DISCUSSION

A major difficulty in developing legume-grass pastures in tropical areas has been to find legumes which are not only well adapted to the environmental conditions but are compatible with aggressive grass species and are able to withstand heavy grazing.

Legume adaptation to heavy grazing is a function of species compatibility as modified by management and/or morphology of species (e.g. trailing vs. stoloniferous habit of growth). The typical trailing tropical legume with its growing points widely separated along the stem axis is more vulnerable to overgrazing and trampling than those with hidden buds and stoloniferous rooting.

The data presented in this paper corroborate this observation. In both cutting experiments, stoloniferous forms of *C. macrocarpum* (CIAT 5396, 5452) and *Centrosema* sp. nov. (CIAT 5568, 5610 and 5277) were in the high yielding group of accessions and outyielded non-stoloniferous forms of both species. One accession of *Centrosema* sp. nov. resisted grazing and yielded better than non-stoloniferous accessions of *Centrosema*.

Centrosema is a genus of major economic potential. Specialized forms of *Centrosema* spp., as shown by the results, are adapted to climatic and soil fertility extremes, such as the Llanos ecosystem. The potential of the genus, however, is far from being exhausted. It is still relatively easy to domesticate "new" species (forms), and much useful variation can be found in species of established value.

ACKNOWLEDGEMENTS

Thanks are due to Ing. Agr. E. Salazar and Ing. Agr. F. Diaz for technical assistance.

REFERENCES

BARBOSA-FEVEREIRO, V. P. (1977)– *Centrosema* (A. P. de Candolle) Bentham do Brazil. *Leguminosae-Faboideae* Rodriguésia XXIX (42), pp. 159–219.

CLEMENTS, R. J. and WILLIAMS, R. J. (1980)—Genetic diversity in *Centrosema*. *In* "Advances in Legume Science". Eds R. J. Summerfield and A. H. Bunting. Proceedings of the International Legume Conference, Kew, Vol. I, pp. 559–567.

COCHRANE, T. T., SANCHEZ, L. G., AZEVEDO, L. G., PORRAS, J. A. and GARVER, C. L. (1985)—"Land in Tropical America". (CIAT: Cali), Vol. 2, Part 1, pp. 63.

GROF, B. and THOMAS, D. (1986)—Experiences with some pastures legumes in the tropical savannas of South America. II. Species of *Centrosema*, *Desmodium* and *Zornia*. *Herbage Abstracts* (in press).

SCHULTZE-KRAFT, R., ALVAREZ, G., BELALCAZAR, J., DEL R. HENAO, M., NUNEZ, R., ORTIZ, J. (1983)—"Catálogo de Germoplasma de Especies Forrageiras Tropicales". (CIAT: Cali).

(Accepted for publication May 19, 1986)

EFFECT OF EARLY SOWING ON ESTABLISHMENT, GROWTH PATTERN AND RUST INFECTION OF ANNUAL SOWINGS OF RYEGRASS (*LOLIUM* SPP.) IN SUB-COASTAL SOUTHEAST QUEENSLAND

K. F. LOWE[1], T. M. BOWDLER[1] AND J. C. MULDER[2]

[1]Department of Primary Industries, P.O. Box 96, Ipswich, Qld, Australia. 4305.
[2]Department of Primary Industries, Oonoonba Veterinary Laboratory, P.O. Box 1085, Townsville, Qld, Australia. 4810.

ABSTRACT

*The effect of four sowing times, early March, mid March, late March and mid April, on the establishment, growth pattern and rust incidence of annually sown ryegrass cultivars (*Lolium *spp.) was investigated in irrigated experiments at Gatton in southeast Queensland.*

Late March and mid April sowings gave better plant establishment than earlier sowing dates. Ryegrass establishment was negatively correlated with maximum and minimum daily temperature and with relative humidity.

In three of the four years, sowing in early March produced up to 2.2 t ha^{-1} more forage in autumn than sowing in late March and up to 3.8 t ha^{-1} more than sowing in mid April. Annual, broadleaf weeds contributed up to 45% of this early forage. There was a compensating loss of production in winter from early March sowings but all sowing times gave similar spring yields. Late March sowings produced the highest ryegrass, and the lowest weed, yields over the full growing period (March to December). Sowing time had little influence on the incidence of rust and there were no cultivar/sowing date interactions.

