PASTURE DEVELOPMENT IN THE SPEAR GRASS REGION AT WESTWOOD IN THE FITZROY BASIN

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ABSTRACT

Pasture development in the spear grass region at Westwood, in the Fitzroy Basin, Central Queensland, is described in relation to a program of species testing, plant nutrition and fertilizer studies on two soil types. Green Panic (Panicum maximum) *and buffel grass cultivars* (Cenchrus ciliaris) *of the grasses, and Siratro* (Phaseolus atropurpureus) *and Townsville Stylo* (Stylosanthes humilis) *of the legumes were the most promising species. Potassium may be the key to the growth and persistence of Siratro in association with these grasses on the relatively infertile prairie-like soil. Animal production on unimproved native pasture over an 11 month period of less than 8 lb per acre in comparison with 100 lb per acre obtained from a Green Panic/Siratro mixture indicates the potential of pasture development using improved species in this region.*

INTRODUCTION

Under the stimulus and direction of the late Dr. J. Griffiths Davies regional field studies were undertaken by the several agrostology groups in the Division of Tropical Pastures and his general philosophy in this type of approach has been described by Davies and Shaw (1964). Briefly the objective was the development of suitable pastures for a particular region and the initial research work involved in each case was a combination of species testing, plant nutrition and fertilizer studies.

The spear grass region of Queensland (described by Shaw & Bisset, 1955, and 't Mannetje 1965), has been shown to be one of great potential and regional studies have been carried out by the Division at Rodd's Bay in central coastal Queensland (Shaw, 1961) and the Eskdale district of S.E. Queensland ('t Mannetje, 1967). In 1963, this work was extended into the spear grass country of the Fitzroy Basin which is one of the major beef producing areas of Queensland. This paper describes the initial work at a site in this area, namely on "Evergreen", a private property situated 5 miles south west of Westwood at approximately 23° 39' S latitude and 150° 7' E longitude.

THE EXPERIMENTAL AREA

The climate of the Dawson-Fitzroy area of Queensland has been described in detail by Fitzpatrick (1968) and the Bureau of Meteorology (1960). Areas west of the coastal range, such as Westwood, are characterized by higher summer temperatures, lower rainfall, and a greater incidence of frost than coastal areas, e.g. Rodd's Bay. Temperature records for Rodd's Bay are not available but climatic data for Gladstone (18 miles north of Rodd's Bay) are presented in Table 1 for comparison with Westwood. The hotter summer conditions at Westwood are further illustrated by the fact that Westwood can expect 69 days per year with a maximum greater than 90°F whereas the expectation at Gladstone is only 8.9 days. The rainfall at Rodd's Bay is less than that at Gladstone (33.20 inches per annum) and though the temperature regime would be very similar, two or three light frosts per year can be expected.

Another important feature of the climate at Westwood is that rainfall is erratic; referring to the Dawson-Fitzroy area as a whole, Fitzpatrick (1968) states that variability of both summer and winter rainfall is higher than for areas of comparable

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TABLE 1

A comparison of climate at Westwood and Gladstone (data from Bureau of Meteorology, Melbourne)

	Temperature °F				Annual incidence of light frosts (32°–36°F)	Annual rainfall in inches
	January		July			
	Max.	Min.	Max.	Min.		
WESTWOOD	90.5	68.3	71.8	43.9	10.5 days	27.82
GLADSTONE	85.7	72.1	71.8	52.3	0.0 days	39.91

rainfall in northern and southern parts of the continent. Rainfall received at "Evergreen" over the experimental period is shown in Table 2. These figures illustrate the variability of both summer and winter rainfall and show the results to be described have been obtained in a series of difficult years.

