiment in April, 1967, there was approximately 25% clover and 75% paspalum. Very little weed was present at any stage in the experiment.

*C.S.I.R.O., Division of Tropical Agronomy, Cunningham Laboratory, Mill Road, St. Lucia, Queensland, 4067.

†Now released as *Trifolium semipilosum* cv. Safari.

Cutting treatments were imposed on this existing stand to study the effects of 4 and 8 week cutting frequency and 3.8 and 7.5 cm cutting height. The four treatments were incorporated into a randomized block design with four replications. Plots measured 2 m × 1.4 m. At each harvest an area of 1.07 m^2 was cut for yield estimation. The remainder was cut similarly and discarded.

A sub-sample of approximately 500 g total weight from each plot was sorted into clover and "other species", dried over-night at 100°C, weighed, and ground to pass a 1 mm sieve. The clover samples were analysed for N, P, K, Ca, Mg, and Na. Initially, samples from all treatments were analysed after bulking over replicates. After the first year, however, only the samples cut at 3.8 cm for the two cutting intervals were retained for analysis since there was little effect of cutting height on chemical composition (Table 2a).

In vitro dry matter digestibility was measured on the clover fractions by the method of Tilley and Terry (1963) as modified by Minson and McLeod (1972).

The plots received 400 kg single superphosphate and 200 kg potassium chloride/ha/annum (38 kg P, 40 kg S, 100 kg K) in two equal applications in early spring and late summer, and in addition 120 g Mo (as sodium molybdate) in 1967 and in 1971 with the superphosphate dressing. No lime was applied.

The first harvest was taken on May 2, 1967, and the last on May 25, 1971. Over this four year period the plots were cut at 4 or 8 weeks whenever the material exceeded the predetermined cutting height.

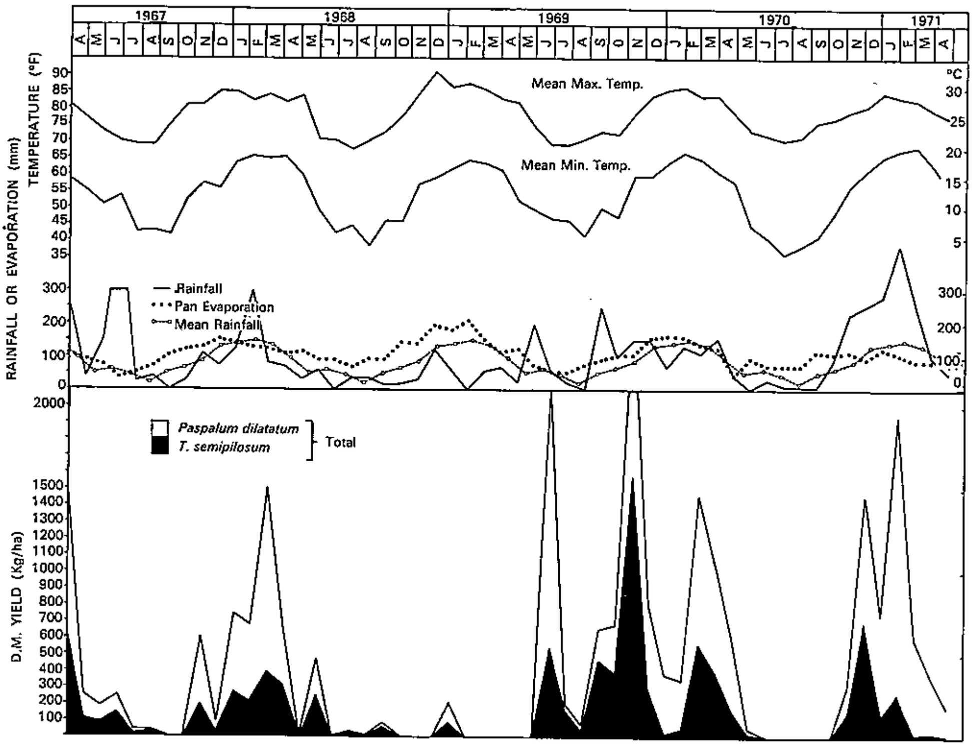

FIGURE 1

Dry matter yields of *Trifolium semipilosum* and associated *Paspalum dilatatum* under a four-weekly cutting regime in relation to rainfall, temperature and open pan evaporation over a four-year period. The mean monthly rainfall for Samford is also plotted.

RESULTS

Temperature, rainfall and evaporation during the experimental period are given in Figure 1. Notable departures from the mean rainfall pattern occurred.

Yields of dry matter

The responses to cutting treatments were similar in each year and so only the mean annual yields over the four years are presented (Table 1).

TABLE 1

Mean annual yields of a Trifolium semipilosum/Paspalum dilatatum *pasture as influenced by cutting interval and cutting height treatments. Values are means of four replicates over the four year period* 1967–1971.

