GROWTH AND MANAGEMENT OF SAINFOIN ON PUMICE SOILS

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ABSTRACT

Sainfoin is seen as a possible alternative to lucerne on the pumice soils of the Central Plateau of the North Island of New Zealand. The growth pattern and response of sainfoin cv. Melrose to a range of frequencies and heights of defoliation are described.

Rapid spring growth by sainfoin commenced in mid-September, and dry matter accumulation continued until full bloom in early-mid December. Sainfoin regrowth from January to March was low relative to lucerne, and sensitive to moisture stress. Cutting to 3 or 10 cm had little effect on productivity. An eight week cutting interval gave higher dry matter yields than at 6 or 4 weeks respectively. Plant population density was reduced by four-weekly cutting.

The potential role of sainfoin is discussed.

INTRODUCTION

Sainfoin (*Onobrychis viciifolia* Scop.) is a deep rooted perennial legume that is used as forage in many parts of the world. It is generally sown where the growing season is six months or less, and provides a large bulk of forage in one or two cuts. Its productivity in an extensive series of trials in Canada was generally between 80 and 90% that of lucerne (Hanna *et al.,* 1972). It has not been used in New Zealand to any extent. However, it appears to have potential as an alternative to lucerne (*Medicago sativa* L.), primarily because livestock do not bloat on sainfoin (Hanna *et al.,* 1972), and also because it does not appear to be affected by the same disease/pest complex as lucerne.

In the Central Plateau of the North Island lucerne is a major source of forage, particularly on dairy farms where it occupies around 25% of the farmed area (Mace, 1979). Most lucerne stands remain in a productive state for around six years after which plant populations and hence stand density gradually falls. Attempts to directly re-establish lucerne on these areas has met with variable success (R.B. Gordon pers. comm.). In these situations sainfoin is seen as an alternative crop. This paper reports on trials conducted from 1976-80 looking at the agronomic potential of sainfoin for the Central Plateau.

MATERIALS AND METHODS

The trials were located at Broadlands, 30 km North-East of Taupo, on Whenuaroa stony silty sand, a coarse bouldery soil derived from pumice alluvium.

Experiment 1 (1976-78)

The objective was to determine the pattern of yield accumulation of sainfoin cv. Melrose in relation to stage of development, and subsequent effects on regrowth. The trial was begun in October 1976 on a stand sown nine months previously. Plant population density was $155/m^2$ at the commencement. The trial was conducted during the 1976/77 and 1977/78 growing seasons. Treatments were as follows:

(i) Cut at the pre-bud stage
(ii) Cut at the late-bud stage
(iii) Cut at early flowering
(iv) Cut at full bloom.

Each treatment was replicated eight times. Plots (10 x 1.5m) were cut using a sickle bar mower set at 15 cm in 1976/77 and 10 cm in 1977/78, and foliage removed by hand raking. Clippings were discarded. Weed ingress particularly by yarrow and white clover was controlled by application of a cyanazine (2 kg/ha a.i.)/pronamide (1.5 kg/ha a.i.) mixture in July 1977 and February 1979. Soil fertility and pH of the site was adequate, with pH over 6 and high levels of potassium, phosphorus, and magnesium. At the start, the trial was topdressed with calcium ammonium nitrate (40 kg/ha N) and 50% potassic superphosphate (400 kg/ha). A further 500 kg/ha 50% potassic superphosphate was applied in July 1977.

Experiment 2 (1978/80)

The effects of defoliation frequency and intensity on productivity and persistence of sainfoin cv. Melrose were studied during the 1978/79 and 1979/80 growing seasons. To avoid residual treatment effects between years each trial area was used for only one year. The stands used were both two years old. Cutting frequency treatments (4,6,8, and 12 weeks) were applied from the onset of rapid spring growth (mid-September), and the cutting intensities (3 and 10 cm) to each frequency except the 12 week treatment which was only cut at 3 cm. Treatments were applied for 24 weeks, with a final common cut (3 cm) made approximately four weeks later (mid-April). Plot size was 7 x 1.2 m with four replicates. Herbage was harvested with a small-plot flail harvester and clippings removed. Sainfoin population densities were recorded in May following the completion of the season's cutting. Weed control was the same as given in experiment 1 and was applied in early spring.

RESULTS

Experiment 1.