INTRODUCTION

Autumn feed shortage remains the most limiting factor to dairy production in southern Queensland and northern New South Wales (Chopping *et al.* 1983). Winter and spring production can adequately be supplied by annually sown ryegrass or clover pastures (O'Grady 1978; Chopping *et al.* 1983; Lowe *et al.* 1984) but these provide little feed prior to June (Kemp 1974; Murphy and Whiteman 1981; Lowe *et al.* 1984).

Sowing earlier in the autumn increases early yields of winter forages, particularly oats (Stillman and Lowe 1979). However, in southeast Queensland, sowing prior to April gives poor establishment of perennial ryegrass (Greasley 1962; Lowe *et al.* 1981). Murphy and Whiteman (1981) demonstrated that February sowing of both annual and perennial ryegrass and oats was unsuccessful and that March sowing was less productive than April sowing.

Several cultivars of ryegrass better adapted to southeast Queensland than those used in earlier studies are now available. This experiment examines the reliability of early and mid March sowing of these and other annual ryegrasses as a means of increasing autumn forage production, and also examines the influence of this early sowing on subsequent production and rust infection.

MATERIALS AND METHODS

The experiment was established at Gatton Research Station (Lawes, southeast Queensland) on a black earth (Ug 5.15, Northcote 1974). Sown areas for each year were not adjacent, but were on similar soils (Powell 1982). Four experiments were sown from 1980 to 1983 as randomised block designs with two treatment factors (sowing dates and cultivars) and four replications. In the first two years, three ryegrass cultivars, *Lolium multiflorum* cvv. Grasslands Tama and Midmar and *Lolium rigidum* cv. Wimmera were sown, while in 1982, *Lolium multiflorum* cv. Tetila, and in 1983, *L. perenne* cv. Ellett, were also included. Plot size was 5 m × 3 m. The pastures were sown from early March to mid April. Sowing times are listed below:-

Treatment	*1980*	*1981*	*1982*	*1983*
Early March	March 4	March 2	March 1	March 1
Mid March	March 13	March 16	March 18	March 15
Late March	March 31	March 30	April 5	March 30
Mid April	April 17	April 15	April 20	April 14

Seed was broadcast onto the surface of fully prepared seedbeds at 20 kg ha^{-1} of pure live seed and covered by raking. Ammonium nitrate to give 50 kg N ha^{-1} was broadcast on to the soil surface. Irrigation was applied (12.5 mm per week) throughout the establishment phase (i.e. from the date of the first sowing until the end of April).

Plant establishment was measured 20 and 40 days after sowing by counting 15 quadrats (20 cm × 20 cm) located at random within plots. The plant populations at 40 days from sowing were not recorded for the late March and mid April sowings in all years because the first defoliation had already taken place. Dry matter yields were measured by cutting, at 5 cm above ground level, one 2.4 m × 0.9 m strip from the centre of each plot with an autoscythe. The ryegrass stands were cut for yield determination at three-weekly intervals after an initial establishment period of 5 to 7 weeks. After each sampling, the remainder of each plot was cut to 5 cm and the material removed, ammonium nitrate (≡ 50 kg N ha^{-1}) was applied to the surface and 50 mm of irrigation given.

Rust ratings were made on foliage using the method previously described (Lowe *et al.* 1984). The degree of rust damage to the leaf surface of a random sample of leaves at each defoliation was rated on a scale from 0 (no visible symptoms) to 4 (greater than 25% of the leaf blade carrying rust pustules).

Climatic indices (Table 1) were recorded at a site approximately 0.4 km from the experimental area. These data were averaged (or totalled) for the 20 days following each sowing.