TABLE 2

Rainfall at "Evergreen" over the last seven seasons

Year	Rainfall in inches		
	October–April	May–September	Total
1962/3	16.61	2.89	19.50
1963/4	7.25	11.01	18.26
1964/5	20.36	0.77	21.13
1965/6	14.07	8.50	22.57
1966/7	16.49	6.35	22.84
1967/8	23.59	5.71	29.30
1968/9	6.80	0.25	7.05
45 year mean	19.82	7.31	27.13
Standard Deviation	6.54	5.36	9.74
Coefficient of Variation	33	73	36

Soils

The country at "Evergreen" is undulating with large areas of ridge country carrying mainly bloodwood (*Eucalyptus dichromophloia*) and ironbark (*E. melanophloia*) but with isolated areas of poplar box (*E. populnea*). There are also important areas of flats carrying poplar box and blue gum (*E. tereticornis*). Experiments have been carried out on areas representing both these types of country.

The major soil of the ridges* is a red-brown prairie-like soil with a clay fraction of 27-41 per cent in the surface horizon. The proportion of clay is higher in the B horizon and the pH increases from 6.8 at the surface to a maximum of 8.9 below 24", where there is some occurrence of free calcium carbonate. Sample chemical data for this soil are:— available P 3-13 p.p.m.; total P 0.023—0.041%; total N 0.058—0.118%; total K 1.5 m-equiv.%; exchangeable cations Ca 12.8, Mg 7.4, K 0.16, and Na 0.0 m-equiv.%. The main soil of the flats is a fertile, dark, alkaline (pH 6.5—7.5) soil of alluvial origin with high levels of available phosphorus (up to 570 p.p.m.).

* Soil descriptions by courtesy of G. D. Hubble, and analyses by courtesy of R. Reeve and I. Little of Division of Soils, C.S.I.R.O., Brisbane.

FERTILIZER STUDIES

To obtain preliminary information on the nutrient status of both the prairie-like and alluvial soils, glasshouse pot studies were commenced in 1963. *Phaseolus lathyroides* was used as the test species in most cases and the procedure adopted followed that outlined by Andrew and Fergus (1964). The experiments tested for P, K, S, Mo, Ca, Zn, Mn, and Mg. Subsequently, a field experiment was carried out on the prairie-like soil based on the results of the pot studies. Full details of these experiments will not be presented here; it will suffice to outline the main nutrient responses and to indicate how these may influence fertilizer practices.

Pot experiments

The alluvial soil showed significant responses to only sulphur and molybdenum; subsequent growth of legumes in the field on this soil has reaffirmed that phosphorus and potassium fertilization is unwarranted. As might be expected from the chemical data presented for the prairie-like soil, there was a significant response to phosphorus. Yields increased linearly with rate of phosphorus up to the equivalent of 15 cwt/acre of superphosphate, although at this level the response was only in the order of 25%. Addition of sulphur produced the highest level of response both in yields of dry matter and nitrogen, plants without sulphur being generally small with yellowish leaves. The main effects of both calcium and molybdenum were significant, but the response to calcium occurred principally in the absence of molybdenum. The best treatment, receiving S, P, and Mo yielded approximately double the dry matter of the nil treatment, at a nitrogen content of 4.69% as opposed to 2.59%.

Field experiment

The field experiment was started on the prairie-like soil in 1964, using a Green Panic plus Siratro mixture sown on well-cultivated land. Fertilizers were applied annually and comprised the following treatments in factorial combination with four replicates:— P as calcium phosphate equivalent to 6 cwt/acre superphosphate, S at 30 lb/acre (as calcium sulphate), K as potassium chloride at 1 cwt/acre, and molybdenum as sodium molybdate at ½ lb/acre. Potassium was included despite the absence of response in the pot experiment because of the low reserve levels indicated by soil analysis. The experiment extended over four seasons and there were periodic samplings for yield and chemical composition.