The onset of rapid spring growth by sainfoin occurred in the latter half of September. Maximum growth rates were in mid-November to mid-December, but declined after extensive inflorescence development (Table 1). The peak yield in late spring represented foliage up to 1m high. Total sainfoin production over the season was maximised by delaying the first cut until flowering was well advanced. In those treatments where initial defoliation was not until early or full flowering, regrowth during the summer period tended to be lower. Growth rates of sainfoin from late February onwards were very low except where the initial cut was at the prebud stage.

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TABLE 1 — Yield accumulation and whole season productivity of sainfoin cv. Melrose in relation to stage of development of defoliation.

Stage of development at cutting	Mean date 1st cut	Number of cuts		Sainfoin yield (kg DM/ha)				Total herbage yield (kg DM/ha)	
				1st cut		Whole season			
		76/77	77/78	76/77	77/78	76/77	77/78	76/77	77/78
Pre-bud	5 Nov	3	3	a	1105	a	2627	a	3699
Late-bud	22 Nov	2	2	1057	2492	3075	3480	5168	3816
Early flowering	3 Dec	2	2	1466	3557	3109	4499	5410	4719
Full bloom	15 Dec	2	2	2154	3664	4100	4454	6645	4988
Least significant difference	5%			566	456	804	640	838	727
	1%			786	620	ns	871	1140	990

a) Results not considered because incorrect cutting height used.

Experiment 2

The effects of frequency and height of defoliation were generally similar in both years, and the data given are the mean of the two years (Table 2). The major effects were from frequency rather than height of defoliation. Total herbage and sainfoin component yields, and percentage sainfoin were all maximised by an eight week cutting interval. All these parameters were lowest at a four week interval, and intermediate at six weeks. The 12 week interval gave yields slightly lower than at eight weeks, and was long enough for seed to be set (and shed in the second cutting cycle; seed yields were not measured). The overall effect on the proportion of sainfoin (whole season) was less pronounced in 1979/80, only occurring at the 3 cm cutting height.

Growth rates of sainfoin for individual periods within the growing season followed a similar pattern to total yields over the whole season. Mid-spring growth rates for the 4, 6, and 8 week cutting frequencies were 36, 45, and 54kg DM/ha/day respectively (mean of two years). During January and February the same relative growth rates were 13, 16 and 27 kg DM/ha/-day.

Cutting to 3 cm at eight week intervals gave greater total herbage and sainfoin yields than cutting to 10 cm at the same interval. However, cutting height had no effect on yields at the 4 and 6 week intervals.

The four week cutting interval resulted in a substantial reduction in plant numbers in the 1978/79 season (Table 3). There was a similar trend in 1979/80 but differences were not significant. Cutting height had no effect on population density.

DISCUSSION

Growth of sainfoin in experiment 1 was approximately only half that of experiment 2. This in part appeared to result from invasion of plots by yarrow in experiment 1, which proved very difficult to control with herbicides. The sites selected for experiment 2 were relatively free of yarrow. Another contributing factor was the cutting height. In experiment 1 it was difficult to collect all cut herbage from amongst the stubble. The use of a flail harvester in experiment 2 avoided this problem.

TABLE 2 — The effects of height and frequency of defoliation on the productivity and proportion of sainfoin cv. Melrose (mean of two years data).

Cutting interval (weeks)		4	6	8	12		LSD	
	Cutting Height (cm)					Comparison	1%	5%
Total herbage yield	3	5780	7050	9340	9040	3/10[b]	571	417
(kg DM/ha)[a]	10	5840	6840	8590		4/6/8[c]	700	511
Sainfoin yield	3	4460	5890	8760	8250	3/10	560	409
(kg DM/ha)	10	4610	5670	7860		4/6/8	686	501
Sainfoin percentage	3	77	84	94	89	3/10	3	2
	10	79	83	92		4/6/8	4	3

a) Dry matter yields over whole growing season
b) Least significant difference applies to 3/10 cm comparison
c) Least significant difference applies to 4/6/8 week comparisons.

TABLE 3 — The effects of height and frequency of defoliation on sainfoin cv. Melrose population density (plants/m²)

Cutting interval (weeks)		4	6	8	12		LSD	
Growing season	Cutting height (cm)					Comparison	1%	5%
1978/79	3	12	20	21	19)	3/10[a]	4.7	3.4
	10	16	20	22	)	4/6/8[b]	5.7	4.2
1979/80	3	12	14	15	14)	3/10	3.8	2.8
	10	13	14	13	)	4/6/8	4.7	3.4

a) Least significant difference applies to 3/10 cm comparison.
b) Least significant difference applies to 4/6/8 week comparisons.