TABLE 1

Climatic data recorded for 20 days following ryegrass sowings over a 4-year period at Gatton, southeast Queensland

Sowing time	Mean maximum temperature[1]	Mean minimum temperature[1]	Highest temperature recorded[1]	Total rainfall[1]	Mean relative humidity[1]	Number of wet days[2]
	(°C)	(°C)	(°C)	(mm)	(%)	
1980						
Early March	30.8	15.9	34.5	6.6	74.0	4.0
Mid March	33.8	14.8	39.5	0.0	66.8	0.0
Late March	30.2	13.7	36.0	7.2	74.0	4.0
Mid April	26.2	12.8	31.0	2.0	81.1	5.0
1981						
Early March	30.8	16.6	36.5	19.9	66.7	3.0
Mid March	28.7	17.0	36.5	99.2	72.1	8.0
Late March	27.3	19.6	30.5	113.6	73.7	10.0
Mid April	27.0	11.3	30.5	0.6	72.1	1.0
1982						
Early March	28.0	19.4	32.5	127.6	79.2	10.0
Mid March	29.2	17.1	33.0	32.4	75.6	3.0
Late March	25.5	13.1	28.5	5.4	75.2	5.0
Mid April	27.1	10.1	30.0	3.6	71.4	3.0
1983						
Early March	29.9	17.9	33.5	62.4	69.4	7.0
Mid March	29.8	17.7	36.0	94.2	77.5	8.0
Late March	28.1	14.7	30.0	17.6	69.8	4.0
Mid April	23.7	14.9	23.8	176.4	80.4	11.0

1. For the 20-day period.
2. Number of days with a rainfall of over 1 mm.

Analyses of variance were conducted on all establishment and production measurements. With respect to dry matter yields, the following seasonal periods were defined: **autumn** (prior to July), **winter** (July and August) and **spring** (September to December).

Multiple linear regression analysis was used to assess the effect of climatic factors on establishment at 20 days after sowing. A subset of indices which had a significant influence on plant establishment was also linearly regressed with establishment for each of the three cultivars sown in all four experiments. Multiple linear regression equations were established from 64 data values. Replications were used to test these equations for lack of fit.

RESULTS

Establishment

Late March and mid April sowings achieved substantially higher ($P < 0.05$) plant populations than the two earlier sowings (Table 2). Generally, more than 350 plants m^{-2} established at these later sowing times, thus > 30% of the viable seed sown gave established seedlings at 20 days after sowing. Early March sowings achieved an established population of more than 100 plants m^{-2} in all years. Mid March sowings were the most variable, ranging from a population of only 10 plants m^{-2} in 1980 to 250 plants m^{-2} in 1981.

TABLE 2

The effect of sowing time on the number of seedlings established (plants m^{-2}) and the efficiency of establishment[1], measured 20 days after sowing of ryegrass cultivars under irrigation on a black earth at Gatton, southeast Queensland

Treatment	1980		1981		1982		1983	
	Establishment	Efficiency[1]	Establishment	Efficiency	Establishment	Efficiency	Establishment	Efficiency
Sowing time								
Early March	133.0 b[2]	11.8 b	197.9 d	16.8 d	122.7 c	12.8 c	206.6 c	17.2 c
Mid March	9.6 c	0.9 c	250.6 c	21.6 c	170.5 c	15.4 c	73.8 d	5.8 d
Late March	368.2 a	32.6 a	343.8 b	31.7 b	533.7 b	54.0 b	446.1 a	39.6 a
Mid April	343.0 a	30.8 a	411.0 a	35.6 a	635.2 a	64.9 a	343.5 b	30.8 b
Cultivar								
Midmar	179.9 b	16.3 b	348.4 a	25.1 b	477.2 a	34.1 b	321.3 a	22.9 b
Wimmera	231.6 a	19.9 a	319.4 b	23.0 c	419.7 a	30.2 b	304.9 b	21.8 b
Gr. Tama	113.0 c	20.8 a	234.7 c	31.3 a	281.5 b	40.8 a	197.3 d	28.2 a
Tetila					283.9 b	42.1 a		
Ellett							246.6 c	20.6 b

1. Efficiency of establishment is defined as the number of plants established per 100 seeds sown.
2. Figures followed by the same letter within sowing times, within cultivars and within years do not differ significantly (P = 0.05).

