SEASONAL DISTRIBUTION OF DRY MATTER PRODUCTION FROM PURE AND OVER-DRILLED LUCERNE AND FROM LUCERNE-GRASS MIXTURES AS COMPARED WITH PASTURE ON PUMICE COUNTRY

I. P. M. MCQUEEN

Agricultural Research Division, MAF, Whangarei

J. A.. BAARS

Ruakura Soil and Plant Research Station, MAF, Hamilton

Abstract

Dry matter production data for pure lucerne, overdrilled lucerne and pasture are presented for 14 sites on pumice soils. On average, the annual dry matter yield of lucerne, harvested at early basal shoot movement, was 50% higher than from pasture, ranging from 128% higher on a drought-prone soil where the pasture was dominant browntop to 33% on a more moisture-retentive soil type where the pasture was ryegrass dominant.

From April until late October there was little difference in total dry matter between lucerne and pasture, although pasture had a more even distribution of usable production than lucerne 'managed for maximum yield. Attempts to fill the winter/spring gap in lucerne production through introducing grasses and cereals have met with variable success.

It is suggested that, on the more moisture-retentive soils, pasture production could be improved through grazing management and the use of more drought-resistant cultivars. Such an approach may meet the feed demands of animals more closely than an increasing dependence on lucerne with its specific management requirements.

INTRODUCTION

ANNUAL yields of lucerne *(Medicago sativa,* L. cv. Wairau) on pumice soils are higher than those of pasture (Gordon, 197 1; Clare, 1971; Baars *et al.,* 1975). Lucerne has the added advantage of being resistant to grass grub attack (King et al., 1975), an important attribute in the Rotorua-Taupo area. However, lucerne has many diseases, such as Verticillium wilt (*Verticillium albo-atrum*) (Sanderson, 1976), and insect pests like blue-green aphid (*Acyrthosiphon kondoi)* which may also cause large decreases both in life expectancy of the stand and in annual and seasonal yields (Kain *et al., 1977).* The introduction of wilt- and aphid-resistant cultivars may overcome these limitations.

TABLE 1: DETAILS OF EXPERIMENTAL SITES

Site No.	*District*	*Soil Type*	*Period of Measurement*	*Mean Annual kg DM/ha*
Lucerne				
1	Wairakei	Atiamuri sand	1966-72	13 130
2	Wharepaina	Taupo sandy silt	1975-9	13 350
3	Wairakei	Atiamuri sand	1972-5	10 750
4	Wairakei	Oruanui sand	1972-5	10 750
5	Murupara	Galatea sand	1972-5	13 380
6	Galatea	Galatea sand	1975-6	13 020
7	Galatea	Galatea sand	1976-8	11 330
8	Rerewhakaaitu	Tarawera gravel	1973-5	14 270
9	Broadlands	Whenuaroa sand	1978-9	12 530
			Overall lucerne mean:	12 670
Pasture				
10	Wairakei	Atiamuri sand	1964-11	5 750
11	Wharepaina	Taupo sandy silt	1975-9	10 060
12	Wairakei	Oruanui sand	1964-71	9 050
13	Tikitere	Rotomahana shallow sandy loam	1973-9	9 040
			Overall pasture mean:	8 475
Overdrilled lucerne				
14	Tirohanga	Oruanui loamy sand	1975-8	

It is well established that harvesting at other than the early basal shoot/general terminal bud stage decreases lucerne yields (Keoghan, 1967; Thom, 1978). Douglas and Wilkinson (1976) noted large reductions (52 to 65%) in spring production when lucerne was grazed in early spring. At Wairakei Research Station, harvesting luceme at 40 cm height (vegetative stage) resulted in 35 to 40% less annual DM production compared with harvesting at the general terminal bud stage (McQueen, unpubl.) , If maximum annual production is sought from lucerne, cuts or grazing must take place at this stage of growth and farm management should be planned with full consideration of the relatively fixed seasonal availability of lucerne herbage.