(kg/ha)

(a) *Total Yields*

Cutting Interval (weeks)	Cutting Height (cm)		Mean
	3.8	7.5	
4	5,920	4,810	5,360
8	6,930	5,340	6,130
Mean	6,420	5,070	

L.S.D. for cutting interval and cutting height means 5% 620
1% 890

(b) T. semipilosum *yields*

Cutting Interval (weeks)	Cutting Height (cm)		Mean
	3.8	7.5	
4	2160 (36.5)*	1210 (25.2)	1690 (31.4)
8	2430 (35.2)	1260 (23.6)	1850 (30.1)
Mean	2300 (35.8)	1230 (24.3)	

L.S.D. for cutting height means 5% 330
1% 480

Effect of cutting interval N.S.
*( ) bracketed values are percentage contribution of *T. semipilosum* to total yield.

The major effect on yield was due to the cutting height treatments. Cutting to 3.8 cm increased yields of dry matter by 27% and the yields of clover by 87% compared with cutting to 7.5 cm. There was a corresponding increase in the clover percentage on plots cut at the lower stubble height but very little effect of cutting interval on the clover percentage (Table 1).

Cutting every eight weeks gave higher total and clover yields than cutting every four weeks, but only the difference for total yields was significant ($P < 0.05$).

Pattern of dry matter yield

The pattern of clover dry matter yield over the four years was similar for all cutting treatments. The yields for the 4 week plots cut to 3.8 cm are presented in relation to the climatic factors in Figure 1.

It is evident that temperature was less important than rainfall in limiting the growth of *T. semipilosum* in the field at Samford over the four years of this study.

Yields of over 400 kg DM/ha/4 week regrowth were recorded in spring (September), summer (December), autumn (March and April) and in winter (June). The low yields after November 1970 in spite of good prolonged rainfall were due to virus attack which was most pronounced on plots cut to 3.8 cm. This virus is similar to bean yellow mozaic virus (G. M. Behncken, personal communication).

In general, the total yields and clover yields followed a similar pattern with a tendency for a lower clover component in summer. The increase in total yields towards the end of the experiment when clover yields declined could be due to a stimulating effect on the grass after the death of much of the clover from virus attack.

Mineral composition

A feature of the chemical analysis data was the relative constancy of the mineral composition irrespective of cutting height or interval (Table 2). Nitrogen and phosphorus concentration was slightly higher for the 4 week cuts and the K, Ca and Mg concentrations were somewhat higher for the 8 week cuts.

TABLE 2

(a) *The effect of cutting height on the chemical composition of four-weekly regrowth of* T. semipilosum. (*Means of 7 harvests in* 1969).

Cutting height cm	Chemical Component (percent of DM)					
	N	P	K	Ca	Mg	Na
3.8	4.57	0.29	2.77	1.51	0.27	0.05
	(0.13)*	(0.02)	(0.08)	(0.10)	(0.01)	(0.003)
7.5	4.40	0.29	2.62	1.59	0.27	0.05
	(0.14)	(0.02)	(0.07)	(0.11)	(0.01)	(0.004)

*( ) Standard error of the mean.

(b) *The effect of cutting interval on the chemical composition of* T. semipilosum *cut to a* 3.8 *cm stubble.* (*Means over* 4 *years*).

Cutting interval (weeks)	Chemical Component (percent of DM)					
	N	P	K	Ca	Mg	Na
4	3.90	0.31	2.51	1.53	0.30	0.04
	(0.11)†	(0.009)	(0.07)	(0.04)	(0.01)	(0.01)
8	3.86	0.26	2.79	1.80	0.31	0.04
	(0.14)‡	(0.01)	(0.18)	(0.10)	(0.03)	(0.005)

† Standard error of the mean of 28 harvests.
‡ Standard error of the mean of 12 harvests.

TABLE 3

The influence of season of the year on the nitrogen content and IVDMD of T. semipilosum.

Season	Mean* % N	S.E. of Mean	Mean* IVDMD	S.E. of Mean
Summer (Dec-Feb)	3.75	(0.10)	76.0	(1.9)
Autumn (Mar-May)	3.27	(0.09)	73.4	(1.0)
Winter (June-Aug)	4.31	(0.10)	72.8	(0.9)
Spring (Sept-Nov)	4.24	(0.19)	74.1	(1.3)

* Mean of both the 4 week and 8 week harvests.

The nitrogen concentration varied with season, values were higher in winter and spring than in summer or autumn (Table 3). No other noticeable trends in mineral composition with season of the year occurred.

IN-VITRO *digestibility*

The mean *in-vitro* digestibility for the 4-week cuts was 3.8 digestibility units higher than for the 8-week cuts (Table 4). There were no large differences in digestibility with season of the year although the digestibility of material harvested in summer tended to be higher than that harvested in winter (Table 3).

TABLE 4

Mean in vitro *dry matter digestibilities for* T. semipilosum *cut to a* 3.8 *cm stubble at* 4 *week and* 8 *week intervals.*

Cutting interval (Weeks)	Mean IVDMD	Standard Error of Mean	Range
4	75.1†	[0.7]	68.0–85.5
8	71.3‡	[0.9]	66.9–77.1

† Mean of 28 harvests.
‡ Mean of 12 harvests.