Direct responses of Green Panic to the added nutrients were small and no trend in yield or nitrogen percentage reflecting the vigour of the legume was obvious. The response of Siratro was of greater interest and differed from that obtained in pots. No response to molybdenum or sulphur was obtained, and increased yields of Siratro with applied phosphorus occurred only in the presence of potassium after the first

TABLE 3

Relative yield responses and changes in chemical composition of siratro to applied phosphorus and potassium fertilizers at two sampling dates

		Fertilizer treatment Nil	P	K	PK
SIRATRO Feb. 1966	Relative Yield	100	85	166	205
	Potassium %	0.86	0.82	1.48	1.54
	Phosphorus %	0.15	0.24	0.15	0.21
SIRATRO June 1967	Relative Yield	100	67	234	410
	Potassium %	0.39	0.41	0.75	0.56
	Phosphorus %	0.12	0.20	0.13	0.14

season. Highest yields of legume were obtained where both nutrients were applied. The relative responses of Siratro to these nutrients at two sampling dates are illustrated in Table 3, together with data for chemical composition.

These figures illustrate the magnitude of response of Siratro to potassium and the interaction with phosphorus. Harvests were usually taken from this trial during periods of maximum growth following good rain; the data shown for February 1966 were obtained in this manner. However, the June 1967 sampling was taken after a three month period with no worthwhile rain. Relative responses of siratro to potassium and potassium and phosphorus together are greater as is the reduction in yield with phosphorus alone. These effects were associated with lower levels of phosphorus and particularly potassium in the dry matter, suggesting that uptake of nutrients may be restricted in dry periods. This aspect is being explored in further work.

SPECIES ASSESSMENT

Ridge country

Initial species testing started in the summer of 1963 when the grasses and legumes listed in Table 4 were sown on well-cultivated land in plots measuring 20 x 30 links with two replicates. Grasses were sown at 8 lb/acre (except for *Digitaria decumbens* (Pangola grass) which was established vegetatively) and were fertilized with 50 to 100 lb nitrogen as urea depending upon the season. Legumes were sown at 4 lb/acre (inoculated seed) except *Lotononis bainesii* (at 2 lb/acre) and *Leucaena leucocephala* and *Dolichos* sp. C.P.I. 24973 (at 8 lb/acre) together with Green Panic (*Panicum maximum* var. *trichoglume*) at 8 lb/acre. The basal fertilizer application was 4 cwt/acre superphosphate (with molybdenum in the case of the legumes) plus 2 cwt/acre potassium chloride, and half these amounts were added in subsequent years. The plots received intermittent grazing at first but in later years access by stock was less restricted and there were longer periods of heavy grazing. The risk of accidental grass fires affecting the experimental area was accepted as part of the environment and except during the early establishment period, steps were not taken to preclude them. In fact the plots were burnt in this way on two occasions.

Assessment of performance in this trial was primarily based on visual observations on persistence and productivity; within a few seasons it became apparent that the number of successful species was limited. A number of grasses failed to establish in the first year; these were resown in the following season in new areas, but with similar results. A list of species and cultivars used in this trial classified according to their performance is shown in Table 4.

Of the grasses, introductions of *Panicum maximum* (and in particular Green Panic), *P. coloratum* and *Cenchrus ciliaris* (buffel grass) have shown most promise. *Phaseolus atropurpureus* (Siratro) and *Stylosanthes humilis* (Townsville stylo) were the outstanding legumes, but a few others showed some potential, particularly *P. bracteatus, Lotononis bainesii* and *Leucaena leucocephala. Medicago sativa* (Hunter River lucerne) persisted for 3 years; nodulation appeared satisfactory, but its productivity was not high. *P. atropurpureus* C.P.I. 18556 provided an interesting comparison with Siratro. Its ability to recover after periods of drought or frost was relatively poor, and plants tended to die off completely above ground, limiting regrowth to that from the plant crown. The better survival of aerial parts in Siratro may have contributed to its superior ability to recover after periods of extreme stress.

Flats

A species trial was sown in 1964 on the alluvial soil, and its content and conduct were essentially comparable to that on the ridge country except that fertilization with superphosphate and potash was abandoned after the first year when knowledge of the fertility status became available. Species performance was similar in many respects, except that *Glycine wightii* cv. *Tinaroo* and Hunter River lucerne compared favourably with Siratro, and Pioneer, Samford and Callide rhodes grasses (*Chloris gayana*) were as productive as the panicum and buffel cultivars, but were less acceptable to stock.