The fate of the established ryegrass seedlings in the second 20 days after sowing varied considerably with sowing time. In most years, there was a nett loss of plants from the early March sowing, and up to 60% of the established plants died (data not presented). On the other hand, increased establishment occurred from the mid March sowing. Generally this increase was about 30% but in 1980, almost all the recorded establishment occurred in the second period of 20 days. In the only year when a 40-day count was obtained from a late March sowing, a small increase in the number of established seedlings was recorded.

Sowing time had more effect on establishment than did choice of cultivar. Seed size varied between cultivars. As this influenced the number of established seedlings, efficiency of establishment (the number of plants established per 100 viable seeds sown) was also used to compare cultivar performance. The larger-seeded Grasslands Tama (and Tetila when sown) gave superior efficiency of establishment, but always produced lower stand densities (Table 2). Midmar and Wimmera, with similar seed size, generally gave equivalent establishment and similar levels of efficiency. There was a small significant sowing time/cultivar interaction in each year, suggesting that Wimmera and Midmar established better than Grasslands Tama at the early March sowing time (data not presented).

Weather factors influencing establishment

The three most important climatic factors affecting establishment were relative humidity, and maximum and minimum daily temperature. A multiple linear regression for each cultivar produced negative response slopes for each of these variables (Table 3). Higher maximum and minimum temperatures were correlated with poorer establishment of ryegrass. Maximum temperature had two to three times the effect of minimum temperature on ryegrass establishment, with the greatest effect occurring with Midmar and Grasslands Tama. An increase in relative humidity also tended to suppress establishment, the effect being strongest for Midmar.

All equations had an explained percentage variance above 65%. There were differences between the equations determined for the three cultivars in both intercept and slope. All relationships had a significant lack of fit. This remained after quadratic terms and a crossproduct term for temperature were included in the multiple linear equation. Fitting these extra terms also did little to improve the percent variance that was explained.

TABLE 3

The intercept (I), slopes for Humidity (H), Minimum daily temperature (L), and Maximum daily temperature (M) for the regression of plant establishment (y) against relative humidity (h), daily minimum temperature (l) and daily maximum temperature (m) in the equation: $y = I + Hh + Ll + Mm$, the percentage variance explained ($100R^2$) and the F ratio for lack of fit

Cultivar	Intercept (I)	Slopes H	Slopes L	Slopes M	$100R^2$	Lack of fit
Midmar	4971	−27.0**	−29.3**	−76.6**	72.9	10.6**
Wimmera	3291	−13.1**	−34.4**	−51.3**	66.0	5.3**
Grasslands Tama	3154	−15.0**	−18.4**	−54.3**	71.4	18.8**
Pooled	3805	−18.4**	−27.4**	−60.7**	62.9	10.4**

*P = 0.05; **P = 0.01.

TABLE 4

The effect of sowing time on dry matter yields ($t\ ha^{-1}$), and efficiency of nitrogen use[1] by annual ryegrasses grown under irrigation in southeast Queensland

Sowing time	No. of nitrogen applications: Autumn	No. of nitrogen applications: Total	Seasonal yield: Winter (July–August)	Seasonal yield: Spring (September–December)	Total yield: Ryegrass	Total yield: Ryegrass + weeds	Efficiency of nitrogen use[1]
			($t\ ha^{-1}$)	($t\ ha^{-1}$)	($t\ ha^{-1}$)	($t\ ha^{-1}$)	(kg d.m. $kg\ N^{-1}$)
1980							
Early March	3	11	5.38 c[2]	5.81 a	14.78 a	15.48 a	26.9 b
Mid March	2	10	5.95 b	6.10 a	13.93 b	14.22 b	27.9 b
Late March	2	10	6.47 a	5.77 a	14.87 a	14.88 b	29.7 a
Mid April	1	9	6.31 a	5.84 a	13.46 b	13.46 c	29.9 a
1981							
Early March	2	12	5.54 c	6.54 a	13.40 c	14.09 b	24.4 c
Mid March	2	12	5.65 bc	6.55 a	14.22 b	14.56 ab	25.8 b
Late March	2	12	5.94 b	7.03 a	15.05 a	15.30 a	27.4 a
Mid April	1	11	6.51 a	6.78 a	14.08 bc	14.17 b	28.1 a
1982							
Early March	3	12	5.45 b	9.80 b	18.12 b	19.30 a	32.2 d
Mid March	2	11	5.71 b	10.18 b	18.33 ab	18.84 a	34.3 c
Late March	1	10	6.14 a	11.09 a	19.15 a	19.38 a	38.8 a
Mid April	1	10	6.25 a	11.16 a	18.44 ab	18.56 a	37.1 b
1983							
Early March	3	11	5.62 b	7.91 b	15.99 ab	18.72 a	32.0 c
Mid March	3	11	5.18 c	7.82 b	13.98 c	16.35 c	28.0 d
Late March	2	10	6.07 a	8.62 a	16.56 a	17.26 b	36.9 b
Mid April	1	9	6.19 a	8.74 a	15.59 b	15.91 d	39.0 a