DISCUSSION

The performance of *T. semipilosum* on this site is in contrast with the conclusion of Mwakha (1969) that the usefulness of this species will be limited to upland tropical areas similar to those where it originated. On this rather dry ridge-top site *T. semipilosum* has persisted under severe cutting treatments and was still productive one year after cutting treatments ended, i.e. ten years after the original planting.

It is important to realise, however, that the work was done on a well established stand that had passed through the phase of susceptibility to rugose leaf curl virus (RLCV) (Grylls, Galletly and Campbell 1972) before the cutting treatments commenced and so no problems were encountered with this virus throughout the period of study. Severe growth restriction on younger stands established from seed at Samford have been directly attributable to RLCV attack (N. E. Grylls, personal communication).

The total yields of herbage for the 8-week cutting at 3.8 cm were very similar to those reported from Kenya for well fertilized *Nandi setaria*/Kenya white clover pastures growing under less drought prone conditions than recorded at Samford (Suttie 1970), and some 50% higher than those recorded under drier conditions in Rhodesia (Clatworthy 1970). No comparison of legume yields is possible because these were not reported in the African trials.

Yields of *T. semipilosum* were comparable with yields of *Phaseolus atropurpureus* grown with *Paspalum plicatulum* at Samford and grazed only three times a year (Jones, Davies and Waite 1967) and are higher than those of Siratro grown with Nandi setaria and grazed four times a year (Jones 1970). Yields at the 4-weekly, close cutting treatment were almost double those from Siratro cut in a similar manner (Jones 1967). Unlike the tropical legumes Siratro and Greenleaf desmodium (Jones 1971), *T. semipilosum* showed little reduction in yield at a cutting interval of 4 weeks compared with yields at 8 weeks. The response to cutting height was also notably different. Yields of *T. semipilosum* increased at the lower cutting height whereas yields of Siratro and desmodium were shown to decline when cut frequently to a low stubble height (Imrie 1971, Jones 1971). It is therefore important to recognise that these differences exist if meaningful comparisons between legumes under cutting are to be made. For this reason the poorer performance of *T. semipilosum* relative to *Desmodium intortum* reported from Kenya (Keya, Olsen and

Holliday 1972) may well have been due to the technique of harvesting the plots at a 10 cm stubble and to the long intervals between cutting.

The stability of the legume percentage with increasing cutting interval at both cutting heights contrasts with the results obtained for white clover at Samford where the clover contribution was much reduced in swards cut infrequently (Jones 1971). In addition, *T. semipilosum* grows better in summer and is more drought tolerant.

The sodium content of *T. semipilosum* was low, but the other minerals measured were sufficient for good animal production. The results are in agreement with the few analyses published for *T. semipilosum* grown in Kenya (Dougall 1962). The lower N concentrations in summer compared with those measured in winter and spring could be due to the higher temperatures encountered in summer partly inhibiting nitrogen fixation (Date 1971) but this does not explain the lower values in autumn. The absence of a depressing effect of high temperatures on the digestibility of *T. semipilosum* differs from the results reported for grasses (Minson and McLeod 1970, Wilson and Ford 1971), where lower digestibility was associated with growth at higher temperatures.

In comparison with tropical legumes (Milford 1967, Jones 1971), the digestibility values recorded for *T. semipilosum* are consistently high. They are, however, lower than those of white clover grown in S.E. Queensland (Minson and Milford 1967, Jones 1969). This lower digestibility for harvested material of *T. semipilosum* may be due to the inclusion of stem in cut samples, no stem material occurs in samples of white clover cut in the vegetative stage.

The susceptibility to the virus similar to bean yellow mozaic virus gives cause for some concern. It can be spread by cutting equipment and this may have increased the incidence on the frequently cut plots. Certain plants appeared to be unaffected and they increased in vigour when others died out. The very great effect on yield indicates that the selection or breeding of cultivars resistant to the virus would result in greater yield stability in virus prone areas. Under grazing at Samford, however, this virus has not been a problem (author's unpublished data).

The relationship in *T. semipilosum* between available moisture and yield would suggest that in conditions drier than those at Samford the yield of *T. semipilosum* would be lower. Such low productivity has been measured in drier environments (Jones and Rees 1972) although persistence was good. Conversely, on more favourable lower lying sites than the one chosen for the experiment, the production of *T. semipilosum* may not be so markedly affected by the rainfall pattern and in areas with higher annual rainfall increased yields of this legume would be possible. While winter temperatures in S.E. Queensland are unlikely to be too low for growth, the rainfall pattern will determine the pattern of productivity. Highest production on average must therefore occur in summer.

The results presented here strongly indicate that Kenya white clover is a persistent nutritious legume which may be a valuable addition to the suite of legumes available in the wetter sub-tropics. They confirm the promise shown by *T. semipilosum* in earlier species testing work at Samford ('t Mannetje 1964) and at Howard (Evans 1967) in S.E. Queensland.

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