TABLE 4

Evaluation of grass and legume species on the prairie-like soil at Westwood

Evaluation	Legume Species	Cultivar or C.P.I. No.	Grass Species	Cultivar or C.P.I. No.
Unsuited to area. Failed to establish or develop into a productive stand in or beyond first season	*Centrosema pubescens*	Centro	*Hyparrhenia* sp.	17782
	Dolichos axillaris	17814		17267
	Vigna schimperii	28706	*H. hirta*	14372
	V. gracilis	25378	*Digitaria* sp.	16267
				7915
			D. smutsii	19902
			Chloris gayana	Mbarara
			Paspalum notatum	9073
				11863
			P. dilatatum	"Comm."
				11824
			P. conspersum	17651
			P. commersonii	2696
			P. plicatulum	2741
				11826
				27681
			P. malacophyllum	11861
			P. gueanorum	20324
			Setaria anceps	Nandi
			Panicum antidotale	21008
Established well in first year but did not persist through second year	*Dolichos* sp.	24973	*Eragrostis curvula*	Ermelo
	Teramnus uncinatus	25937		16666
	Desmodium intortum	Greenleaf	*Melinis minutiflora*	"Comm."
	D. uncinatum	Silverleaf	*Chloris gayana*	Pioneer
	Vigna luteola	21347		Samford
	V. reticulata	17856		Callide
	V. oblongifolia	CQ502		
		28764		
	V. vexillata	15452		
Persisted with medium to good production over 2–3 years	*Medicago sativa*	Hunter River Lucerne	*Sorghum almum*	Crooble
				Nunbank
			Panicum maximum	Guinea
				Coloniao
				16724
Persisted throughout but production low or erratic	*Lotononis bainesii*	Miles	*Digitaria decumbens*	Pangola
	Leucaena leucocephala	Peru		
	Glycine wightii	Tinaroo		
		Cooper		
		17673		
	Phaseolus atropurpureus	18556		
Persisted throughout and showed limited potential	*Phaseolus bracteatus*	27404	*Panicum coloratum*	Burnett
	P. lathyroides	Murray		Makarikari
	Stylosanthes guyanensis	Oxley	*P. maximum*	15511
		Schofield		Sabi
				Gatton Panic
Most suitable for further trial. Well adapted to area	*Stylosanthes humilis*	Townsville Stylo	*Panicum maximum*	Petrie Panic (Green Panic)
	Phaseolus atropurpureus	Siratro	*Cenchrus ciliaris*	all cultivars

SPECIES MIXTURES

The successful pasture species in the initial studies distinguished themselves by their superior tolerance of prolonged drought and ability to respond quickly to light falls of rain, as well as being productive in good seasons. Cultivars of *P. maximum*, *P. coloratum* and *Cenchrus ciliaris* were selected for further study on the prairie-like soil in association with Siratro.

Two trials were laid out as randomized blocks with four replicates of each pasture mixture; plot size was 40 x 30 links. One trial consisted of six introductions of panicum, namely Guinea Grass, Coloniao, Sabi Panic, Gatton Panic (all *P. maximum*) Burnett Makarikari (*P. coloratum* var. *makarikariense*), and *P. coloratum* var. *Kabulabula* C.P.I. 16796. The second included six cultivars of *Cenchrus ciliaris*, namely Tarewinnabar, Molopo, Nunbank, Biloela, American and Gayndah buffel grasses.

The grasses were sown in January 1965 at 3 lb/acre together with Siratro at 4 lb/acre. A basal fertilizer dressing of 4 cwt/acre molybdenized superphosphate and 2 cwt/acre potassium chloride was applied before sowing and half these amounts applied annually as maintenance dressings. Both trials were grazed intermittently for the first season, but have been more heavily grazed since.