1. Efficiency of nitrogen use is defined as the dry matter produced per kg of nitrogen applied.
2. Figures within years and seasons followed by the same letter do not differ (P = 0.05).

Dry matter production

Autumn yields

In three of the four years, autumn yields were significantly increased from an early March sowing compared to all later sowing times (Fig. 1). However in 1981, production from an early March sowing was lower ($P < 0.05$) than the other sowing times. Mid March sowing generally produced lower autumn yields than late March sowing.

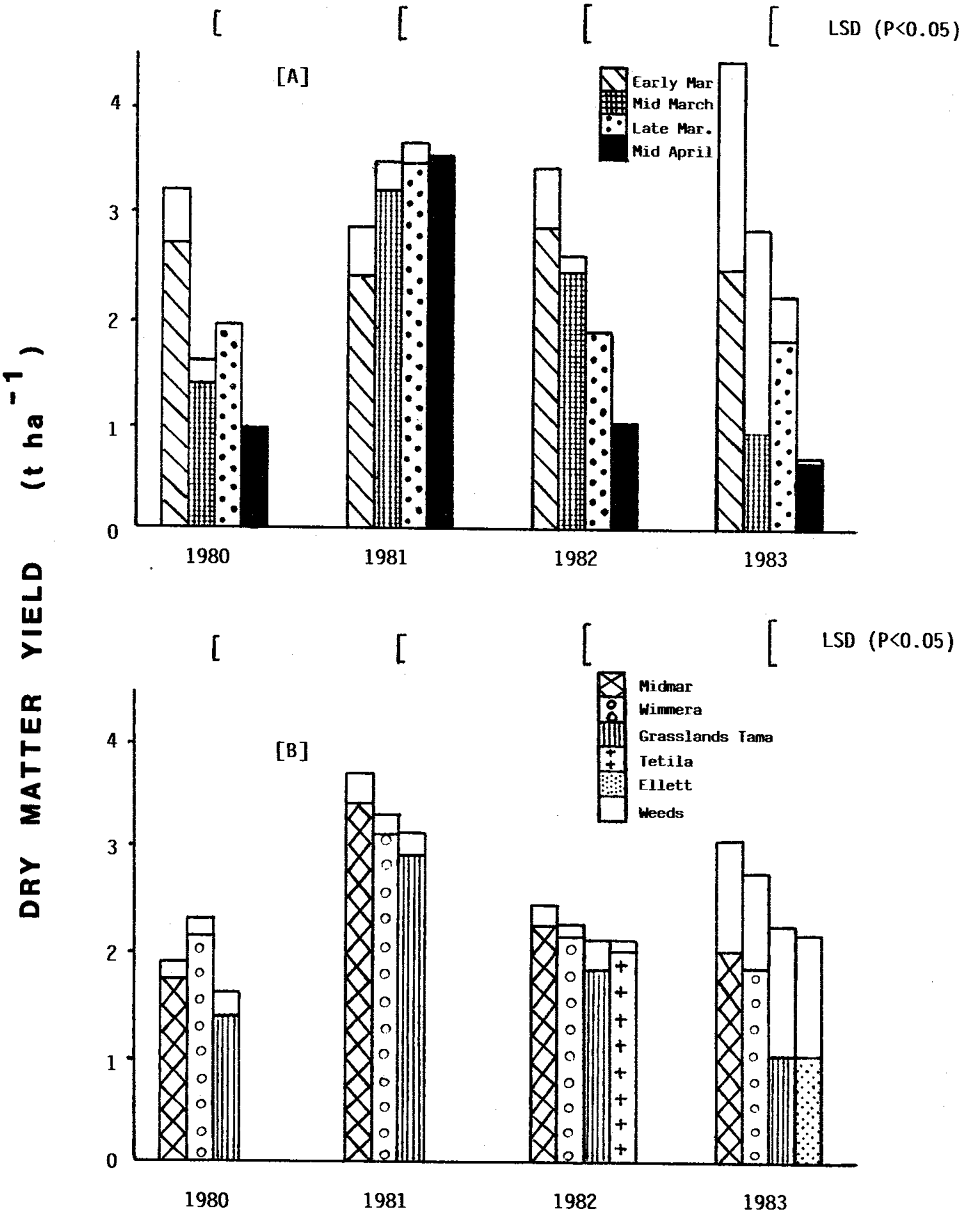

FIGURE 1

Autumn dry matter yields (t ha^{-1}) of ryegrass and weeds in response to [A] sowing date and [B] cultivar at Gatton, southeast Queensland

Wimmera and Midmar produced equivalent autumn yields in all but one year. Grasslands Tama produced lower ($P < 0.05$) yields than Midmar in all years. Tetila produced more than Grasslands Tama, but less than Midmar, and Ellett gave equivalent yields to Grasslands Tama in the years they were sown. Only in 1980 was there a significant interaction between cultivar and sowing time. Wimmera yielded twice as much as the other cultivars from early March sowing; at other times, cultivar responses were similar ($P < 0.05$).

Winter and spring yields

Winter yields from early April and late March sowings were significantly higher than that from the two earliest sowing times in all years (Table 4). Sowing date had less effect on spring yields than on autumn or winter yields, although on two occasions, the two later-sown treatments outyielded the earlier-sown ones. Over the full growing season, late March sowing produced the highest yield ($P < 0.05$) in all years. When weeds were included, early sowing produced higher yields than later sowing times.