Alternatively, if another regime is to be applied, then the probable lower level of production and reduced life expectancy of the stand should be allowed for before considering lucerne as an alternative to pasture.

In this paper the seasonal distribution of dry matter from pure lucerne cut at the optimum stage of growth is compared with that from pasture. Extension of the productive season of luceme stands through overdrilling winter-active species is also discussed.

EXPERIMENTAL

LUCERNE

Sites were selected that had given five cuts a year. A total of 9 lucerne sites (1 to 9, Table 1) and 24 complete harvest years were available. Cuts were normally taken at the early basal shoot or general terminal bud stage of growth. Lucerne stands were at least 2 years old and adequately fertilized. Weeds were controlled with herbicides in winter where necessary. Lucerne and pasture production were compared for Wairakei (sites 1 and 10, 200 m apart) and Wharepaina (sites 2 and 11, 500 m apart) over corresponding cutting periods (respectively, 1964-71 and 1975-79). The remaining sites and years were used to calculate overall means.

PASTURES

There were four pasture sites (10 to 13, Table 1) on which at least four successive years' data were available. Pasture measurements were made by the standard "rate of growth" technique (Lynch, 1966; Radcilffe, 1974). The yields were adjusted to standard dates using methods similar to those described by Radcliffe (1974).

While white clover (*Trifolium repens* L.) accounted for 20 to 30% of pasture production in each case, the main grass species varied. On site 10 it was browntop (*Agrostis fenuis* Sibth.); on sites **11** and 12, perennial ryegrass (*Lolium perenne* L.) ; and on site 13, Yorkshire fog (*Holcus lanatus* L.) and browntop (*A. tenuis*). On all four farms grazing was mainly by sheep, with cattle used occasionally. Grazing management and fertilizer applications were those normal for the farm concerned.

OVERDRILLED LUCERNE

The overdrilling experiment was conducted over the years 197578 on site 14 (Table 1) using a stand of Hunter River lucerne sown in 1973. Treatments consisted of a control (pure lucerne), Amuri oats, Zephyr barley, CRD ryecorn, 'Grasslands Tama' ryegrass (*Lolium mulfiflorum* Lam.), 'Grasslands Paroa' ryegrass (*L. mulfiflorum* Lam.), and 'Grasslands Matua' prairie grass (*Bromus catharticus*). The seven treatments were sown in randomized blocks with five replicates.

Harvesting, by sickle bar mower, was timed to measure winter (sowing — August) and early spring production (August — October). Thereafter cuts were taken at the optimum stage of growth for lucerne.

RESULTS

LUCERNE AND PASTURE PRODUCTION

Mean annual yields of dry matter at each site are shown in Table 1. On average, lucerne yields were 50% higher than those from pasture, although there was little difference between the best pasture and worst lucerne yields.

Table 2 shows the mean cutting dates for lucerne at the sites where lucerne and pasture could be compared (Wairakei and Wharepaina), and for all' other sites combined. Standard errors of the latter indicate the low variation in time of harvest for lucerne cut at early basal shoot movement. The Wairakei site had cutting dates substantially later than the means. This was due to cutting at full flower during the early years of the trial.

Dry matter yields of lucerne and pasture at Wairakei and Wharepaina are also shown in Table 2. The pasture yields are expressed as the totals accruing between lucerne cuts. There was little difference in production between lucerne and pasture in late autumn and winter at either site, or in spring at Wharepaina. The difference in spring at Wairakei may be affected by the late-

TABLE 3: DRY MATTER YIELDS OF OVERDRILLED LUCERNE EXRESSED AS A % DIFFERENCE FROM PURE LUCERNE (3-YEAR MEANS)