The growth pattern of sainfoin in the current trials, viz. increased dry matter yields up to the full bloom stage but very much lower growth rates thereafter, was very similar to comparable studies in North America (Baker *et al.*, 1952; Carlton *et al.*, 1968; Smoliak and Hanna, 1975). The growth rate of sainfoin from January to March in all years was substantially lower than that of lucerne in adjacent paddocks. Whether this was due to an inherently lower regrowth potential (Melrose sainfoin is derived from Russian material which developed in areas with a very short growing season) (Hanna *et al.* 1972), a management factor, or water stress was not clear. Koch *et al.* (1972) showed sainfoin could extract moisture from up to 180cm. However, sainfoin appeared to be quite sensitive to water stress, particularly during a drought experienced in early 1978.

If sainfoin were to be used as a forage crop in New Zealand, an understanding of its reaction to the intensity and frequency of defoliation would be essential to planning of its utilisation. While there has been little emphasis on study of these overseas, the effects of intensity and frequency of defoliation on lucerne have been studied in depth, and provide an analogous situation (Langer and Steinke, 1965; Leach, 1968). Frequent defoliation of lucerne usually reduces regrowth, but the effect depends on the closeness of cutting and on root reserves. The effects of low cutting in experiment 2 were small compared with those of cutting frequency. The lower sainfoin yields in the 10 cm/8 week treatment were probably the result of leaves senescing between 3 and 10 cm during the growth period. However, the absence of a reduction in the percentage sainfoin from 4 and 6 week cutting at 10 cm in the second year was probably a direct effect of cutting intensity and may have been related to the lower sainfoin populations. The absence of a reduction in yield from low cutting may have reflected a number of factors:

(i) Sainfoin regrowth was from basal buds at or just below ground level, and hence should not be directly affected by cutting to 3 cm.
(ii) High levels of root reserves capable of being mobilised after defoliation.
(iii) The method of cutting usually resulted in some leaf area remaining. Utilisation of sainfoin in New Zealand would be normally by cattle or sheep grazing *in situ*. Their pattern of defoliation would result in removal of more leaf than a cutting regime, with possible detrimental effects on regrowth.

It was clear from both years of experiment 2 that an 8 week cutting interval resulted in the highest sainfoin and total herbage yields. This pattern occurred both for the whole season and individual periods within the season. Yields tended to stabilise with a cutting interval greater than 8 weeks. Four week cutting not only suppressed yield potential but also lowered plant population. Use of an 8 week interval should provide 3 large harvests and a smaller one in late autumn. This is fewer than usually occurs with lucerne in the same district.

The annual growth from sainfoin in the two experiments was lower than the mean of 12,700 kg DM/ha from lucerne (9 sites), but in the range of the 8,500 kg DM/ha from pastures (4 sites) on pumice soils of the Central Plateau (McQueen and Baars, 1979). A more accurate comparison with lucerne growth was the 12,600 kg DM/ha recorded on an adjacent farm (same soil type) in 1978/79 (unpublished data), relative to the highest yielding sainfoin treatment in the same year of 10,800 kg DM/ha. In considering sainfoin as an alternative to lucerne a number of factors other than yield have to be considered. On the positive side are:

- Higher nutritive value. English studies indicate that both dry matter digestibility and voluntary intake of sainfoin are higher than with lucerne (Osbourn *et al.*, 1966; Allinson and Osbourn, 1970).
- Non-bloating (Hanna *et al.*, 1972).
- Greater utilisation of available dry matter (Smoliak and Hanna, 1975).
- Relative ease of flower pollination (by honey bees). Large numbers of new sainfoin seedlings were observed in the paddock adjacent to experiment 1 after the stand had been allowed to mature and shed seed.
- Not susceptible to the same range of pests and diseases. In particular, sainfoin is not a host of the blue-green and pea aphids of lucerne, and does not appear susceptible to bacterial and Verticillium wilt diseases.

The negative factors include:

- Lower regrowth potential.
- Greater weed control requirements.

The conclusions that can be drawn from the two experiments are limited by use of the variety Melrose. A number of other varieties are available, which have either been selected for greater regrowth or have their origin in climates with a longer growing season. It is suggested that a comparison of a range of these varieties with Melrose and lucerne is required at a number of sites in New Zealand.

A recent economic evalution of using sainfoin for bloat control concluded there was no advantage over growing lucerne and applying existing bloat prevention methods (Scott, 1979). The report failed to consider several of the above advantages and disadvantages, and a more in-depth study is required. Irrespective of this it is clear that widespread plantings of sainfoin should not be advocated unless it mid-summer/autumn productivity is improved.

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