Midmar and Wimmera were the highest ($P < 0.05$) yielding cultivars in winter, with Midmar alone giving the highest production in spring (data not presented). Ellett was superior in spring to all the annual cultivars except Midmar. Over the full growing season, Midmar was superior to all cultivars in three of the four years. Wimmera outyielded Midmar in that other year (data not presented).

Efficiency of nitrogen use

The number of defoliations in autumn differed between sowing dates (Table 4). As maintenance fertilizer was applied only after sampling, later-sown treatments received less nitrogen in autumn than early-sown ones. To investigate the effects of these different nitrogen applications, results are also expressed in terms of efficiency of nitrogen use. This is defined as the yield of grass per kg of nitrogen applied. Later sowings used nitrogen more efficiently ($P < 0.05$) than early sowings (Table 4). An early March sowing needed more nitrogen to achieve yields equivalent to the later sowing times. Nitrogen utilization was better in 1982 and 1983 than in the first two years.

Rust incidence

The level of rust damage was affected ($P < 0.05$) by sowing time on only three occasions, two being associated with early spring infections (Table 5). Generally these differences were small compared with the cultivar differences. Wimmera and Grasslands Tama always showed more rust damage than Midmar (data not presented).

TABLE 5

Rating[1] of rust damage on ryegrass leaves as influenced by sowing time

Treatment	1980		1981		1982		1983	
	Sept	Nov	Sept	Nov	June	Dec	Oct	Nov
Early March	2.1 b[2]	2.9 a	1.9 b	3.8 b	0.2 a	1.7 a	1.0 a	2.1 a
Mid March	2.4 b	2.6 a	1.5 a	3.9 b	0.1 b	1.5 a	1.0 a	2.0 a
Late March	2.7 b	2.8 a	1.5 a	3.4 a	0.0 a	1.7 a	0.8 a	1.9 a
Early April	1.3 a	2.8 a	1.3 a	3.2 a	0.0 a	1.6 a	1.0 a	2.0 a

1. Ratings range from 0 (no damage) to 4 (more than 25% of the leaf blade covered in rust pustules).
2. Figures within the same month followed by the same letter do not differ ($P = 0.05$).