	Pure Lucerne Yield (kg/ha)	*% Increase When Overdrilled With:*					
		Barley	*Ryecorn*	*Oats*	*Paroa*	*Tama*	*Matua*
Winter (Aug.)	544	12.3	15.8	-1	12.5	12.3	53.7
Early spring (Oct.)	2 840	7.7	37.1	4.8	13.5	13.2	3.6
Late spring (Dec.)	3834	5.5	5.6	3.7	11.6	17.5	5.8
Summer (Jan.)	3 155	0	-3.8	-4.4	10.6	11.6	4.3
Early autumn (Mar.)	3432	1.7	-2.0	-4.5	1.0	-2.3	4.3
Mean annual yield/ha	14 193	14 752	15 342	14 138	15460	15615	15035

TABLE 2: LUCERNE AND PASTURE PRODUCTION — MEAN CUTTING DATES AND MEAN YIELDS

	Lucerne Cuts 1	2	3	4	5
Wairakei					
Lucerne — date cut	22.11	10.1	28.2	21.4	27.6
— kg DM/ha	4 060	4 150	3 060	1 660	430
Pasture — kg DM/ha	2 920	1770	880	550	470
Wharepaina					
Lucerne — date cut	28.10	13.12	26.1	15.3	30.4
— kg DM/ha	3 030	3 660	3 230	2 390	1210
Pasture — kg DM/ha	3 080	2 620	1950	1 180	1230
All Other Lucerne Sites					
Mean cutting date	28.10	8.12	17.1	24.2	20.4
S.E. (days)	5.1	3.5	4.9	5.5	10.2

Note: Pasture yields are totals recorded between lucerne cutting dates.

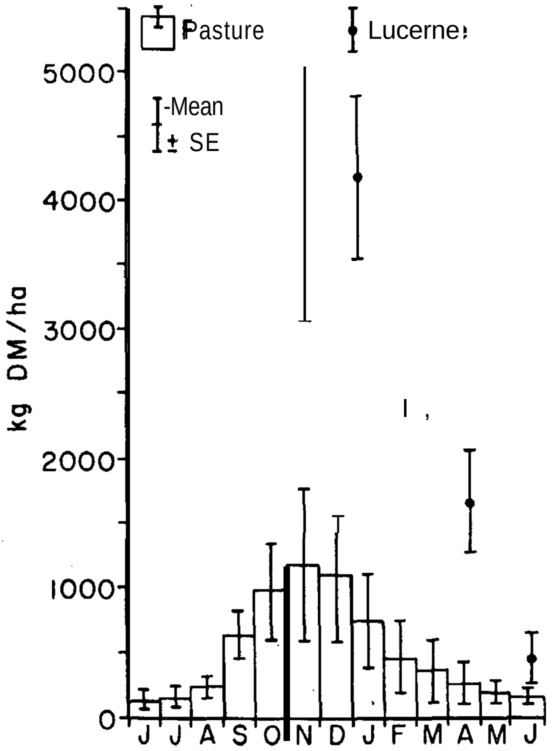

FIG. 1: *Seasonal distribution of dry matter production from pasture and lucerne on Atiamuri sand at Wairakei, 1966-72. Pasture-yields adjusted to 28-day periods.*

ness of the first lucerne cut. In summer and early autumn, luceme was greatly superior at both sites.

Figures 1 and 2 show the distribution of yields in more detail, including the variation at each point as indicated by standard errors. Both sites gave very low pasture production from May to early September. The Wharepaina site produced at higher levels than that at Wairakei throughout the rest of the year. Variation in lucerne and pasture production between years was fairly high in both situations at any particular time of year.

The distribution of pasture production on Oruanui sand at Wairakei (site 12) and at Tikitere (site 13) was similar to that at Wharepaina.