Guinea grass, Coloniao and Sabi Panic failed to establish well and only occasional plants persisted. The remaining panicum and all the buffel cultivars did establish well, *P. coloratum* C.P.I. 16796 being outstanding. Of the panicum group Green Panic and *P. coloratum* C.P.I. 16796 were the most vigorous; Burnett Makarikari yields were generally low and at best were only 60% of Green Panic. However Burnett Makarikari did exhibit drought and frost tolerance. Possibly by virtue of their short growth habit, the American and Gayndah buffels could not compare in productivity with the four taller types, e.g. Tarewinnabar, the best, gave approximately twice the yield of American.

Siratro has persisted and produced well in association with the panicum and buffel cultivars with one exception. The Molopo buffel/Siratro combination was disappointing; despite excellent establishment of both species, Siratro had virtually disappeared by the end of the third season. In November 1966, it was noted that Siratro showed foliar symptoms of potassium deficiency in these plots, but not with other cultivars or the panicums. Chemical analyses of samples taken at this time confirmed that the potassium content (0.65%K) was lower than with other cultivars (e.g. with Tarewinnabar buffel it was 0.91%K, and Green Panic 0.97%K) and indeed it was comparable to the value for Siratro grown with Green Panic in the absence of potassium fertilizers (0.63%K). These results suggest that the Molopo cultivar may be more competitive for potassium than other cultivars or the panicum species and this possibility is being investigated.

Summing up the species work, Green Panic, *P. coloratum* C.P.I. 16796 and the Nunbank, Biloela and Tarewinnabar buffel grasses seem the most suitable for use on the ridge country in combination with Siratro. Townsville stylo has been oversown successfully in the coastal areas into native pasture and could have similar potential in this area. Additional species considered of value on the alluvial soil would be *Glycine wightii* cv. *Tinaroo* and lucerne.

ANIMAL PERFORMANCE

Experiments to study the more successful pasture species were begun in 1967, but as yet animal production data have been limited to the alluvial soil, and it is too early to assess these fully. It has been possible to collect data on native pasture, however, using a group of animals running with the commercial herd on unimproved ridge country. Liveweight gains of these animals are shown in Table 5 for the period September 21st 1967 to August 21st 1968, together with production data of animals grazing a Green Panic/Siratro pasture over the same period. Bearing in mind that the two sets of data were obtained from different soils, and hence are not strictly comparable, they do however serve to illustrate the limitations of native pasture and the value of improved species with a longer growing season and higher feed value. The production from native pasture was very low by comparison, animals either losing or

TABLE 5

Animal production data from a green panic-siratro mixture compared with that from native pasture for the period September 21st 1967 to August 21st 1968

	Liveweight gain in lb/head				
	Sept. 21st–Dec. 19th	Dec. 20th–Mar. 25th	Mar. 26th–Aug. 21	Total	L.W. gain lb/acre
GREEN PANIC/ SIRATRO 1 beast: 3 acres	+43	+167	+91	301	100
NATIVE PASTURE 1 beast: 12 acres	—22	+169	—55	92	<8

failing to gain weight except during the summer months; during this period however, liveweight gains per head were identical with those obtained from Green Panic/ Siratro. Though it was impossible to give an accurate rate of stocking for the native pasture it was known not to be greater than 1 beast to 12 acres, and output per acre was calculated on this basis. A figure of less than 8 lb/acre from native pasture does not compare favourably with 100 lb/acre from the Green Panic/Siratro.

CONCLUSIONS

A number of grasses and legumes have shown themselves well adapted to this area and it is hoped to test these more fully with the grazing animal. The species evaluation programme was carried out during a period of low rainfall, which included two of the driest summers on record; this has served to add confidence to the assessment.

More animal production data is needed from these species but it would appear likely that similar levels of animal performance to those obtained in the coastal areas may be possible (Shaw, 1961). Potassium may be the key to persistence and productivity of Siratro with sown grasses on the ridge country. However, more work is needed to examine this aspect particularly as evidence available at present has been obtained largely from trials not involving the grazing animal.

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