DISCUSSION

Sowing annual ryegrasses in the first week of March increased the amount of forage produced in autumn in three out of four years, despite much lower plant populations compared with other sowing times. This advantage was negated in one year because autumn temperatures were well above normal, allowing the later-sown swards to grow more rapidly. Early sowings were generally lower yielding in winter and spring because the lower plant populations did not allow swards to achieve maximum growth rates.

Despite large differences in the number of established seedlings achieved by the different sowing dates, total yield over the full growing season showed only small differences. This poor relationship between plant establishment and yield has been reported previously with perennial ryegrasses (Lowe *et al.* 1981). More tillering compensated for the lower plant populations, while weeds, even in these thinner swards, provided little competition, except at the beginning and end of the growing period. Overall, late March sowing appeared to be the best, giving the highest ryegrass yields, the least establishment problems, and a more even, weed-free pasture in all four years. There appeared to be no advantage from sowing in mid March because autumn production was lower than from early March sowings and this was not fully compensated for by improved winter and spring production. Delaying sowing until the cooler mid April period gave no advantage in total yield over a late March or early April sowing and autumn yields were generally very low.

In the sub-tropical environment of this experiment, three climatic factors, maximum daily temperature, minimum daily temperature and relative humidity, were related to the establishment of irrigated ryegrass. The lack of fit for the multiple regression equations may indicate that other climatic measurements (which were not measured at the site, e.g. radiation or evaporation), or soil factors, could have improved the fit. However, our results clearly show that high temperatures after sowing suppress seedling establishment. Under extreme temperature situations such as occurred in March 1980, germination was totally suppressed during a week-long heat wave despite ideal soil moisture conditions. Wilson and Ford (1971) have shown delayed germination in controlled environment conditions at similar daily temperature ranges. McWilliam *et al.* (1970) did not find that high temperatures suppressed ryegrass germination, but their maximum temperature was only 29 °C, somewhat lower than the temperatures experienced in our early March sowing. It appears likely that, in sub-tropical and tropical environments, temperature plays a greater role in germination and establishment than it does in temperate situations, due to the greater chance of supra-optimal temperatures occurring.

McWilliam and Dowling (1970) found that water relations in the microenvironment of the soil surface were critically important in temperate pasture germination and subsequent establishment. Because of this, the significant, negative coefficient determined by our linear regression model for atmospheric relative humidity is difficult to explain as the aim of irrigation is to maintain optimum moisture relations in the soil/air/seed microenvironment.

Wimmera and Midmar were more suitable cultivars to use for early sowing than were Grasslands Tama, Tetila or Ellett, producing better plant establishment and higher early yields. On the other hand the bigger-seeded cultivars (Grasslands Tama and Tetila) were more efficient, achieving a greater number of plants for each 100 seeds sown. Our results do not show whether the lower efficiency of the smaller-seeded cultivars was due to poor germination and/or establishment, or to increased inter- and intra-species competition, resulting in a greater number of early deaths.

CONCLUSIONS

We recommend that farmers should aim to sow the majority of their annual ryegrass areas in the last week of March or the first week of April to maximise overall production. However, a proportion of the planned area of ryegrass could be planted in the first week of March to take advantage of the extra forage produced in autumn. There will be some unreliability in these early sowings, and a small loss of production can be expected later in the growing season. However, the increased autumn production of up to 2.2 t ha^{-1}, compared with that from the optimum sowing time of late March will provide one heavy or two light early grazings and should compensate for any loss of production later in the season. Early-sown ryegrass has only a slight chance of being more affected by rust than later-sown swards, even with the more susceptible cultivars such as Wimmera and Grasslands Tama (Lowe *et al.* 1984).

ACKNOWLEDGEMENTS

The authors acknowledge the assistance of the staff of Gatton Research Station for day to day management of the experiments.