OVERDRILLED LUCERNE PRODUCTION

The mean yields of dry matter over a 3-year period following annual autumn overdrilling with cereals and grasses are presented

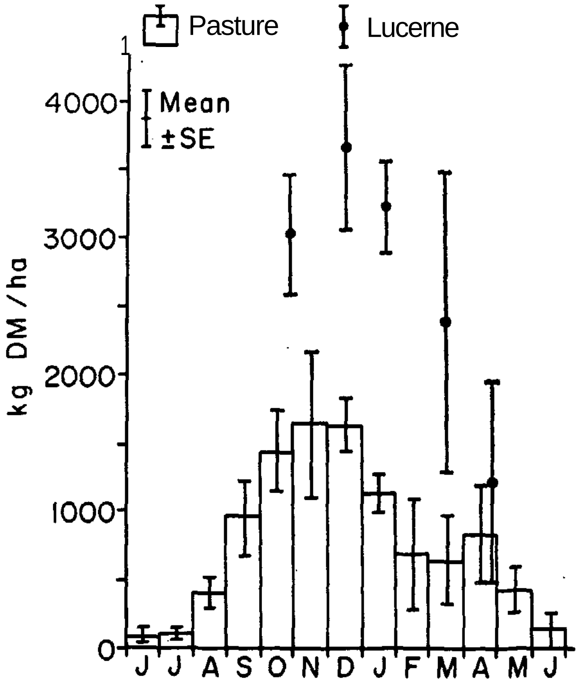

FIG. 2: *Seasonal distribution of dry matter production from pasture and lucerne on Taupo sandy silt at Wharepaina, 1975-9. Pasture yields adjusted to 28-day periods.*

in Table 3. Yields of pure lucerne are shown as kg DM/ha, while those of overdrilled areas are shown as the percentage above or below that of pure lucerne.

Matua prairie grass was the only species to yield much more than lucerne alone during winter. Ryecorn provided the greatest yield increase in early spring, with Paroa and Tama ryegrasses giving much lower extra production.

TABLE 4: RELATIVE DM YIELDS OF OVERDRILLED TREATMENTS WITHIN YEARS

Season	*Pure Lucerne (kg/ha)*	*Barley*	*Ryecorn*	*Oats*	*Paroa*	*Tama*	*Matua*
			(% ± Lucerne)				
Winter							
1975	200	20	48	20	21	53	12
1976	860	12	10	-10	10	8	93
1977	570	10	13	5	13	5	8
Early spring							
1975	2 920	20	67	17	30	31	10
1976	3 910	1	26	-3	6	5	1
1977	1 690	2	10	2	·2	3	-2

In Table 4 dry matter yields in winter and early spring for individual years are shown in a similar manner to Table 3. The variable nature of the results is obvious. Allowing for the low base of lucerne production in winter, only Matua prairie grass in 1976 gave a substantial real increase in dry matter production. In early spring, most overdrilled species improved on pure lucerne yields in 1975 while' only ryecorn did so in 1976, and in 1977 none were of great benefit.

Overdrilling increased mean annual yields by about 3 to 10% compared with pure lucerne.

DISCUSSION

It is important to recognize that the techniques used in these trials differ between lucerne and pasture both in their objective and in their effect on results. With lucerne the objective was maximum production, and the best known treatments were applied to achieve this. With pasture the objective was to establish seasonal patterns of growth under a standard management. There was no attempt to maximize pasture production. Higher annual pasture yields and a different seasonal distribution of dry matter production have been obtained by longer intervals between cuts and altering both the interval between defoliations and the height of defoliations (e.g., Lynch and Mountier, 1954; Brougham, 1970).

With this proviso, the pastures at sites, 10 to 13 in Table 1 exhibit a range in annual production which suggests that good pastures can be grown on pumice country, and that the best sites have similar yields to those recorded in the Waikato by the same technique (Baars, 1976). Although mean lucerne yields of sites 1 to 9 were 50% higher than those of pastures at sites 10 to 13, there was a large variation between sites, possibly due to soil type. Moreover, the difference will be less where lucerne is utilized in early rather than late spring.

Under optimal management the first lucerne harvest cannot be expected before the end of October (Table 2). Meanwhile, spring growth of pasture is already considerable by September and, on good sites, can equal in total the yield from lucerne (Figs. 1 and 2; Table' 2). Similarly, in late autumn. lucerne and pasture produce much the same total dry matter, although yields of both are low.

Lucerne also remains at the optimum stage of growth for a short period and then deteriorates rapidly in nutritive value (Joyce and Brunswick. 1975). This optimum stage for harvesting lasts for probably less than 7 days on each occasion. Thus lucerne not only provides a discontinuous feed supply (Figs. 1 and 2), but is relatively inflexible as to when it should be harvested. Utilization of a discontinuous supply of dry matter to meet a continuous feed demand involves unavoidable sacrifices of either quantity or quality of lucerne. On the other hand, lucerne has considerable value as a high producing crop for conservation or grazing at certain predictable times of the year.

Ryegrass-dominant pastures not only yield more dry matter under reasonably frequent defoliation (Brougham, 1970). but retain a high digestibility while in the vegetative state (Ulyatt, 1978). With total spring yields on pumice country similar to lucerne. such pastures have considerably more flexibility of use than lucerne at a time when feed supplies are critical.

The introduction of winter-growing grasses and cereals into lucerne stands in order to fill the winter/spring gap in production has been the subject of several trials on pumice country.

A study of lucerne/grass mixtures has been made by Baars and Cranston (1976). They found that 'while a lucerne/prairie grass mixture outyielded lucerne alone by 61% in the first year, the improvement was not repeated in subsequent years when lucerne reached full production. Additional data from this trial indicated that it is difficult to reconcile the management requirements of lucerne and grasses over the early spring period. The experiment showed that where a cutting regime aimed for the maximum yield of lucerne, there was no sustained advantage from the companion grasses in the cool season. The proportion of lucerne decreased with age, and re-establishment would be required on a more regular basis than for pure lucerne. This trial also showed the value of 'Grasslands 4710' tall fescue, which out-competed lucerne after 4 years.

Overdrilling winter-growing annual ryegrasses and cereals into lucerne stands has met with variable success. At Wairakei Research Station, Baars and Douglas (1976) compared Tama, ryecorn, barley and oats as companion species for lucerne with lucerne alone. Barley and oats gave good total production (3100 and 2200 kg/ha, respectively) when cut in early August. Between August and October, additional dry matter from sown species was partly offset by a suppression in lucerne production.

However, the 3-year trial reported in this paper gives evidence of the uncertainty of overdrilling. Vartha (1971) discusses some of the causes of variable results from overdrilling lucerne with Tama in Canterbury. On light soils, giving low annual yields of lucerne (3000 to 5000 kg/ha), he draws attention to the need for adequate moisture at sowing and mild temperatures during early establishment. On heavy soils with much greater lucerne growth (> 14 000 kg/ha) , the main problem was competition from the lucerne. On the pumice soils with dry autumns and cool winters (Baars et *al.,* 1975) and with moderately high lucerne yields, all three problems can exist. It is not certain that other species are affected similarly to Tama, but identification of more tolerant grasses and cereals is important for more consistent success with overdrilling.

CONCLUSION

Lucerne is an expensive crop to establish and maintain. It should be harvested at stages of growth resulting in maximum production and a long life of the stand. Attempts to extend the production season of lucerne. stands by overdrilling other species have met with mixed success and further research is required before definite recommendations can be made.

On low-moisture-retentive soils, such as Atiamuri sand, lucerne outproduced browntop dominant swards, which are common on this soil type under present management practices, by a considerable margin. This difference will be much less where more drought-tolerant species like 'Grasslands 4710' tall fescue are introduced. On the more moisture-retentive soil types the difference in dry matter production between pasture and lucerne is much less. Moreover, that difference may only exist if the lucerne is managed on the rather inflexible basis required for maximum yield.

On these pumice soils it may prove more economic to concentrate on increasing, pasture production by improved grazing management and by the introduction of more drought-tolerant pasture cultivars, than to rely on a high proportion of lucerne.

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