REFERENCES

Chopping, G. D., Lowe, K. F. and Clarke, L. (1983)—Irrigated pasture systems. *In* "Dairy Management in the 80's, Focus on Feeding, 1. Seminar Sessions and Farm Feeding Workshops." (Queensland Department of Primary Industries: Brisbane.)

Greasley, A. S. (1962)—Effect of time of sowing on irrigated pastures in south-east Queensland. *Queensland Journal of Agricultural Science* **19:** 177–188.

Kemp, D. (1974)—Comparison of oats and annual ryegrass as winter forage crops. *Tropical Grasslands* **8:** 155–162.

Lowe, K. F., Bowdler, T. M. and Mulder, J. C. (1981)—Effect of sowing time on the establishment and early production of tropical and temperate pasture mixtures under irrigation in south-eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **21:** 410–416.

Lowe, K. F., Bowdler, T. M., Ostrowski, H. and Stillman, S. L. (1984)—Comparison of the yield, nitrogen and phosphorus content, and rust infection (*Puccinia coronata*) of irrigated ryegrass swards in south-eastern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **23:** 294–301.

McWilliam, J. R., Clements, R. J. and Dowling, P. M. (1970)—Some factors influencing the germination and early seedling development of pasture plants. *Australian Journal of Agricultural Research* **21:** 19–32.

McWilliam, J. R. and Dowling, P. M. (1970)—Factors influencing the germination and establishment of pasture seed on the soil surface. Proceedings of the XI International Grasslands Congress, Surfers Paradise, Australia, pp. 578–583.

Murphy, Helen and Whiteman, P. C. (1981)—Yield responses of oats and ryegrass varieties to sowing dates in south-east coastal Queensland *Tropical Grasslands* **15:** 145–149.

Northcote, K. H. (1974)—"A Factual Key for the Recognition of Australian Soils". Third Edition. (Rellim Technical Publications: Glenside, S. Aust.)

O'Grady, R. H. (1978)—High 'N Rye. *In* "Management of South-East Queensland Coastal Pastures". (Queensland Department of Primary Industries: Brisbane), pp. 74–85.

Powell, B. (1982)—Soils of the Gatton Research Station. Queensland Department of Primary Industries Bulletin QG 82005.

Stillman, S. L. and Lowe, K. F. (1979)—Winter forage crops for dairy cattle. *Queensland Agricultural Journal* **105:** 121–136.

Wilson, J. R. and Ford, C. W. (1971)—Temperature influence on the growth, digestibility and carbohydrate composition of two tropical grasses, *Panicum maximum* var. *trichoglume* and *Setaria sphacelata*, and two cultivars of the temperate grass *Lolium perenne*. *Australian Journal of Agricultural Research* **22:** 563–571.

(Accepted for publication June 25, 1986)

SELECTION OF PLANT SPECIES BY CATTLE GRAZING NATIVE MONSOON TALLGRASS PASTURE AT KATHERINE, N.T.

M. H. Andrew

CSIRO Division of Tropical Crops and Pastures, PMB 44, Winnellie, N.T. 5789, Australia.

ABSTRACT

The defoliation of pasture species by cattle was monitored for two wet-dry seasonal cycles in recently burnt native monsoon perennial tallgrass pastures. Three uncleared 50 ha paddocks were used. Alternate halves of each paddock were burnt each dry season. Relative defoliation ratings were combined with relative abundance (frequency of occurrence) values to derive, for each pasture species, a selectivity index, whose values could range from −*1 to* +*1, with zero indicating non-selective grazing.*

The mean index values for the four dominant perennial grass species Themeda triandra *(formerly* T. australis*),* Sehima nervosum, Sorghum plumosum *and* Chrysopogon fallax*) were significantly different (respectively 0.49, 0.14, 0.04 and* —*0.44) and indicated selectivity for* Themeda *and avoidance of* Chrysopogon. *The cattle were least selective at the start of the rainy season when the post-burn growth was short, and were most selective at the end of the rainy season when herbage was stemmy and mature.*

*Four other pasture components (*Eriachne obtusa, *annual grasses, leguminous forbs and other forbs) were generally rejected by the cattle.*

The approach described forms the basis of a rapid field survey technique for assessing diet selection.